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# Analyzing spillover effects between sovereign, financial and real sectors during the euro zone crisis

Syed Muhammad Noaman Shah

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DE LA SOCIÉTÉ**

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**Syed Muhammad Noaman Ahmed SHAH**

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**Analyzing spillover effects between  
sovereign, financial and real sectors during  
the euro zone crisis**

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*To my Mother*



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## List of acronyms

3SLS	Three-Stage Least-Squares estimation method
AIC	Akaike Information Criteria
ASF	Available Stable Funding
BIC	Business Identifier Code
BIS	Bank for International Settlements
CA	Current Account balances as a share of gdp
CDS	Credit Default Swaps
Clsp	Corporate loan spread
CNTS	Cross-National Time Series data archive
CPI	Consumer Price Index
EBITDA	Earnings before Interest, Taxes, Depreciation and Amortization
ECB	European Central Bank
EFSF	European Financial Stability Facility
EMU	European Monetary Union
ESM	European Stability Mechanism
EU	European Union
EZ	Euro Zone
FC	Fiscal Consolidation measures
FED	Federal Reserve (US Central bank)
FIML	Full Information Maximum Likelihood
GDP	Gross Domestic Product
GEV	Generalized Extreme Value distribution
GFC	Global Financial Crisis
GIPSI	Greece, Ireland, Portugal, Spain & Italy
GMM	Generalized Method of Moments
HQIC	Hannan-Quinn Information Criteria
IBRC	Irish Bank Resolution Corporation
ICRG	International Country Risk Guide

IFS	International Financial Statistics
IMF	International Monetary Fund
IR	Impulse-Responses
IV/2SLS	Instrumental Variable/Two-Stage Least-Squares estimation method
LBO	Leverage Buy-Out
Lci	Liquidity creation index (Berger and Bouwman, 2009)
LCR	Liquidity Coverage Ratio
MMSC	Moment and Model Selection Criteria (Andrews and Lu, 2001)
NPL	Non-Performing Loan
NSFR	Net Stable Funding Ratio
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares estimation method
OTC	Over-the-Counter
PF	Project Finance
PPI	Producer Price Index
PVAR	Panel Vector Autoregression model
Q	Quarters
QEDS	Quarterly External Debt Statistics (World Bank)
RSF	Required Stable Funding
SDC	Securities Data Company database (SDC Platinum)
SEM	Simultaneous Equations Model
SGP	Stability and Growth Pact (EU)
SIC	Standard Industrial Classification codes
SME	Small & Medium Enterprises
SPV	Special Purpose Vehicle
Ssp	Sovereign bond Spread
TFEU	Treaty on the Functioning of the European Union
VAR	Vector Autoregression model
VD	Variance Decomposition

VIF	Variance Inflation Factor
VIX	Volatility Index (S&P 500)
WDI	World Development Indicators



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## Introduction Générale (*en Français*)

### Contexte

La récente crise de la dette souveraine<sup>1</sup> de la zone euro provient d'une combinaison de deux facteurs principaux: les effets<sup>2</sup> de la crise financière mondiale (ci-après CFM) et les asymétries structurelles inhérentes au Système Monétaire Européen (ci-après SME) depuis sa création. Par le passé, le phénomène de crise de la dette publique était associé aux économies en voie de développement. Ceci est dû au fait que les pays émergents ne disposent pas de marchés de capitaux développés et ne peuvent par conséquent pas emprunter dans leur propre devise. Cependant, avec le début de la crise de l'euro, le phénomène de déséquilibre budgétaire et de croissance économique durable s'est déplacé vers les pays plus avancés (notamment les États Membres de la zone euro). Il existe à ce sujet de nombreuses publications portant sur les marchés émergents concernant les retombées négatives de la crise de la dette souveraine sur le secteur financier et sur l'économie réelle des pays concernés<sup>3</sup>. À l'inverse, concernant la zone euro, peu de travaux ont été publiés et ces recherches méritent d'être complétées. La présente thèse vise à étudier les retombées de la récente crise de l'euro non seulement sur l'économie réelle, mais également sur les secteurs financier et public respectivement, dans la zone euro<sup>4</sup>.

Suite à la grande récession due à la crise américaine des subprimes, les investisseurs ont commencé à regarder de plus près le risque de défaut des États Souverains des économies les plus avancées, particulièrement dans les pays de la zone euro (Mody, 2009). Dans les différents pays, les marchés financiers se sont livrés à la réévaluation et au réexamen des titres de la dette publique en fonction de la compétitivité du pays concerné, ce qui a conduit à des différences dans les écarts de taux entre les obligations souveraines dans les pays SME. Cette fragmentation des marchés et cette augmentation de la prime de risque souverain a conduit les économistes à réétudier cette question. Par conséquent, les travaux actuels se concentrent sur l'étude des facteurs déterminants de cette augmentation des écarts de taux sur les marchés de

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<sup>1</sup> Dans la présente thèse, les expressions: crise souveraine, crise de la dette publique, crise de l'euro, crise de la dette européenne et crise récente de la dette sont utilisées de manière interchangeable.

<sup>2</sup> Selon Blundell-Wignall et al. (2008) plus d'un tiers de tous les titres américains adossés à des créances hypothécaires étaient détenus par des institutions financières européennes.

<sup>3</sup> Voir: Panizza et al. (2009), Nelson (2012) et Presbitero (2010) entre autres

<sup>4</sup> Des exemples récents dans le contexte de la zone euro sont Andrade et Chhaochharia (2012) et Bai et Wei (2012)

la dette publique en examinant ses retombées sur les marchés financiers concernés. Dans ce domaine, les études empiriques actuelles s'attachent soit aux causes de la volatilité des écarts entre taux souverains ou analysent le «lien États Souverains-Banques» et son rapport de causalité potentielle dans la crise de l'euro<sup>5</sup> dans les pays SME.

Néanmoins, les variations rapides des primes de risque entre les marchés européens de la dette dues au choc qui a suivi la grande récession, ont conduit les chercheurs et les praticiens à concentrer leur attention en priorité sur la répartition du risque souverain, mais malheureusement ces études ont négligé les effets de contagion du risque de crédit sur le secteur de l'économie réelle. Plus particulièrement, l'impact de la situation de crise dans les marchés de la dette publique sur le risque de crédit des entreprises non financières n'a pas été étudié dans le contexte de la zone euro. Comme les études portant sur les économies émergentes l'ont démontré, le choc financier du secteur souverain a tendance à déstabiliser les entreprises par le biais d'une taxation plus élevée, de mesures de contrôles des changes ou le tarissement (des mouvements de capitaux), ce qui a des conséquences négatives sur les coûts des emprunts pour les entreprises et sur leur accès aux marchés financiers<sup>6</sup>.

Lorsque ce phénomène se produit, les primes de risque plus élevées sur les marchés de la dette souveraine et la plus grande probabilité de défaut de la dette souveraine qui s'ensuit, se propagent au secteur de l'économie réelle en raison des perturbations des marchés intérieurs du crédit. Le secteur bancaire, en particulier, investit et conserve de grandes quantités de titres souverains dans son bilan: pour satisfaire aux obligations réglementaires comme, par exemple, la nécessité d'avoir des liquidités en vue d'un refinancement auprès de la BCE, ou uniquement pour placer les liquidités bancaires en avoirs sûrs aux rendements minimaux. Quelle qu'en soit la raison, les conséquences négatives d'une augmentation de la prime du risque souverain sur la valeur de ces titres nuisent à la liquidité des banques et conduisent à un resserrement des emprunts et à une réduction de l'activité hors-bilan, ce qui se propage ensuite au secteur des entreprises sur les marchés du crédit intérieur. En outre, les entreprises qui sont fortement dépendantes du financement bancaire sont plus sensibles aux variations des primes de risque souveraines. La zone euro est un excellent exemple de ce phénomène.

De plus, avec la crise de la dette souveraine, les niveaux de la dette publique plus élevés et l'augmentation potentielle des déficits fiscaux suscitent des doutes quant à la capacité et la

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<sup>5</sup>Voir Gennaioli et al. (2014) et Noyer (2010) entre autres

<sup>6</sup>Ces dernières conséquences ne s'appliquent pas à la zone euro.

volonté des gouvernements de rembourser leurs dettes à leur valeur nominale. Par voie de conséquence, les déficits en cours et les niveaux de dette publique plus élevés entraînent un risque souverain accru ainsi qu'une baisse de la croissance économique et une augmentation des taux d'intérêt qui contribuent à l'augmentation du levier des entreprises, des institutions financières ainsi que des ménages. La viabilité budgétaire s'amointrit, ce qui entraîne une crainte accrue de défaut chez les investisseurs sur leurs propres marchés. Dans la zone euro, ce phénomène de variation abrupte de l'opinion des marchés a été très nettement observé. On a pu observer, au début de la mise en place de la zone SME la convergence des primes de risque sur la dette souveraine indépendamment de l'hétérogénéité de la compétitivité entre les différents états membres de la zone euro. L'arrivée de la CFM a cependant conduit à une plus grande incertitude sur les marchés financiers concernés, ce qui a, à son tour, conduit à la réévaluation des primes de risques et des taux d'intérêt correspondants et à une moindre situation de confiance dans la zone euro. C'est dans ce contexte qu'est apparue la contagion du risque de défaut. Ceci a joué un rôle important conduisant à une réappréciation générale des risques sur les marchés de dette correspondants (dette souveraine, banques et entreprises) dans la zone euro.

## **Motivation**

Avec la crise de 1929, la crise financière mondiale récente est la seule à avoir profondément affecté les marchés financiers internationaux des pays développés aussi bien que des pays en développement. Elle a commencé suite aux perturbations causées par les prêts hypothécaires à haut risque sur les marchés américains, qui ont entraîné de lourdes pertes pour les institutions financières. A cause de l'inter-connectivité accrue des institutions financières au niveau mondial, ces effets négatifs se sont fait ressentir sur les marchés internationaux et particulièrement sur les économies de la zone euro.

De plus, le lancement de la zone euro et l'introduction de la monnaie unique dans l'union économique et monétaire a fourni aux états membres une opportunité de dépenser plus et de manière erratique, ce qui a conduit à des niveaux de dépense potentiellement impossibles à maintenir sur le long terme, comme nous pouvons le voir actuellement dans les déficits de compte courant des pays concernés. L'attitude stricte de la BCE quant aux tendances inflationnistes suite au comportement de la Bundesbank<sup>7</sup> a agi comme élément déclencheur

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<sup>7</sup>Voir Alessi (2013). Germany's Central Bank and the Euro zone. <http://www.cfr.org/world/germanys-central-bank-eurozone/p29934>

pour réduire les attentes inflationnistes et conduit à une chute des taux d'intérêt nominaux parmi les membres de la zone euro comme la Grèce, l'Irlande et l'Espagne où ces taux étaient historiquement élevés à cause des attentes inflationnistes. Ceci a entraîné une augmentation brutale du niveau d'endettement de presque tous les acteurs économiques, à savoir les états souverains, les banques, les entreprises et les ménages. Ainsi, pour répondre à l'augmentation de la demande agrégée provenant du secteur des entreprises, le secteur bancaire a accrues activités de crédit en finançant des prêts à long terme aux entreprises avec du passif à court terme, tels que des emprunts obligataires de court terme, des certificats de dépôt, etc. Les investisseurs sur les marchés financiers internationaux ont également exploité cette opportunité d'investissement en se basant sur l'idée que les banques de la zone euro détenaient des titres de dettes publiques comme actifs, qui par refinancement auprès de la BCE, fournissent un accès facile à des fonds à bon marché aux banques concernées en cas de difficultés financières.

D'autre part, les banques du SME étaient convaincues de pouvoir se tirer des difficultés financières grâce à la BEC, ce qui a conduit à une situation d'aléa moral. A cet égard, un tel régime augmente l'interdépendance entre le secteur public et le secteur financier, ce qui a des effets négatifs sur le secteur de l'économie réelle en cas de choc externe sur l'économie de la zone euro.

Si on garde à l'esprit les répercussions de la CFM et les faiblesses structurelles inhérentes à l'union monétaire, l'Union Européenne (ci-dessous UE) à la fin de 2008 a accepté, pour répondre à cette situation de crise, un programme de relance de 200 milliards d'euros pour redynamiser la croissance économique dans le SME (Baimbridge and Whyman, 2015, pg: xiii). Les gouvernements nationaux ont également contribué à cette relance. Par exemple, les Etats économiquement forts y ont participé de manière significative, à hauteur de 45% environ (l'Allemagne à hauteur de 31%, la France 13%). L'Irlande a fourni des garanties à son secteur financier en difficulté à hauteur de presque deux fois son PIB. La dette privée se transformant en dette publique et s'ajoutant à une dette publique déjà élevée, les risques sur la dette souveraine s'amplifiaient avec pour conséquence immédiate la crainte des investisseurs sur les marchés de capitaux internationaux concernant la capacité des Etats à honorer leurs dettes, qui ont alors soulevé la question de la viabilité budgétaire. Cette situation posait plus précisément la question de savoir si les gouvernements étaient capables et disposés à s'acquitter de leurs dettes, ce qui à son tour a conduit à une augmentation des primes de risque des obligations souveraines sur les différents marchés et à la crise de l'euro.

Dans la littérature existante, nous pouvons noter que les conséquences de la crise récente de la dette publique de la décomposition du spread souverain et de son effet de contagion sur les institutions financières dans le contexte de la zone euro. D'autre part, peu de travaux ont été publiés sur l'analyse des conséquences sur l'économie réelle des problèmes de dette souveraine dans la zone euro et ces recherches n'en sont encore qu'à leur début.<sup>8</sup> La présente thèse étudie les retombées de la crise de l'euro sur les écarts de taux sur les emprunts des entreprises non-financières. Elle s'intéresse plus précisément à l'évaluation de l'importance de la dette détenue à l'étranger, détenue au niveaux domestique et totale sur le niveau des taux d'intérêt des entreprises non financières et sur leur accès aux marchés de capitaux internationaux dans le contexte de l'augmentation des primes de risque souverain. Notre étude, tout comme les études portant sur les marchés émergents tente de révéler les effets d'interaction entre la protection des droits des créanciers et les relations entre les primes de risque souverain et les coûts d'emprunt pour les entreprises de la zone euro, en particulier, en période de crise de la dette publique. Finalement, afin d'évaluer les actions prises par les institutions de l'UE pour répondre à la situation de difficulté financière croissante et de détérioration de l'activité économique, nous mesurons l'efficacité, lors de la crise récente, des mesures d'austérité financière sur les écarts de taux sur les prêts aux entreprises privées.

Les conséquences négatives de l'augmentation des primes de risque souverain sur le secteur de l'économie réelle se propagent par des canaux différents. Nous savons par exemple, au vu des publications portant sur les marchés émergents, que les retombées de la crise de la dette publique se propagent au secteur de l'économie réelle par les canaux suivants: le canal du commerce international, le canal du financement et le canal de la confiance. En bref, concernant le canal du commerce, les difficultés des États souverains atteignent le secteur de l'économie réelle par le biais des variations dans la demande agrégée des biens et services d'importation à cause de la diminution du revenu disponible et de la dégradation de la compétitivité qui en résulte dans les économies en difficulté. Au contraire, le canal du financement consiste en un transfert par les banques de la vulnérabilité des États souverains vers l'économie réelle parce qu'elles resserrent leur capacité de financement, du fait de la réduction de la valeur de leur bilan et/ou d'un problème de liquidité. Le canal de la confiance, quant à lui, reflète les changements brusques de l'attitude des investisseurs et son corollaire, la perte de confiance lorsque le risque de défaut de paiement s'accroît même légèrement, perte

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<sup>8</sup>Voir Andrade et Chhaochharia (2012) et Bai et Wei (2012).



de confiance qui se propage au secteur de l'économie réelle par le risque de crédit du secteur financier.<sup>9</sup>

Dans ce domaine, nous concentrons notre attention principalement sur les canaux financiers et contagion, étant donné que la crise récente de la dette souveraine, dans l'ensemble, n'a pas eu d'impact sur l'activité commerciale entre les pays membres de la zone euro. Selon D'Auria et al. (2014): «...la crise n'a entraîné ni un affaiblissement des marchés ni un changement dans les préférences des pays de la zone euro à commercer entre eux.». Ainsi, cette étude note que la crise récente de la dette n'a pas eu d'influence sur le volume des échanges entre les pays de la zone euro.

Si l'on s'intéresse donc plus particulièrement au canal financier, on note qu'une augmentation de la prime de risque souverain a des conséquences négatives sur les marchés financiers qui, à leur tour, transfèrent cette vulnérabilité au secteur des entreprises. Plus particulièrement, les perturbations et les distorsions sur les marchés du crédit dues à un risque plus élevé de défaut souverain se propagent au secteur de l'économie réelle en période de crise de l'euro dans le SME. En général, les banques investissent et détiennent de vastes quantités de titres publics dans leur bilan. Avec la crise de la dette souveraine, ces titres passent du statut d'actifs sans risque à celui d'actifs risqués, et ceci génère des problèmes de liquidité pour les institutions financières concernées. Par conséquent, le secteur financier en difficulté réduit son exposition au risque de liquidité et met en place un processus de désendettement qui a des retombées négatives sur le coût des emprunts des entreprises non financières et sur leur capacité à se financer. En outre, les publications empiriques actuelles concentrent leur attention uniquement sur le rapport entre les états souverains et les banques lorsqu'elles étudient les conséquences de la crise de la dette souveraine.<sup>10</sup>

Dans ce contexte, la présente thèse tente d'évaluer le risque de contagion de la dette souveraine vers le secteur de l'économie réelle au travers du risque de liquidité des banques. Nous proposons en particulier d'utiliser le canal dominant de la création de liquidités, qui constitue la fonction traditionnelle des banques commerciales, comme vecteur de la prime de risque souverain vers le secteur de l'économie réelle lors de la crise de la dette publique dans la zone euro. Etant donné que l'un des rôles majeurs des banques est de fournir des services

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<sup>9</sup> Dans ce contexte, nous traitons le canal de la confiance comme canal de la contagion du risque de crédit sur les différents marchés de la dette. Pour plus de détails, voir l'étude de 2014 de la BCE sur "Cross-border spillovers in the euro area" de D'Auria et al.

<sup>10</sup> Voir Gennaioli et al. (2014) et Noyer (2010) entre autres.

aux acteurs économiques nationaux concernant la demande et l'offre de fonds pour subvenir à leurs besoins de liquidités, les banques commerciales fournissent donc du crédit au secteur de l'économie réelle pour soutenir l'activité économique tout en tenant compte de leur propre exposition au risque de liquidité, qu'elles-mêmes génèrent en transformant des passifs liquides (par ex. des dépôts à vue) en actifs illiquides (par ex. des prêts aux entreprises).<sup>11</sup>

Nous pouvons ajouter que la crise de la dette souveraine a eu un effet plus important sur les entreprises qui s'appuyaient sur le secteur bancaire local pour financer leurs investissements. Par conséquent, les entreprises qui sont fortement dépendantes des banques nationales ont à faire face à de plus grandes difficultés financières étant donné l'effet de contagion négatif des primes de risque souverain sur le rôle de création de liquidités des banques.

D'autre part, si nous suivons les canaux de la contagion, les publications actuelles ont dans l'ensemble négligé l'importance de l'interconnexion du risque de crédit du secteur réel et des secteurs financiers et souverain dans le contexte de la zone euro (Gray, 2009). Au lieu de considérer que le risque souverain mesuré par les primes de swaps souverains évolue de façon progressive dans le temps, les investisseurs ont tendance à considérer que le risque de défaut sur ces marchés existe ou non. Il semble qu'il n'y a pas de position moyenne. Dans cette optique, la convergence et la divergence qui s'ensuit sur les écarts entre taux souverains sur les marchés de dette européens constituent un exemple pertinent. Au début du SME, les investisseurs ont diminué les primes de risque pour tous les États membres quel que soit leurs niveaux de compétitivité et leurs marges de manœuvre budgétaires et les ont tous considérés de la même manière. Au contraire, avec la survenance du choc général dû à la CFM, les investisseurs ont réévalué le risque souverain qui provient de la divergence et des écarts plus élevés concernant les états membres disposant d'une marge de manœuvre budgétaires moindre. De plus, les marchés pour les dettes d'entreprises et pour les dettes des institutions financières ont suivi une tendance similaire.

Dans ce domaine, certains auteurs de publications portant sur la contagion notent que la volatilité des primes de risque des secteurs souverain et financier ne se limite pas aux aspects fondamentaux et aux facteurs de risque habituels mais qu'il existe également un effet de contagion.<sup>12</sup> D'autres affirment par ailleurs que le risque de contagion est surestimé et qu'il n'existe qu'une augmentation des corrélations entre les risques de crédit des différents

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<sup>11</sup> Voir Diamond et Dybvig (1983) pour des précisions à ce sujet.

<sup>12</sup> Voir Ang et Longstaff (2013), Aizenman et al. (2013) et Missio et Watzka (2011) entre autres

marchés de crédit de la zone euro pendant la crise de la dette souveraine.<sup>13</sup> De plus, parmi les partisans de la thèse de la contagion dans l'augmentation des spreads des primes de risques souveraines et financières, il n'existe aucun consensus quant à l'ordre dans lequel s'est produite la contagion dans le SME pendant la crise récente. Il existe d'autre part une controverse entre les différents auteurs des analyses empiriques quant à la contagion du risque de crédit à partir des pays périphériques vers le reste de la zone euro. La polémique porte également sur l'identité du pays détenant la plus grande part de responsabilité à cet égard<sup>14</sup>. Il y a par ailleurs des travaux qui étudient l'importance du risque de crédit des pays du cœur de la zone euro dans la contagion vers le reste de la zone euro et qui font remarquer que les pays périphériques n'ont pas été à l'origine de façon significative de la contagion du risque de crédit. Il n'est par conséquent pas absurde de noter que les corrélations du risque de crédit du secteur de l'économie réelle et des secteurs financier et souverain ont été totalement ignorées dans le contexte de la récente crise de la dette publique dans le SME.

Par conséquent, afin que les politiques économiques prennent mieux en compte la manière dont ces dynamiques du crédit agissent et se propagent lors des périodes de turbulence financière dans la zone euro, une étude empirique est nécessaire. Le dernier chapitre de la présente thèse se concentre donc simultanément sur la contagion et les interconnexions entre les secteurs souverain, financier et réel lors de la récente crise des dettes souveraines.

## **Questions de recherche**

Depuis le début de la crise de l'euro, les universitaires et les décideurs ont accordé une attention particulière sur l'évaluation de l'interdépendance du risque de crédit uniquement dans le lien états souverains-banques. L'importance du secteur de l'économie réelle a donc été négligée en même temps que des mesures correctives ont été formulées pour le relèvement de la croissance économique particulièrement en période de crise dans la zone UEM. Les travaux actuels qui évaluent les effets de la crise des dettes souveraine sur l'économie réelle se concernent surtout sur les marchés émergents. Dans le contexte de la zone euro, les publications empiriques sont rares et seuls quelques chercheurs se sont penchés sur ce sujet pendant la période de la crise de l'euro.<sup>15</sup> Cette thèse présente une étude qui analyse les conséquences et les canaux de transmission de la récente crise de la dette publique sur les secteurs financier et réel de la zone euro. Après avoir examiné les effets de contagion de la

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<sup>13</sup>Voir Cochrane (2010)

<sup>14</sup>Voir Koop et Korobilis (2016)

<sup>15</sup> Voir Augustin et al. (2016)

dette publique extérieure, intérieure, et globale sur les entreprises non financières, nous étudions l'efficacité des mesures d'austérité prises pendant la crise de l'euro dans les pays du SME. La présente thèse explore ensuite les canaux de contagion par lesquels les difficultés financières souveraines se sont transmises à l'économie réelle notamment durant la crise des dettes publiques souveraines.

En définitive cette recherche se propose de répondre aux questions suivantes:

- Premièrement, nous estimons l'effet de contagion de la crise de la dette souveraine sur les coûts de crédit pour les entreprises non-financières de la zone euro. Dans cette perspective, nous avons concentré notre attention sur l'importance de l'impact de la dette publique détenue à l'étranger par opposition à la dette détenue au niveau domestique et à la dette totale respectivement sur les coûts de crédit des entreprises privées dans l'optique de l'attitude adoptée par les investisseurs étrangers pendant la crise de l'euro. Après avoir confirmé l'impact négatif de la crise de la dette publique sur l'économie réelle et son lien avec le niveau de protection des droits des créanciers, l'étude se porte sur l'évaluation de l'efficacité des mesures prises par les pays de la zone euro pour contrecarrer la crise. Nous analysons alors l'impact des mesures d'austérité sur les écarts de taux des crédits syndiqués accordés aux entreprises non financières pendant et avant la crise de l'euro dans le SME.
- La deuxième question porte sur les canaux de transmission du risque souverain vers l'économie réelle dans la zone euro notamment pendant la crise récente. Nous nous demandons tout particulièrement si ce sont les distorsions dans le secteur bancaire intérieur qui transmettent les effets de contagion de la crise souveraine au secteur de l'économie réelle. Si c'est le cas, quel rôle joue le secteur bancaire dans le mécanisme de transmission? Nous avançons l'hypothèse que c'est le processus de création de liquidités des banques qui transmet les difficultés souveraines aux entreprises non financières dans la zone euro. De plus, nous cherchons à savoir si le secteur bancaire agit comme un canal de report des faiblesses du secteur réel vers le secteur public parmi les pays membres de la zone euro pendant les périodes de turbulences.
- Enfin, nous tournons notre attention vers l'évaluation de la présence d'un canal de la transmission de la vulnérabilité souveraine vers les secteurs financier et réel pendant la crise de l'euro. Nous examinons en particulier la dynamique du risque de crédit dans le «lien états souverains-banques-entreprises» simultanément dans la zone euro. L'hypothèse principale de cette étude est qu'une augmentation brusque des primes de

risque dans le «lien états souverains-banques- entreprises» pendant la crise de l'euro est due en partie à la crainte d'un effondrement simultané des marchés de dettes. Nous évaluons en outre le risque de contagion inter et intrasectoriel entre les pays de la zone euro et également la contagion du risque de crédit entre pays sur les marchés de la dette correspondants dans le SME. Cette étude se concentre donc sur les perturbations sur les marchés de CDS consécutives à la crise de l'euro.

## Plan

Les chapitres I à III que nous venons de soulever contiennent des analyses empiriques autonomes et cherchent à évaluer les effets de contagion, caractéristiques de la crise récente tels qu'on vient de les évoquer. Dans notre conclusion nous résumerons les principaux résultats de ces recherches et nous tenterons d'en tirer les enseignements de politique économique. Ci-après nous présentons un résumé de chacun des chapitres.

*Le premier chapitre* vise à répondre à la question de savoir si le risque souverain a eu des conséquences négatives sur les coûts de l'emprunt des entreprises non-financières pendant la période de crise de l'euro en présence de mesures d'austérité dans la zone de l'euro. Dans ce domaine, les études théoriques et empiriques portant sur la dette souveraine et le risque de défaut de remboursement de la dette, ne tiennent pas suffisamment compte dans l'ensemble, de la relation entre la contagion du risque de la dette souveraine et les coûts d'emprunt du secteur privé. Les publications actuelles en particulier, se concentrent surtout sur l'identification et l'analyse des causes du défaut de remboursement souverain et des coûts associés, afin de trouver des stratégies optimales pour diminuer ces conséquences du point de vue des états souverains. Cependant, un petit nombre de chercheurs a tourné son attention vers cette problématique afin d'évaluer les effets du fort risque que fait peser la dette souveraine sur l'économie réelle. Cette branche de recherche n'en est encore qu'à ses débuts et n'étudie que les marchés émergents. La présente thèse tente d'évaluer empiriquement les effets de la dette publique détenue à l'étranger sur les coûts d'emprunt du secteur privé à l'étranger, sur les marchés des pays développés, notamment dans la zone euro. Nous évaluons d'autre part l'importance de la dette publique totale et domestique sur l'écart des crédits syndiqués. Cette étude se penche également sur l'impact des mesures d'austérité prises par les pays de la zone euro sur les écarts des crédits syndiqués sur les entreprises privées, et sur les tentatives de relance de la croissance économique dans la région.

Afin de tester ces hypothèses, nous utilisons la méthode d'estimation de la régression des moindres carrés ordinaires (ci-après MCO) pour évaluer les effets des niveaux de la dette publique extérieure par rapport au PIB sur le coût d'emprunt des entreprises privées. En utilisant les données d'émission de crédits syndiqués étrangers des entreprises non-financières sur la période 2005 à 2011, nous tentons d'évaluer dans quelle mesure le coût du crédit dans le secteur des entreprises privées varie en présence de niveaux de dette extérieure publique excessivement hauts dans la zone euro. De plus, nous élargissons les résultats des travaux récents, sur la crise du crédit des états souverains, en utilisant des mesures alternatives pour traiter l'effet de contagion de la dette du secteur public sur le secteur privé dans les économies avancées. Nous allons dans le sens des publications actuelles et examinons l'importance de la part de la dette publique globale et intérieure dans le PIB sur le coût du crédit des entreprises privées non financières. Dans ce contexte, nous analysons également dans quelle mesure les efforts récents de consolidation fiscale lors de la crise de l'euro ont eu un impact sur le *spread* des crédits syndiqués étrangers du secteur privé dans ces économies frappées par la crise.

Nos résultats montrent un effet de contagion d'une valeur statistique significative de la dette publique externe sur le coût du crédit des entreprises privées dans la zone euro. Une augmentation de la dette publique extérieure d'un point de base par rapport à la moyenne augmente l'écart des crédits syndiqués étrangers de 89 points de base (c'est-à-dire une augmentation de 47% par rapport à la moyenne). De plus, la faible protection des créanciers prévalant dans la zone euro aggrave et approfondit les effets causés par les niveaux élevés de la dette publique externe sur l'écart des crédits syndiqués étrangers. Nous n'avons cependant pas remarqué un effet significatif de la dette publique interne sur les coûts d'emprunt du secteur privé. Les résultats montrent en outre un effet significatif des efforts de consolidation fiscale sur l'écart des crédits syndiqués du secteur privé, que ce soit au cours de la période précédant immédiatement la récente crise de la zone euro ou pendant la crise. En particulier, un changement d'écart type de la moyenne conditionnelle de la consolidation budgétaire a réduit le *spread* des crédits syndiqués de 22 points de base (soit une diminution de 12% par rapport à la valeur moyenne) pendant la crise de la dette publique. Ceci indique une crédibilité des mesures d'austérité dans les pays de la zone euro. Néanmoins, les efforts de consolidation fiscale valident également la présence d'un canal de demande agrégée keynésien par la légère augmentation du *spread* des crédits syndiqués pendant la période précédant la crise.

Dans le *deuxième chapitre*, nous approfondissons notre analyse en étudiant la mesure dans laquelle la vulnérabilité souveraine se propage au secteur de l'économie réelle. Nous

montrons que le processus de création de liquidités des banques est un vecteur important de cette contagion. Dans ce domaine, les publications actuelles se concentrent soit sur le «lien états souverains-banques» ou sur le «lien banques-entreprises» tout en évaluant les effets de la crise souveraine surtout dans le contexte des économies émergentes. Ceci a conduit à une polémique parmi les auteurs des études empiriques concernant la contagion de la vulnérabilité entre le «lien états souverains-banques» lors de la crise récente. D'autres études récentes notent que les banques changent leurs stratégies de gestion des liquidités au début d'une période financière turbulente et hésitent beaucoup plus avant d'accorder des prêts aux entreprises. En gardant ces éléments à l'esprit, nous tentons d'analyser les conséquences rationnelles de la récente crise souveraine sur le secteur de l'économie réelle en traitant ensemble le «lien états souverains-banques-entreprises» en tant que système structurel instantané à l'origine d'un cercle éternel créateur de défaut de remboursement.

Afin de tester ces hypothèses, nous suivons une approche de modèle d'équations simultanées, et la méthode d'estimation des Triples Moindres Carrés pour évaluer si le risque de liquidité du secteur bancaire a agi comme vecteur de propagation des difficultés financières vers le secteur de l'économie réelle lors de la récente crise de l'euro dans le SME. Pour ce faire, nous utilisons la méthodologie fournie par Berger et Bouwman (2009) pour mettre au point un indice de risque de liquidité qui permet d'appréhender le processus de création de liquidités des banques commerciales lorsqu'elles accordent des prêts aux entreprises. Pour cette étude, nous nous concentrons sur 12 états de la zone euro pour la période allant de 2005 à 2012. Etant donnée la corrélation instantanée entre les systèmes d'équations simultanées, les publications économétriques considèrent que l'hypothèse d'orthogonalité dans la matrice de variance-covariance résiduelle n'est pas tenable. A cet égard, la méthode des moindres carrés ordinaire (MCO) et celle des doubles moindres carrés fournissent des estimateurs biaisés. Nous avons donc utilisé la méthode d'estimation des triples moindres carrés afin d'évaluer ce système d'équations simultanées car il révèle non seulement l'endogénéité des régresseurs mais résout également la question de la corrélation croisée dans les erreurs d'équation du système. De plus, la méthode des moindres carrés ordinaire et celle des doubles moindres carrés sont des méthodes d'estimation à équation unique alors que celle des triples moindres carrés est une méthode d'estimation qui évalue en même temps les coefficients de l'équation linéaire en une seule et même opération.

Les résultats empiriques montrent un fort risque de contagion des états souverains vers le processus de création de liquidités du secteur bancaire qui se transmet ensuite au coût

d'emprunt de l'économie réelle tout en le redirigeant vers le secteur public, notamment en période de crise de l'euro. En outre, l'intervention stratégique par le biais du plan de sauvetage de la BCE est également visible dans nos résultats. En particulier, les banques tentent de créer des liquidités sur le court terme pour les entreprises non commerciales, mais à des taux d'intérêt très élevés. Ceci explicite peut-être l'attitude de *carry trade* des banques (la mise à profit par les banques des différentiels de taux d'intérêt) pendant la crise de l'euro dans les pays SME. Par contre, si l'on analyse les résultats portant sur la période précédant la crise de la dette souveraine, nous pouvons corroborer les résultats des travaux d'Ivashina et Scharfstein (2010) qui affirment que les banques changent leurs stratégies de gestion des liquidités en fonction de la nature de la crise. Nos résultats confirment les distorsions sur le marché de crédit intérieur dues à la crise souveraine qui propage ses difficultés au monde de l'économie réelle dans les pays membres de la zone euro.

*Le troisième chapitre* enfin se concentre sur l'évaluation de la présence d'un effet de contagion depuis les primes de risques souveraines sur le secteur de l'économie réelle en créant des distorsions sur les marchés des CDS respectifs avec un passage potentiel du risque de crédit du secteur bancaire, notamment lors de la crise de la dette européenne. Nous soupçonnons en particulier qu'une augmentation des primes de risque souveraines se transmet au secteur financier et au secteur de l'économie réelle en période de crise de l'euro. Depuis le début de la crise financière mondiale et pendant la crise de la dette souveraine en 2010, les décideurs politiques et les universitaires ont détourné leur attention des effets de contagion possible sur les marchés de la dette, notamment sur les secteurs financier et souverain de la zone euro. Malgré une augmentation rapide du nombre de publications empiriques dans ce domaine, il n'y a pas de consensus quant à la présence d'un effet de contagion des dynamiques du risque de crédit sur les marchés de dette respectifs. Dans ce domaine, une poignée de chercheurs affirment que le risque de contagion se transmet depuis les états souverains faibles vers le risque de crédit des banques, alors que d'autres affirment que c'est la fragilité du secteur bancaire qui est à l'origine de la contagion des primes de risque souveraine respectives en période de crise de l'euro. Il existe, de plus, des publications actuelles qui ne notent pas d'effet de contagion dans la dynamique du risque de crédit du «lien états souverains-banques» et suggèrent d'augmenter l'interdépendance et les corrélations entre les pays membres de la zone euro pendant la crise de la dette européenne. Dans ce contexte, l'importance de l'interconnexion du risque de crédit entre le secteur de l'économie réelle et le «lien états souverains-banques» est entièrement négligé par les travaux de



recherche dans ce domaine en période agitée, comme le soulignent Gray (2009) et BIS (2011a).

A cet égard, ce chapitre vise à approfondir les travaux empiriques non seulement en traitant la question du risque de contagion dans le lien «états souverains-banques» mais en incluant en même temps le risque de défaut associé au secteur non financier dans la dynamique du risque de crédit. Gardant à l'esprit cette polémique empirique, nous adhérons à la définition de la contagion fournie par Constâncio (2012), qui la considère comme un «débordement excessif» du risque de crédit sur les marchés de la dette correspondants. En particulier, nous éliminons les facteurs de risques macro-économiques et idiosyncratiques, puis utilisons les valeurs résiduelles des CDS sur les variables de «lien souverain-banques-entreprises» dans les modèles vectoriels autorégressifs (PVAR) pour évaluer l'effet de contagion du risque de crédit. Ainsi, pour établir la présence d'un effet de contagion du «lien secteur souverain-banques-entreprises» dans le risque de crédit pendant la crise de l'euro, notre analyse se base sur les fonctions de réponses impulsionnelles avec décomposition des variances respectives et les tests de causalité au sens de Granger découlant des résultats des estimations du PVAR qui sont significativement différentes de zéro. En outre, le modèle PVAR est conforme aux objectifs de cette étude dans l'évaluation de l'effet de contagion de la transmission des chocs entre différents pays et secteurs de l'économie, puisqu'elle fournit un outil économétrique concret et précieux pour analyser la dynamique des processus financiers et économiques (Canova and Ciccarelli, 2009). Ainsi, le PVAR non seulement traite de manière efficace la question de l'hétérogénéité dynamique non observée, mais elle traite également de l'interdépendance statique et dynamique, qui sont sujettes à des variations dans le temps de leurs coefficients et variance d'innovations (Hayashi, 2000).

Au niveau de l'agrégat zone euro, nos résultats révèlent les contributions systémiques de chaque secteur au moyen de mesures de contagion du risque de crédit qui démontrent leur capacité à évaluer l'interdépendance, variable dans le temps, entre les secteurs et une interdépendance à l'intérieur des secteurs du «lien états souverains-banques-entreprises» non variable dans le temps pendant la récente crise. De plus, le risque de contagion entre les marchés de la dette souveraine et de la dette des banques est plus élevé que celui des entreprises non financières dans la zone euro. En outre, pendant la crise des *subprimes*, le risque de contagion était présent, non seulement en partance des banques vers le risque de solvabilité des états souverains, mais la présence d'un débordement excessif du risque de défaut des entreprises vers le risque de crédit du secteur public correspondant était également

attestée. En ce qui concerne la crise de l'euro, il y a des signes évidents montrant que les primes de risques souverains se propagent par contagion au secteur bancaire. D'autre part, le secteur de la finance recourt à des activités d'exploitation des différentiels de taux d'intérêt, suite à un constat lucide de la transformation du secteur privé vers le secteur public du risque de crédit dans le SME.

A cet égard, nous essayons de valider ces résultats en analysant la dynamique du risque de crédit dans le «lien états souverains-banques-entreprises» dans certains pays de la zone euro. Les résultats portant individuellement sur les pays membres confortent en partie les résultats de l'agrégat zone euro. D'une part, nous notons qu'il n'est pas nécessaire que la nature de la crise demeure variable dans le temps entre les secteurs pendant les périodes de turbulences; d'autre part, il n'est pas raisonnable de présumer que la nature de la crise est invariable selon les secteurs pendant une période donnée, comme le font les travaux actuels. Tout particulièrement, les publications à ce sujet affirment que depuis 2010, la nature des turbulences affectant la zone euro est uniquement liée aux déséquilibres fiscaux (voir Harjes, 2011 et Popov et van Horen, 2013, entre autres.).

Enfin, en étudiant l'effet de contagion des états membres vers le reste de la zone euro, nos résultats démontrent la forte présence d'un risque de contagion des PIGS (à part l'Italie) vers le reste de la zone euro surtout pendant la période de crise de la dette européenne récente. Cependant, ce risque de contagion ne provient pas uniquement de la vulnérabilité de la solvabilité du pays; il y a également des traces de débordements excessifs provenant du risque de crédit des secteurs bancaires faibles (dans le cas de l'Irlande). Par ailleurs, les résultats des simulations de chocs de primes de risque des pays «noyaux» de la zone euro confirment l'existence d'effets indirects sur le reste de la zone. De plus, nous constatons un phénomène de fuite des investisseurs vers les valeurs refuges. Ces résultats démontrent donc la présence de liquidités supplémentaires en direction des pays de l'union monétaire européenne qui sont stables fiscalement et financièrement. Ils prouvent également que les investisseurs sur leurs marchés de dette respectifs sont sensibles aux perturbations et recherchent la qualité en retour dans la zone euro.



## General Introduction

### Setting the thesis background

The recent sovereign debt crisis<sup>16</sup> in the euro zone is a combined consequence of the global financial crisis (hereafter, GFC) effect<sup>17</sup> and the inherent structural asymmetries present in the European Monetary Union (hereafter, EMU) since its commencement. Historically, the public debt crisis phenomenon was related to developing market economies. This is due to the fact that emerging countries lack developed capital markets and are unable to borrow in their domestic currency with a higher roll-over risk. However, with the onset of the euro crisis episode the phenomena of fiscal imbalances and sustainable economic growth shifted towards advanced countries (especially to euro area member states). On this topic, there is a plethora of literature on emerging markets regarding the spillover effects of the sovereign debt crisis on financial and real sectors in respective economies.<sup>18</sup> On the contrary, in the context of the euro zone, literature is sparse and still in its infancy. In this thesis, we attempt to evaluate the spillover effects of the recent euro crisis especially on the real sector as well as on the financial and public sectors in the euro zone, respectively.<sup>19</sup>

Following the great recession due to the US sub-prime mortgage crisis, investors started to re-examine the risk of default for sovereign states in advanced markets especially in euro zone countries (Mody, 2009). The respective capital markets indulged in re-evaluating and re-pricing public debt securities with regard to their inherent competitiveness, which resulted in the divergence of yield spread among sovereign bonds in the EMU. This fragmentation in corresponding markets and increase in the risk premium of sovereign debt led economists and practitioners to re-examine the issue. Consequently, the extant literature focuses on either evaluating the determinants of such increase in spreads in public debt markets or at most its spillover effect on respective financial markets. In this regard, existing empirical studies

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<sup>16</sup> In this thesis we use: sovereign debt crisis, public debt crisis, euro crisis, European debt crisis and recent debt crisis terms interchangeably

<sup>17</sup> According to Blundell-Wignall et al., (2008) more than one-third of the total US mortgage backed securities were purchased by EU financial firms.

<sup>18</sup> See: Panizza et al. (2009), Nelson (2012) and Presbitero (2010) among others

<sup>19</sup> Recent examples in the context of euro zone are Andrade and Chhaochharia (2012) and Bai and Wei (2012)

either study the causes of volatility in sovereign spreads or analyze the sovereign-bank nexus and its potential causality in the context of the EMU in a euro crisis episode.<sup>20</sup>

Nevertheless, abrupt changes in the risk premia among European debt markets due to a shock from the great recession have led academics and market practitioners to focus their attention primarily on the decomposition of sovereign risk and they have overlooked its spillover effect on the real sector's credit risk. More specifically, the effect of increased distress in public debt markets on the non-financial firms' credit risk during the euro crisis episode is being ignored in the context of the euro zone. As outlined in emerging market studies, the financial distress in the sovereign sector is prone to transmitting vulnerability to the corporate sector either through higher taxation, foreign exchange controls, or through the seizing of private investments, which has adverse consequences on firms' borrowing costs and their access to financial markets.<sup>21</sup>

When this occurs, the higher risk premia in sovereign debt markets and subsequent increased probability of default are conveyed to the real sector through disruptions in domestic credit markets. In particular, the banking sector generally invests and retains large amounts of sovereign securities in its balance sheet for several reasons: for regulatory requirements, for collaterals, or just to place banks liquidities in safe assets with minimum returns. Whatever the reason, the negative effects on the value of such securities adversely affect the banks' liquidity condition and leads to constriction in loans and reduction in off-balance sheet activities, which then moves on to the corporate sector in domestic credit markets. Moreover, firms that are highly dependent upon bank funding are more sensitive to the change in sovereign risk premium. In this respect, the euro zone is a prime example of this condition.

Furthermore, with the sovereign crisis, the higher public debt levels and potential increase in prevalent fiscal deficits generate doubts as to governments' ability and willingness to repay their outstanding debts at face value. In turn, the increased deficit and public debt levels beget a higher sovereign risk with a reduction in the economic growth and an increase in interest rates, which leads to raise the cost of borrowing not only for financial institutions but also for the corporates and households. Consequently, fiscal sustainability worsens, which generates fear among investors in respective debt markets regarding the risk of default. This phenomenon of abrupt change in market opinion was clearly established in the case of the

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<sup>20</sup> See: Gennaioli et al. (2014) and Noyer (2010) among others

<sup>21</sup> The latter consequences are not applicable in the context of euro zone

euro zone. Historically, we have seen the quick convergence of sovereign risk premia since the onset of the EMU, irrespective of the significant heterogeneity in underlying competitiveness among euro area member states. However, the occurrence of the GFC generated increased uncertainty in respective debt markets, which urged these markets to re-evaluate corresponding risk premia and interest rates, which in turn, further exacerbated the confidence situation in the euro zone. Hence, default risk contagion emerged. This played an important role and led to a sizeable re-pricing of risk among corresponding debt markets (that is: sovereign, banks and firms) in the context of the euro zone.

### **Motivation of the thesis**

Since the great depression in 1929, the recent global financial crisis has substantially affected the international financial markets of developed as well as developing economies. It started with disruptions in the US sub-prime mortgage market that resulted in huge losses for financial institutions. Consequently, with the increased interconnectedness of financial institutions globally, the adverse effect permeated to international markets and especially to euro area economies.

Moreover, the launching of the euro zone and the introduction of the euro in the monetary union provided a basis for member states to overspend erratically, which generated potentially unsustainable expenditure levels as reflected in countries' current account deficits. Particularly, the ECB's strict conduct against inflationary trends following the Bundesbank<sup>22</sup> behavior acted as a trigger to reduce inflationary expectations and led to a decline in nominal interest rates among euro area member states like Greece, Ireland and Spain where historically these rates were high due to inflation expectations. This led to an abrupt increase in the borrowing levels of almost every economic agent, that is: the sovereign, the bank, the corporate, and the household. Hence, to meet the increased aggregate demand from the corporate sector, the banking sector expanded its lending operations by financing long-term corporate loans through short-term liabilities such as: short-term bonds, certificates of deposits, etc. Investors in international capital markets also exploited this investment opportunity on the premise that euro area banks held sovereign debt securities as assets which under the ECB's umbrella furnish easy access to cheap funds to these banks in the case of financial distress.

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<sup>22</sup>See: Alessi (2013). Germany's Central Bank and the Euro zone. Online at: <http://www.cfr.org/world/germanys-central-bank-eurozone/p29934>

On the other hand, banks in the EMU were also convinced of being able to come out of any financial distress thanks to the ECB; which led to a moral hazard situation. In this regard, such a regime increases public and financial sector interdependence, which adversely affects the real sector in case of any external shock on the euro zone economy.

Keeping in mind the spillover shock from GFC and the inherent structural weakness in the monetary union, as a response to the crisis situation, the European Union (hereafter EU) in late 2008 agreed on € 200bn stimulus package to revitalize economic growth in the EMU (Baimbridge and Whyman, 2015, pg: xiii). Further, National governments also contributed to those funds. For instance, financially strong member states contributed substantially; by around 45% (Germany 31% and France 13%). Moreover, Ireland provided a guarantee to its distressed financial sector which was almost twice its GDP level. Private debt turning into public debt alongside an already high prevalent stock of public debt led to a rise in sovereign risk premia and investors in international capital markets started to doubt governments' ability to pay their debt, and to raise the issue of fiscal sustainability. Specifically, it posed the question on the government's ability and willingness to service their outstanding debt, which raised sovereign risk premia in respective markets and hence the emergence of the euro crisis.

In the existing literature, we observe that the consequences of the recent public debt crisis are identified as being the determinants of the sovereign spread and its related spillover effect on financial institutions in the context of the euro zone. Besides, determining the real effects of the sovereign debt spillover in the euro zone is scarce and still in its infancy.<sup>23</sup> In this regard, we study the spillover effects of euro crisis on the borrowing spread of non-financial private firms. Precisely, with the increase in sovereign risk premium in the EMU, we evaluate the importance of external, domestic and total public debt on the interest rate cost of non-financial firms and their respective access to international capital markets. In line with the emerging markets studies, we also attempt to determine the interaction effects of creditor rights protection on the relationship between sovereign risk premium and the borrowing costs of firms in the euro zone especially during public debt crisis. Finally, to evaluate the response actions of EU institutions against the increasing financial distress and deterioration in economic activity, we gauge the effectiveness of fiscal austerity measures on private firms' loan spread during the recent crisis episode.

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<sup>23</sup> There is handful of recent empirical studies in this regard, kindly see: Andrade and Chhaochharia (2012) and Bai and Wei (2012).

The adverse effect of increase in risk premia of sovereign debt on the real sector is transmitted through various channels. For instance, in the light of emerging market literature, the spillover effect of the public debt crisis transmits to the real sector through: the trade channel, the financial channel and the confidence channel.<sup>24</sup> Briefly, in the trade channel the sovereign adversity principally transfers to the real sector through demand and competitiveness effects. In this regard, a shock on sovereign sector of a country resulted in a reduction of disposable income that changes the aggregate demand for imported goods and services to its trade partner states. Simultaneously, deterioration in the underlying competitiveness in the distress economies also changes the terms of trade as well. On the contrary, the financial channel transfers sovereign vulnerability to the real sector through constriction in its lending capacity due to a reduction in the overall balance sheet value and the occurrence of liquidity problems. As for the confidence channel, it reflects the abrupt change in investors' behavior and consequent loss in confidence due to a slight increase in the sovereign default risk that turns into contagion to the real sector through financial sector credit risk.<sup>25</sup>

In this respect, we mainly focus our attention towards the 'financial' and contagion' channels as the recent sovereign crisis, in general, has not significantly affected the trade activity among euro area countries. As outlined by D'Auria et al., (2014): "*..., the crisis did not entail any market attenuation or reversion of the preference of euro area countries to trade among themselves.*" Thus, the study reports that the recent public debt crisis did not influence considerably the trade volume between euro member states.

Therefore, by following the financial transmission channel, we observe that an increase in sovereign risk premia adversely affects financial markets, which transfer this vulnerability to the corporate sector in the economy. Specifically, disruptions and distortions in credit markets due to a higher sovereign default risk transmit to the real sector during the euro crisis period in EMU. In general, banks typically invest and hold large amount of government's securities in their balance sheets. With the sovereign crisis episode, these securities morph from risk-free to risky assets, which become a catalyst in generating liquidity problems for the respective financial institutions. Consequently, the distressed financial sector starts reducing its exposure to the liquidity risk and hence commences deleveraging that adversely affects non-financial firms' cost of borrowing and funding needs. Besides, extant empirical literature

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<sup>24</sup> In current thesis, we treat the confidence channel as a contagion channel of credit risk in respective debt markets in the context of euro zone.

<sup>25</sup> For details see ECB's 2014 study on "Cross-border spillovers in the euro area" conducted by D'Auria et al.



limits its attention to the sovereign-bank nexus in evaluating the consequences of the sovereign crisis.<sup>26</sup>

In this context, we attempt to evaluate sovereign risk spillover to the real sector through banks liquidity risk. Particularly, we propose to use the prevalent channel of liquidity creation in the traditional function of commercial banks as a conduit of the sovereign risk premia to the real sector during the public debt crisis in the euro zone. Since one of the principal roles of banks is to provide services to domestic economic agents regarding the demand for and supply of funds to meet their liquidity requirements, commercial banks provide credit to the real sector for the sustenance of economic activity by taking into consideration its exposure to the liquidity risk which banks generate while transforming liquid liabilities (i.e. demand deposits) into illiquid assets (i.e. corporate loans).<sup>27</sup>

Moreover, the sovereign crisis effect is higher on firms that fundamentally relied on the local banking sector to fulfill their funding needs. Hence, firms that are highly dependent on domestic banks become more financially constrained due to the adverse spillover effect of sovereign risk premia on banks' fundamental role of liquidity creation.

On the other hand, following the contagion channel, existing literature has mostly overlooked the importance of the real sector's credit risk interconnectedness with sovereign and financial markets in the context of euro zone (Gray, 2009). In particular, rather than to treat the solvency risk as a gradual change in the sovereign CDS premia, the tendency of investors to price risk of default in these markets is like an on-off phenomenon. In this regard, the convergence and then subsequent divergence in sovereign spreads in European debt markets is a prime example. Since the onset of EMU, the investors have reduced risk premia for all member states irrespective of their competitiveness level and fiscal space and have treated them on a par with core countries. In contrast, with the occurrence of a common shock from GFC, investors abruptly started to re-evaluate the sovereign risk that result in divergence and higher spreads for member states with narrow fiscal space especially in the sovereign CDS market. In addition, financial and corporate debt markets follow the similar trend.

In this respect, one strand of existing contagion literature mainly observes that the volatility in the risk premia of sovereign and financial sectors is not only limited to underlying

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<sup>26</sup> See: Gennaioli et al. (2014) and Noyer (2010) among others

<sup>27</sup> See, Diamond and Dybvig (1983) for details

fundamentals and common risk factors but that there is also a contagion effect present.<sup>28</sup> Besides, others observe that the contagion risk is over-emphasized and that increased interdependencies among the credit risk of respective debt markets were present in the euro area during the sovereign debt crisis.<sup>29</sup> Furthermore, among the proponents of the presence of contagion in the increase in spreads of sovereign and financial risk premia, there exists a lack of consensus on the relative order of this contagion in the EMU during the recent crisis episode. In addition, there exists a debate among empirical authors regarding the credit risk contagion from peripheral countries to the rest of the euro zone and also on which periphery member state is the main culprit in this regard.<sup>30</sup> On the other hand, there are some studies that outline the importance of core countries' credit risk as contagion towards the remaining euro zone and observe that peripheral states did not significantly generate a credit risk spillover during the euro crisis episode. So, it is not unfair to observe that the interconnectedness between the real sector credit risk and the financial and sovereign sectors has been altogether ignored in the context of the recent public debt crisis in the EMU.

Therefore, for policy implications to ameliorate the understanding of how such credit risk dynamics act as a contagion during turbulent periods in the euro zone, an empirical study is needed. Hence, the last chapter of this thesis focuses simultaneously on credit risk contagion and its interconnectedness among sovereign-bank-firm nexus due to the consequences of the recent sovereign crisis on the real and financial sectors in the EMU.

## **Research questions**

Since the onset of the euro crisis, academics and policy makers have turned their attention towards evaluating the credit risk interdependence only among the sovereign-bank nexus. In this vein, the importance of the real sector has been overlooked while formulating corrective measures for the recovery of economic growth especially during turbulent times in EMU. Extant literature evaluating the sovereign crisis effect on the real sector mainly focuses on emerging markets. In the context of the euro zone, empirical literature is scarce and only a handful of studies have addressed this issue during the euro crisis period.<sup>31</sup> The current thesis presents a study that examined the consequences and transmissions of the recent public debt crisis on the real and financial sectors in the euro area. After examining the spillover effect of

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<sup>28</sup> See: Ang and Longstaff (2013), Aizenman et al. (2013) and Missio and Watzka (2011) among others

<sup>29</sup> See: Cochrane (2010)

<sup>30</sup> See: Koop and Korobilis (2016)

<sup>31</sup> See: Augustin et al. (2016)

external public debt along with domestic and total public debt on non-financial corporations, we take into consideration the efficiency of austerity measures during the euro crisis period in the EMU. Subsequently, this thesis explores the spillover channels through which sovereign distress transmits to the real sector especially during the sovereign crisis period in the euro area member states.

Therefore, the current work examines the recent sovereign crisis spillover effect on the respective real and financial sectors by addressing the following issues:

- Firstly, we evaluate the spillover effect of the sovereign debt crisis on the borrowing costs of non-financial firms in the euro zone. In this respect, emphasis has been placed on the importance of the impact of the external public debt in contrast to domestic and total public debt on the borrowing costs of private firms in view of foreign investors' behavior during the euro crisis episode. After confirming the adverse spillover effect of the sovereign debt crisis on the real sector and respective interactions regarding the strength of creditors' rights protection, the study focuses on gauging the effectiveness of response actions by euro area member countries against turbulent times. In this vein, we analyze the impact of fiscal austerity measures on non-financial syndicated loan spreads during and before the euro crisis in the EMU.
- The second issue deals with the transmission channels of the sovereign risk to the real sector in the euro zone especially during the recent crisis. In particular, we wonder whether it is the distortions in the domestic banking sector which transfer the sovereign crisis spillover to the real sector. If it is, then how does the banking sector transmit sovereign vulnerability towards the real sector especially during the euro crisis period? In this regard, we evaluate that is it the liquidity creation process of commercial banks that transfers sovereign distress to non-financial firms in the euro zone? Moreover, we determine whether the banking sector acts as a channel of potential causality of real sector vulnerability towards the sovereign sector among euro area member states during recent turbulent times.
- Finally, we turn our attention to evaluating the presence of a contagion channel in the transmission of sovereign vulnerability towards the real and banking sectors during the euro crisis period. In particular, we examine credit risk dynamics in the sovereign-bank-firm nexus simultaneously in the euro zone. The principal hypothesis in this chapter is that the abrupt increase in risk premia of the sovereign-bank-firm nexus during the euro crisis is partially due to the fear of a systemic meltdown of respective

debt markets, which is contagion by nature. Moreover, we evaluate, the inter and intra sector contagion risk within euro area member states and also the inter-country contagion of credit risk among respective debt markets in the EMU. Hence, the last chapter of this thesis treats the disruptions in respective CDS markets due to the adverse impact of the recent euro crisis in EMU countries.

## **Course of analysis**

Following this introductory section, Chapters I to III comprise self-contained empirical studies and address the research questions outlined in this section while evaluating the spillover effect of recent sovereign crisis on real and financial sectors in the EMU. Finally, following chapter III we provide a general conclusion of this thesis. A brief summary of individual chapters follows.

*The first chapter* aims to answer the questions of whether sovereign risk had a negative spillover effect on the borrowing costs of non-financial firms during the euro crisis period in the presence of austerity measures in the euro zone. In this field, theoretical and empirical literature on sovereign debt and default risk, in general, do not adequately take into account the relationship between sovereign debt risk spillovers to the private sector borrowing cost. Particularly, contemporary work mainly focuses on identifying and analyzing the related costs and causes of sovereign default in order to come up with optimal strategies to lessen the adverse effect of these consequences from the sovereign point of view. However, recently a handful of researchers have turned their attention to evaluating the effect of high sovereign debt risk on the real sector. But this strand of literature is still in its infancy and covers only emerging market economies. This chapter empirically attempts to evaluate the effect of external public debt on private sector's foreign borrowing cost in developed markets especially in euro zone countries. In addition, we assess the significance of total and domestic public debt on syndicated-loan spread. Furthermore, the study treats the impact of austerity measures taken by euro area member states, on the syndicated-loan spread of private firms and attempts to revive economic growth in the monetary region.

To test these hypotheses, we follow multivariate Ordinary Least Square (hereafter, OLS) regression estimation to assess the effects of external, domestic and total public debt levels to GDP on the borrowing cost of private firms. By using foreign syndicated-loan issuance data of non-financial private firms covering the period from 2005 to 2011, we attempt to gauge how the cost of credit in the private corporate sector varies with perniciously high levels of

external public debt prevalent in the euro area region. Furthermore, we broaden existing literature on sovereign debt crisis by using alternative measures to study the spillover effect of public sector indebtedness on the private sector in advanced economies. Moreover, in line with the existing strand of literature, we examine the importance of total and domestic public debt to GDP on the cost of credit of non-financial private firms. In this context, we also analyze how recent fiscal consolidation efforts during the euro crisis have affected the foreign syndicated-loan spread of the private sector in these distressed economies.

Our results suggest a statistically significant spillover effect of external public debt on the cost of credit for private firms in the euro zone. In particular, an increase in external public debt by one standard deviation from its sample mean raises the foreign syndicated-loan spread by 89 basis points (that is, 47% increase in the mean value). Furthermore, the weak creditor rights protection prevalent in some euro area countries enhances and deepens the effect of the high levels of external public debt on the foreign syndicated-loan spread in the private sector. However, we do not find any significant effect of domestic public debt on the private sector borrowing cost. In addition, the results show a significant effect of fiscal consolidation efforts on the spread of private sector syndicated-loans, both in the period preceding the crisis and during the recent crisis within the euro zone. Specifically, one standard deviation change in the fiscal consolidation conditional mean reduces the syndicated-loan spread by 22 basis points (that is, 12% decrease in the mean value) during the public debt crisis episode. Thus, it indicates the presence of the credibility channel of austerity measures in euro area countries. Nevertheless, the fiscal consolidation efforts also validate the presence of the Keynesian aggregate demand channel by showing a slight increase in the syndicated-loan spread in the period preceding the euro crisis.

In the *second chapter* we extend the analysis by evaluating how this sovereign vulnerability transmits to the real sector. We suggest that the banking sector liquidity creation process is a major conduit for this transmission. In this field, extant literature fundamentally deals with either the sovereign-bank nexus or the bank-corporate nexus while evaluating the public debt crisis effect especially in the context of emerging economies. This led to a debate among empirical authors' regarding the order of the vulnerability spillover in the sovereign-bank nexus during the recent crisis period. Moreover, other existing studies observe that banks change their liquidity management strategies with the onset of turbulent financial times and become hesitant in extending credit to non-financial firms. Keeping this in mind, we attempt to analyze the rational consequences of the recent sovereign crisis on the real sector by

simultaneously treating the sovereign-bank-firm nexus as an instantaneous structural system that generates an incessant feedback loop of default.

To evaluate these conjectures, we follow the simultaneous equations model approach to assess whether the banking sector liquidity risk acted as a transmission channel of sovereign distress to the real sector during the recent euro crisis in the EMU. To achieve this, we use the methodology provided by Berger and Bouwman (2009) to develop a liquidity risk index that estimates the liquidity creation process of commercial banks while extending corporate loans. For this study, we focus on twelve euro zone member states for the period 2005 to 2012. Since there is an instantaneous correlation present between systems of simultaneous equations, econometric literature argues that the hypothesis of orthogonality among residual variance-covariance matrix does not hold. In this regard, the OLS and 2SLS methods provide biased estimators. Therefore, we use the Three Stages Least Squares estimation (hereafter, 3SLS) method to evaluate this system of simultaneous equations because it not only corrects the endogeneity of regressors but also treats the problem of cross-correlation among equation errors in the system. Moreover, OLS and 2SLS estimators are single equation estimators whereas 3SLS is a system estimator that simultaneously estimates the coefficients of linear equation system in a single process.

The empirical results observe a significant sovereign risk spillover to the banking sector liquidity creation process which then passes this effect to the real sector borrowing cost while simultaneously re-channeling it back to public sector especially in euro crisis period. Furthermore, the effect of policy intervention through the ECB's rescue package is also evident in our results. Particularly, banks attempt to generate liquidity for short term towards non-financial firms but at very high interest cost. This may portray the carry-trade behavior of commercial banks during the euro crisis period in EMU countries. On the contrary, by analyzing the results of the period before the sovereign debt crisis, we substantiate the existing findings of Ivashina and Scharfstein (2010) that banks change their liquidity management strategies according to the nature of the financial crisis. Hence, our results validate distortions in domestic credit markets due to sovereign debt crisis that transmits distress towards real sector in euro area member states.

Finally, *the third chapter* focuses on the evaluation of the presence of a contagion effect from the sovereign risk premia on the real sector through disruptions in respective CDS markets with a potential conduit of the banking sector credit risk especially during the European debt

crisis. In particular, we suspect that the increase in sovereign risk premia contagiously transmitted to the financial and real sectors during the euro crisis episode. Since the onset of the global financial crisis and then sovereign debt crisis in 2010, policy-makers and academics have turned their attention towards the potential effect of contagion in debt markets especially in sovereign and financial sectors of the euro zone. Despite a rapid increase in empirical studies there exists a lack of consensus regarding the presence of contagion effect among credit risk dynamics of respective debt markets. In this field, a handful of authors argue that the contagion risk transmits from feeble sovereign to banks' credit risk whereas others argue that a fragile banking sector contagiously influences respective sovereign risk premia during the euro crisis period. Moreover, there are some current studies that do not observe the contagion effect in the credit risk dynamics of the sovereign-bank nexus and proposed only the increased interdependence and correlation among euro zone member countries during a European debt crisis. At this point, the importance of the credit risk interconnectedness of the real sector with the sovereign-bank nexus is totally ignored by the related literature during turbulent times, as outlined by Gray (2009) and BIS (2011a).

In this respect, this chapter aims to extend the empirical literature by not only dealing with the presence of the contagion risk in the sovereign-bank nexus but by also simultaneously including the related non-financial sector's risk of default in credit risk dynamics. Keeping in mind the said empirical debate, we follow the contagion definition provided by Constâncio (2012) that treats it as the "excessive spillover" of credit risk in corresponding debt markets. Particularly, we purge the macro-economic and idiosyncratic risk factors and use the OLS residuals of CDS spread of sovereign-bank-firm variables in the panel vector autoregression model (hereafter, PVAR) to estimate the credit risk contagion effect. Thus, to examine the presence of the contagion effect in the credit risk of the sovereign-bank-firm nexus during the euro crisis period, our analysis is fundamentally based on the impulse-response functions with respective variance decompositions and Granger causality tests derived from PVAR estimation results that are significantly different from zero. Besides, the PVAR model is in line with this study's objectives to evaluate the contagion effect of the transmission of shocks across different countries and economic sectors as it furnishes a valuable and concrete econometric tool to analyze the dynamics of financial and economic processes (Canova and Ciccarelli, 2009). In this manner, PVAR not only efficiently deals with the issue of unobserved dynamic heterogeneity among parameters but also treats the static and dynamic

interdependence that are subject to time variation in coefficients and variance of innovations (Hayashi, 2000).

On the aggregate euro zone level, our results report evidence of systemic contributions of each sector through credit risk contagion measures that prove to capture time-varying interdependence among sectors and time-invariant interdependence within sectors of the sovereign-bank-firm nexus during recent crisis episodes. Besides, the contagion risk between debt markets of the sovereign and bank sectors is higher than respective non-financial firms in the euro zone. Moreover, during the sub-prime crisis episode, the contagion risk was present not only from banks to the solvency risk of sovereign, but there was also evidence of an excessive spillover of the corporate default risk to respective public sector credit risk. Regarding the euro crisis, there is, on the one hand, evidence of the sovereign risk premia contagiously affecting the banking sector. On the other hand, the financial sector indulges in carry-trade behavior with lucid observation of private-to-public transformation of the credit risk in the EMU.

Furthermore, we try to validate these results by analyzing credit risk dynamics of the sovereign-bank-firm nexus in individual euro area countries. In this regard, our findings on individual member states partially substantiate the aggregate euro zone results. On the one hand, we show it is not necessary that the nature of crisis remain time-variant inter sectors during turbulent periods; on the other hand it is also not reasonable to assume that the nature of the financial crisis remains sector invariant during a specified time period as proposed in existing studies. In particular, related literature reports that since 2010 the nature of turbulence in euro zone has only been related to fiscal imbalances (see: Harjes, 2011 and Popov and van Horen, 2013 among others).

Finally, while examining the contagion effect from individual member states to the rest of the euro area, our results report a significant contagion risk from GIPSI (except Italy) countries towards the remaining euro zone especially during the recent European debt crisis. However, the contagion risk is not only transmitted from vulnerability in sovereign solvency; there is also evidence of excessive spillover from feeble banking sector credit risk to the euro area (in the case of Ireland). With regards to core countries, our results substantiate the peripheral countries findings and additionally report the “flight-to-safety” phenomenon. Hence, this result observes increased liquidity towards core countries which are fiscally and financially



stable in the EMU. In turn, it shows that investors in respective debt markets are sensitive to turbulent times and search for quality in return in the euro zone.

## **Chapter I**

### **Impact of sovereign debt crisis and corrective austerity measures on real sector borrowing cost in the euro zone**

*“Global growth momentum appears to be weakening and the global economy remains unusually vulnerable to key risk. The most immediate risk is a further escalation of financial stress in the euro area gains following exceptional policy actions have been eroding until recently and **the euro area crisis remains the most immediate threat to global growth.**”* 2012 Staff reports for the G-20 Mutual Assessment Process (MAP), Annex 1: Global risk Analysis. IMF (2012)

#### **1 Introduction**

With the onset of sovereign debt crisis in euro area countries,<sup>32</sup> this chapter basically looks into detail as how the spillover effects of related sovereign debt risk impact the private sector especially in advanced economies (such as euro zone). In other words, we attempt to evaluate how syndicated-loan spread of private firms (that is, the borrowing cost) behave in this crisis period, depending upon foreign investors reaction in granting loans / credit to the real sector of developed countries suffering with perniciously high public debt in relation to their respective GDP levels.

Most of the literature regarding the spillover effect of sovereign debt on the real and financial sectors relates to emerging market economies due to a trivial reason that this problem,

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<sup>32</sup> By sovereign debt in this chapter, we mean external public debt unless otherwise stated. Furthermore, it is defined as sovereign debt owed to foreign creditors (that is, debt issued in the foreign capital market)

historically, prevails within the aforementioned countries (Panizza et al., 2009).<sup>33</sup> In developing economies, with lack of well-structured financial and capital markets, the home government in order to fulfill the funding needs extends its presence not only to the domestic markets but more importantly to the international capital markets. In particular, governments in emerging economies increase spending to support the long term investment projects (for example, through funding a public work program or a social program) in order to stimulate the economic growth. This, on the one hand, augments the economic output but on the other hand, incurs budget deficit that leads to higher public debt in relation to their GDP levels.

With increased public debt levels, the developing economies become more vulnerable to related sovereign debt risk mainly because of the following three reasons as identified by Eichengreen and Mody (2000). Firstly, due to the volatile nature of developing economies it is difficult for them to service the outstanding public debt in timely manner (that is, due to the lack of resources). Secondly, absence of strong political, legislative and administrative institutional framework leads to the formation of inadequate and unstable political & economic policies. Finally, the inability of developing sovereign to obtain the credit in home currency with longer maturities render these emerging economies vulnerable to any negative shock in relation to respective creditors currency, which in turn leads to depreciate the home currency and increases the level of outstanding debt in domestic currency. Furthermore, with shorter maturities, the rolling over of current (payable) portion of outstanding public debt is frequent which becomes difficult to renew or streamline, if creditors perception of their debt repayment capacity changes.

In contrast, sovereign in developed economies tend to borrow in their home currency, mainly from well-structured domestic markets and if needed from international capital markets with longer maturities. This, in turn shields them from the exchange rate risk and rollover effect (Nelson, 2013). Nevertheless, with the emergence of the US sub-prime crisis (2007-2009), the focus of sovereign debt sustainability has shifted from emerging markets to advanced economies. In other words, with the commencement of recent financial crisis in the US, the overall global risk aversion in international credit market changes negatively for developed countries especially regarding the euro area. In this context, Mody A. (2009) shows that the change in the risk aversion for euro zone countries started after the rescue of Bear Sterns by the US government in March 2008. Specifically, the study outlines this event as a turning

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<sup>33</sup> However a handful of researchers explore this issue in advanced economies, see: Augustin et al. (2016), Bai and Wei (2012) and Andrade and Chhaochharia (2012).

point for the onset of differentiation among individual sovereign spreads within euro area economies.

In particular, a shock from the US sub-prime crisis in fact unveils deficiencies that are inherent in the fiscal competitiveness between the euro area member states. Ironically, these inherent fragilities were present since the start of European Monetary Union. Specifically, with the launch of the euro zone (hereafter, EZ), the lack of attention on policy measures regarding the fiscal aspect gives birth to the said latent weaknesses in the monetary union that comes to surface after absorbing a “common shock” in the form of global financial crisis (hereafter, GFC). Thus in response, euro area economies in order to cope up with this adversity have followed different initiatives such as approving fiscal stimulus packages and converting the private debt into public debt which leads to increase the overall sovereign risk premia in the euro zone (Nelson 2013). In this context, it is important to note that, historically the sovereign debt and default literature mainly focuses on the emerging and developing economies. However, with the onset of the global financial crisis the trend regarding sovereign debt sustainability has shifted towards advanced economies and especially to the EZ.

Consequently, the empirical literature on this issue is relatively sparse in the domain of advanced economies.<sup>34</sup> Hence, the current chapter fills much needed void by studying and evaluating effects of high levels of sovereign debt on the borrowing cost of private sector (that is, the syndicated-loan spread) of euro area countries. In addition, we try to assess the impact of austerity measures followed by euro zone member states on the syndicated-loan spread of private firms to revive the overall economic growth in the monetary region.

Therefore, this chapter uses foreign syndicated-loan spread data of non-financial private firms for 14 euro area countries covering the period 2005-2011. In this vein, we find that the stress in external public debt level significantly affects the foreign cost of credit of private firms in the euro zone. Particularly, our results show that countries with weak creditor rights protection are subject to manifest more vulnerability against the increased external public debt levels as compared to countries with stronger creditor rights protection. However, in the euro zone, creditor rights protection only play an important role till a certain level (which is in this study is found to be at rank 2<sup>nd</sup> out of 6 in the creditor rights index) after which its moderating

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<sup>34</sup> In context of euro zone, see: Augustin et al. (2016)

effect on the relationship between the external public debt and foreign syndicated-loan spread abates and becomes insignificant.

In addition to the external public debt, following the contemporary literature we examine the significance of total and domestic public debt on the borrowing cost of private firms.<sup>35</sup> Taking into consideration the arguments of Reinhart and Rogoff (2011c) which outline that in fact it's the domestic public debt that needed due attention in comparison to the external public debt because the latter constitutes only a small percentage of the total public debt in the domain of emerging economies. In a similar respect, we also assess the importance of total and domestic debt versus external public debt on the syndicated-loan spread. Our results show that the total and external public debt significantly affects the borrowing cost of private firms in the EMU. Whereas, we do not find significant effect of the domestic public debt on the foreign syndicated-loan spread of these firms. Moreover, a distinct impact of euro crisis is documented on the private sector by analyzing austerity measures effect on the foreign syndicated-loan spread. In particular, our results suggest that during the crisis period, fiscal consolidation efforts significantly affect the cost of foreign credit and in turn reduce the syndicated-loan spread of private firms. Hence, it aids to provide an impetus to rejuvenate the overall euro zone economy during the times of borrasca.

The rest of this chapter is organized as follows. Section 2 briefly presents the related literature. Section 3 explains the data and related empirical approach. In Section 4, we present and discuss the estimation results and finally, Section 5 concludes this work.

## **2 Literature review**

### **2.1 Sovereign debt and default risk**

Despite the lack of a consensual definition, the sovereign debt default can be considered as a situation where a sovereign (that is, the government) fails (that is, defaults) to honor its outstanding debt. In other words, when a sovereign is unable to repay all or part of its debt (that is normally, interest and or principal) to creditors the act of default occurs. Between World War II and 1970, there were very few sovereign defaults around the world. However, between 1970 and 2010, there were over 180 public debt restructurings and these have affected 68 countries (Cruces and Trebesch, 2013). The Latin America tends to be the first region where most sovereign defaults occurred. Some countries such as Argentina, Brazil and

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<sup>35</sup> See: Presbitero (2010), and Reinhart and Rogoff (2011b) among others.

Nigeria have experienced more than six restructurings during this period. The losses suffered by creditors (hereafter, the "haircuts") amounted on average to 37% of the total outstanding debt. These haircuts have increased over time: amounted to 25% in the 1980's and then to almost 50% in the 1990's and the 2000's. During the last half century a sovereign default phenomenon was a main concern only in developing countries. However, the recent debt crisis in the EZ and in particular the budgetary difficulties encountered by Greece, has shown that the developed countries are not immune against the probable risk of sovereign default (Baimbridge and Whyman, 2015).

In general, sovereign debt securities perceived to have risk free status in the international capital markets as compared to corporate securities even when they are not backed-up by any physical collateral as in the case with latter instruments. This is because the government enjoys certain privileges, such as: the power to tax economic agents to raise revenue, or to print the required volume of currency to service the outstanding debt or, ideally, to refinance prevalent debt contracts.<sup>36</sup> In addition, the sovereign debt also differs from the corporate debt in the notion of enforceability of repayment by respective creditors. As creditors have explicit rights and claims to the private debtor's assets, so in the case of non-payment they can sue the defaulted private debtors and can recover the amount due, but with debtor governments this is not the case.<sup>37</sup>

In fact, the sovereign enjoys relatively the absolute legal immunity due to the doctrine of equality under the international law. As put forward by Crawford (2012)<sup>38</sup>, "legal persons of equal standings cannot have their dispute settled in the courts of one of them". In other words, author stipulates that the sovereign cannot be challenged and sued in the foreign courts. However, a debtor sovereign can be prosecuted in international courts only if it is willing to go through with this process. Having said that, the question which can be invoked here is that with such a limited ability of creditors to collect from the debtor governments, why then foreign creditors invest in sovereign debt securities?

In the seminal paper, Eaton and Gersovitz (1981) provide solution to this conundrum by stating that it is the potential threat of losing access to international capital markets which

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<sup>36</sup> See: McConnell, Brue and Flynn (2009)

<sup>37</sup> However, for the past two decades, the legal environment has changed considerably providing enforceable rights in the court of law (especially in the US) to holdout creditors against the defaulted debtor countries, but judgments remain in-definitive, in general (Sturzenegger and Zettelmeyer, 2006)

<sup>38</sup> Crawford (2012), "Brownlie's Principles of Public and International Law", Eighth Edition, Oxford University Press

urges the government to repay the outstanding debt, eventually. In particular, the study mainly focuses on the repudiation cost of defaulted sovereign. The authors arrive at this conclusion by following the underlying assumptions that: (i) creditors only have the option to react by permanently excluding the defaulted sovereign from any future debt contract, (ii) the sovereign does not have any other avenue to fulfill its funding needs, and (iii) the government requires credit only in order to streamline the real output variability prevalent in respective economies.

As with other economic theories, the classical theory<sup>39</sup> of sovereign debt is also criticized on the basis of its assumptions. Bulow and Rogoff (1989) argue that if there are alternative funding avenues available to streamline the country's expected consumption needs against the variability in its output level, then the threat of credit refusal loses its attraction. In particular, the study manifests that as the country exhausts its upper limit on debt levels in international capital markets, then it can start to divert attention and encourage the saving behavior. That is, the debtor country may default on its outstanding external debt irrespective of the consequence to the reputational cost as outlined by Eaton and Gersovitz (1981). In turn, the debtor country never borrows again and indulges in savings to pursue the cash-in-advance contract that serves like an insurance to fulfill its expected consumption needs in the future. Therefore, in such case the debtor country can choose not to repay its outstanding public debt and use the payment stream to pay-up in front to foreign creditors to purchase the cash-in-advance contract. Hence, in this behavior a debtor country is able to buy an insurance contract that replicates the debt contract which provides funds in times of low output (shocks), leading to reduce the significance of credit denial in foreign capital markets in the case of default.

In addition, Dooley and Kletzer (1994) show that in case the debtor government defaults then the feasible option available to both parties (that is, the debtor and the creditor) to benefit, is the renegotiation of debt contract with revised agreement (and not exclusion from the international credit markets). In fact, they argue that as the debtor country defaults, its ability to repay increases and it is not pedagogical for the lender to impose a future ban on lending because it will adversely affect the creditor. On the one hand, this will not only provide an incentive to the creditor to resume future lending but, on the other hand, it furnishes a much needed opportunity to minimize the creditor's losses and in turn leads to a win-win situation for both the parties involved.

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<sup>39</sup> Eaton and Gersovitz (1981)

Notwithstanding, while arguing the Eaton and Gersovitz classical economic theory of sovereign debt, later contemporary work divides the literature into two strands: one group of authors focus on direct punishments and the other group on indirect punishments as a repercussion to the defaulted debtor governments, in general.

### 2.1.1 Costs and consequences

According to related studies, the cost associated with the sovereign default considers to be the main reason that renders the public debt possible. If there was no obligation on states to repay their debt, the economic agents would not naturally be encouraged to lend to them. On the other hand, if it is costly for states to default, then they have an incentive to service their debt. Consequently, the lending decision of economic agents depends on the importance of these costs of sovereign default.

In this context, firstly, there are costs in terms of reputation: a state that does not repay its debt faces the risk of being excluded from financial markets. Eaton and Gersovitz (1981), report that the threat of exclusion of government from international capital markets is a sufficient condition to exhort it to repay its outstanding public debt. In addition, if a sovereign proves to be unable to repay its debt, it would send a negative signal to other economic agents which are presumed to be involved in related transactions that strengthen the debtor government incitement to service its debt. Also, a country with default faces the risk of trade sanctions or even military intervention from the creditor countries or from the region where creditors reside. However, Bulow and Rogoff (1989) doubts the significance of reputation costs in the repayment of outstanding public debt and argue that in fact direct sanctions from lenders are primary factors that force states to repay their debt. In turn, a sovereign default affects the economic activity, generating turbulence in the financial and real sectors.

Hence, contemporary studies distinctly bifurcate the consequences of sovereign debt default into two strands of literature: that is, into a direct and an in-direct punishment cost. In this context, the first strand focuses on the direct punishment from creditors as a consequence for the non-payment of outstanding debt by debtor countries. This group accentuates that default will have an adverse effect on the debtor country's trade flow and payment. In particular, studies in this group outline that as the debtor government defaults on its outstanding debt then creditors penalize the defaulted sovereign by directly influencing its trade flows and related payment not only domestically but also with other trade partner countries (see: Sachs and Cohen, 1982; Bulow and Rogoff, 1989; Fernandez and Rosenthal, 1990; Rose, 2005 and



Zymek, 2012 among others). To this end, Zymek (2012), reports that the trade volumes of the debtor sovereign goes down after its inability to honor the external sovereign debt. In particular, the study shows that the default by a sovereign directly affects the access of its export-oriented firms mainly to international capital markets which lead to the reduction of the overall trade volume.

In a similar vein, the second strand follows the indirect punishment effect on the default of the debtor country from creditors through the change in relationship between domestic economic agents with its debtor government. Strictly speaking, the default event adversely affects sovereign's reputation, not only internationally but also domestically, while evaluating the informational content of the related default in relation to the underlying economic structure (see: Eaton, 1996; Cole and Kehoe, 1998 and Kletzer and Wright, 2000 among others).<sup>40</sup>

In this respect, Cole and Kehoe (1998) document that there are two types of government: "honest" (that always repay) and "normal" (that sometimes default). The study shows that this reputation of sovereign tends to be replicated among its relationship with different economic agents. Assuming the type of government is not known, if the debtor government defaults on its outstanding debt to lenders/creditors (that is, affecting the change in sovereign's reputation with one relationship) then this untrustworthy perception will reproduce within its other relationships as well, that is with domestic economic agents. This led to spread a negative sentiment in local markets which in turn generated the uncertainty regarding the debt repayment to domestic creditors that triggered a chaos in the economy as a whole.

However, the related empirical literature seems to suggest that these various costs are temporary by nature. In this vein, Borensztein and Panizza (2009) confirm that countries which default on the public debt lose access to international capital markets. As a consequence, the credit rating fall immediately and the sovereign risk premium increases by almost 400 basis points. This effect, however, is short term in nature and disappears between three to five years after the default. In addition, Gelos et al. (2011) show that after the sovereign defaults, countries are excluded from international credit markets on average over four years. In short, the temporary exclusion from capital markets suggests that these markets have a considerable short term memory.

Moreover, Cruces and Trebesch (2013) strongly confirm this conclusion. According to the authors, the default generates cost to the government but in medium term. They suggest that

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<sup>40</sup> For a detailed survey of the related literature on the sovereign debt theory, see: Panizza et al., (2009).

these costs could be more significant if sovereign defaults are distinguished according to the losses incurred by creditors. In other words, higher losses or haircuts are associated with higher borrowing costs and longer exclusions from international credit markets.

Besides, empirical studies have also tried to quantify other costs related to sovereign defaults. The analysis by Rose (2005) suggests that the volume of bilateral trade fell about 8% per year following the sovereign default. In a similar vein, Borensztein and Panizza (2009) also report a collapse of trade volume following the sovereign default, but the study fails to accurately identify channels through which default affects the trade volume. The impact once again appears to be short term in nature and seems to disappear after two to three years of default event. In addition, Borensztein and Panizza evaluate the impact of sovereign default on the economic growth. The study reports, on average, that growth rates decrease by 2.5 percentage points in the year of default. However, effects on growth do not seem significant in the following year. Nevertheless, the recession period seems to precede the sovereign default event.

Keeping in mind the brief discussion, it can be said that the contemporary empirical literature lacks to comprehensively take into account the cost effect of sovereign debt risk and its default on the corporate sector in an economy. Thus, the related literature ignores to evaluate adequately the impact of sovereign debt risk on different economic agents (such as non-financial sector) in distressed countries. In particular, recent studies mainly treat the issue only from a sovereign point of view while evaluating its ability to honor the outstanding public debt. Furthermore, as outlined by Borensztein and Panizza (2009), the increase in sovereign debt risk and its probability of default is subject to the state of economy. In other words, the study reports that the volume of debt flows are linked with the economic cycle and in fact the volatility in output growth leads to increase the sovereign risk of default on its public debt.

### 2.1.2 Sovereign debt flows and economic cycle

Mostly, the theoretical literature on the sovereign debt risk focuses on the premise that debt flows from countries with higher income level to economies with lower income level. Specifically, the debt flow tends to follow the transferring of income from sovereigns with stable economies and increased income levels to countries with poor economic conditions having lower to minimal income levels. In particular, these models assume that the debt flows

are counter-cyclical in nature, that is, countries borrow when there is a variability in the output gap (that is to streamline the consumption levels in order to revive the economy) and repays when the economy is in good shape with reduction in the output gap volatility (that is, when in a prospering state) (see: Eaton and Gersovitz, 1981 and Bulow and Rogoff, 1989 among others).

However, this notion is not comprehensively validated by the empirical strand of literature. In fact, the related empirical studies show that the debt flows (especially from private lenders) are pro-cyclical in nature i.e. the borrowing level increases when the economy is in times of bonanza and decreases when it is in times of borrasca (see: Gavin and Perotti, 1997 and Yeyati, 2009 among others). In particular, the proponents of pro-cyclicality stress on the notion that as the economy is in a recovery stage and starts to thrive then it's growth rate gradually increases which leads to higher borrowing by sovereign to streamline the aggregate demand level (Aguar et al. 2009). In other words, the principal reason behind this behavior is due to the increase in the probability of market failure during the recessionary period in debtor countries. Consequently, not only the aggregate demand level goes down but also the emerging economies access to international capital markets tends to get restricted. Hence, it leads to the reduction in the supply of credit especially by private lenders.<sup>41</sup> Therefore it can be inferred from the related literature that generally the private lending is pro-cyclical by nature whereas, the official lending is counter-cyclical to debtor economies.

Furthermore, the empirical literature lacks to validate the sovereign default risk trend outlined by respective theoretical studies. Specifically, theoretical models show that a sovereign does not default on its outstanding debt in the first place. However if it decides to do so, then the default event will ideally takes place when the economy is in good state because the debtor government cannot afford to bear the consequence of default in bad economic times (Rochet, 2006).<sup>42</sup> While, the empirical evidence reports contrasting results showing that a default by debtor countries generally occur in the period of low economic growth (see: Tomz and Wright, 2007 and Yeyati and Panizza, 2011 among others). In addition to analyzing the repercussions of high levels of sovereign debt risk and its default, another strand of literature focuses to evaluate the determinants of sovereign default. In this context, the related studies report that the fundamental cause behind a sovereign default is the reduction in the economic

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<sup>41</sup> Other reasons for a pro-cyclical behavior include; political failures and persistent output shocks (see: Tornell and Lane, 1999; Talvi and Végh, 2005; Aguiar and Gopinath, 2006; Rochet, 2006; Alesina et al., 2008 among others)

<sup>42</sup> Hence, the debtor government follows strategic default rather than the forced one.

growth<sup>43</sup> and foreign reserve levels<sup>44</sup> with a simultaneous increase in the total public debt to GDP levels (see: Rijckeghem and Weder, 2004 and Pescatori and Sy, 2007).

Hence, on the one hand most of contemporary studies mainly evaluate the impact of sovereign debt risk and or default risk on the government's potential capacity to borrow from the international capital market and its relation with real output levels. While, on the other hand the rest of empirical work examines the factors leading to sovereign debt default and its relationship with the economic cycle (see: Eaton and Gersovitz, 1981; Bulow and Rogoff, 1989; Eichengreen, 1991; Ozler, 1993; Gavin and Perotti, 1997; Kletzer and Wright, 2000; Rijckeghem and Weder, 2004; Rochet, 2006; Pescatori and Sy, 2007; Tomz and Wright, 2007; Akitoby and Stratmann, 2008; Yeyati, 2009; Gelos et al., 2011; Tomz and Wright, 2010; Yeyati and Panizza, 2011 among others).

Therefore, in the light of afore-mentioned discussion it will not be unfair to say that the previous literature does not adequately explore the relationship between the sovereign debt risk and private sector borrowing cost and thus is inconclusive in nature. Since the last decade, private firm's presence in global capital markets has increased tremendously in order to access the external funding as a source to finance their operational needs (Gadanecz, 2004). Particularly, in emerging economies, private corporates increase their dependence on the external funding from international capital markets to fulfill their equity capital and debt needs (Das et al., 2010).

### 2.1.3 Emerging vs. Advanced economies

In line with a previous section discussion, emerging countries in order to streamline and neutralize their economic output gap (that is, the overall consumption levels) borrows from international credit markets. This behavior is a consequence of the inherent weakness in developing economies because they lack developed financial and capital markets of their own. To this end, not only the sovereign but also the real sector<sup>45</sup> in the emerging market increases its access to international capital markets in order to satisfy the investment and working capital needs to benefit the growth rates prevalent in respective economies (Panizza et al., 2010).

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<sup>43</sup> That is, as fluctuations in the output gap increase sharply

<sup>44</sup> That is, countries with less trade openness

<sup>45</sup> That is in this chapter it refers to the private corporate sector

However, due to the occurrence of recent financial crisis and the subsequent rise in levels of total public debt, the issue of sovereign debt risk spillover to the real economy becomes sufficiently important in advanced markets. Consequently, there is increased attention from policymakers and academics to address this issue in the context of euro zone (IMF, 2013). Specifically, with the onset of the global financial crisis, countries adversely challenged by the fiscal constraints have been fully or partly isolated from foreign markets due to a sharp increase in the risk premium demanded by investors on respective sovereign securities. This in turn adversely affects the real sector of economy—especially the non-financial private firms, which become more fragile in raising funds from the international capital market that lead to affect negatively domestic production levels and the economic growth.

In this respect, ECB (2010) reports that the increase in volatility and deterioration in the sovereign risk perception, leads to important consequences for the overall economy (especially to the private sector) which has not been given due importance in the contemporary literature in the context of euro zone. Besides, a handful of researchers treat the effect of sovereign debt risk spillover to the real sector, but this strand of literature is scarce and is still in its infancy even for emerging market economies.<sup>46</sup> Ideally, we suggest that this relationship may be explained by following the notion of “sovereign ceiling”. Specifically, the sovereign ceiling notion dictates that the international lenders and credit rating agencies, in general, do not treat or give better credit quality to the private borrowers as against respective sovereign borrowers (Cantor and Packer, 1997; Standard & Poor’s, 2011).

Therefore, the rise in overall debt level of sovereign tends to change the risk aversion in the corresponding debt market which leads to affect the borrowing cost (that is, the debt spread) of firms and consequently their access to international capital markets.<sup>47</sup> In other words, the sovereign debt risk adversely affects the overall macro-economic environment and hence the creditworthiness of its corporate sector, in general. However, Durbin and Ng (2005) provide exception to this rule and termed it as a “sovereign ceiling lite”. The study manifests that, indeed, there exists some private borrowers that receive better credit quality than their respective sovereign due to the increased export earnings and or part foreign ownership. However, Borensztein et al., (2013) furnish empirical evidence that this “sovereign ceilings

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<sup>46</sup> See: Arteta and Hale (2008) and Agça and Celasun (2012) among others.

<sup>47</sup> In particular, when these sovereign debt securities morphs from “risk-free” to “risky” status then their related credit risk act as a harmful catalyst that causes severe damages to respective corporate securities in international capital markets

lite” notion is very rare and that the sovereign’s credit quality remains significant and robust against private corporate ratings.

In the light of afore-mentioned discussion, we can observe that the extant literature on the issue of sovereign debt risk spillover to the private sector is scarce even in emerging market economies. One of the foremost and recent empirical contributions in this vein comes from Arteta and Hale (2008).<sup>48</sup> While evaluating spillover effects of the sovereign debt default to private sector in emerging markets, Arteta and Hale show that the sovereign default and resulting debt renegotiation episodes tend to lower the credit supply to private firms from foreign lenders. Stating differently, the sovereign debt default restricts private firm’s access to foreign credit, increases the overall loan spread (i.e. borrowing costs) of firms and in turn affects the real sector. In particular, using a micro-level data of private domestic firms from 30 emerging economies for the period 1984-2004, the study finds that a decline in credit to private firms is smaller during debt restructuring agreements with commercial creditors (that is, private lenders) as opposed to the official creditors.

In a similar vein, Das et al., (2010) also show that the sovereign default negatively affects private firm’s access to external credit with almost 40 percent drop after controlling for output shocks and loan and firm specific fundamentals. Moreover, the study reports that the sovereign default to private external creditors has stronger impact on the spread of private firm’s external debt than the default to the official creditors. Besides, the study also reports that the use of different sovereign risk measures significantly affect the impact of public debt spillover on the corporate borrowing spread in emerging markets.

In this context, Agça and Celasun (2012) report that the higher external public debt levels are associated with the increase in risk premium of private sector debt. Particularly, the study evaluates the impact of sovereign debt risk on a change in the borrowing cost (that is, loan spread) of private corporates in 15 emerging markets for the period 1990-2006. Moreover, Agça and Celasun show positive correlation between the external public debt level and the corporate loan spread, emphasizing that this relationship is strong in debtor countries where creditor rights are weak or if these emerging countries have experienced a default episode in the last 50 years.

Besides, Dittmar and Yuan (2008) show that the sovereign debt risk does not negatively affect the private sector access to foreign capital markets. In the context of emerging economies, the

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<sup>48</sup> For related theoretical literature see: Sandleris (2008) and Mendoza and Yue (2008) among others

study reports that through the issuance of sovereign bonds, the yield spread of corporate bonds reduces due to the increased liquidity in the corporate bond market. In other words, Dittmar and Yuan show that the sovereign risk as measured by the issuance of sovereign bonds deepens the corporate bond market. In turn, it provides a liquid capital market which consequently leads to weaken the relationship between sovereign debt levels and the private sector borrowing cost emanating from the sovereign risk. Hence, this nexus tends to reduce the yield spread in respective corporate bond markets in emerging economies. However, the findings of Dittmar and Yuan should be consider in relation to the availability of alternative funding markets for the corporate sector: that is, the effect of sovereign risk should, ideally, reduces the borrowing cost of syndicated-loans with the emergence and development of the domestic corporate bond market.

Therefore, in the light of brief review of the contemporary work in the context of developing economies, it will not be unfair to say that the related theoretical and empirical literature lacks to make an accord on the relationship between the sovereign debt risk and private sector borrowing cost. In addition, the previous work mainly focuses on identifying and analyzing the costs and causes of sovereign debt default and attempts to come up with optimal strategies to overcome these consequences from a government's view point. Moreover, the prevalent empirical evidence in understanding these costs and consequences is not definitive. Furthermore, most of the literature mainly treats the issue in the context of emerging economies due to a trivial fact that the problem, in general, exists in that region. However, with the onset of recent financial crisis which increases the sovereign debt of advanced countries to perniciously high levels (especially in the euro zone) diverts the attention of policy makers and the academics to these economies (ECB, 2010).

In this context, there is a widespread idea prevalent that developed countries are structurally different from the emerging one, so they would not have to implement the same economic policies as the developing countries. Nevertheless, until 2007, many policy makers felt that the advanced economies were immunized against the financial and economic instabilities. Even when the turmoil in the subprime lending market in the US started to threaten the global financial and capital markets, the public authorities remain convinced that they can limit its impact on the economic growth in advanced economies. While the global economy started to show signals of recuperation from the recessionary effect, the economic recovery remains particularly slow in advanced economies especially in the euro zone, where sovereign debt is still adhere to unprecedented levels.

Hence in the current chapter, we attempt to fill this void by evaluating the impact of high sovereign debt levels on the borrowing cost (i.e. the spread on syndicated-loan commitments) of private firms in advanced market economies. Following, Ağça and Celasun (2012), we explore this channel within the context of euro region. So, this chapter surmises that the sovereign risk (that is high external public debt to GDP level) adversely affects the spread of foreign credit for private sector firms. In this context, we wonder whether it is prudent to evaluate the impact of perniciously high levels of sovereign debt on the borrowing cost of private sector which provides a distinct evidence for advanced economies because the contemporary literature mainly focuses on the sovereign default consequences in the context of developing markets.

In other words, this chapter suggests that it is not prudent for the policy makers to wait till the occurrence of sovereign default event and not give due attention to the economic condition when the related public debt level sharply increases in relation to the country's GDP. In this context, we strive to highlight the importance of potential adverse effect of high public debt levels on the overall economic activity. Therefore, we investigate one of the potential adverse effects of high public debt levels on the borrowing cost of syndicated-loans of private firms. Since, the increased pressure to service outstanding public debt rationally augments the risk of higher future corporate taxation. In turn, it leads to a volatile bottom line for private firms and as a consequence this generates constraint in meeting respective credit obligations. As a result, this condition adversely affects the overall economic activity. Hence, the aforesaid premise actually attempts to examine and validate the sovereign ceilings notion while evaluating the relationship between the sovereign risk and borrowing cost of firms in the private sector of euro zone.

Furthermore as observed, with the onset of recent financial crisis, the sovereign debt in advanced economies (especially in the euro area) has risen sharply that leads to manifest the increased uncertainty in the long term sustainability of respective debt markets (ECB, 2010). On that ground, the primary objective of this study is to evaluate how such detrimentally high levels of sovereign external debt in the euro zone affects the private sector syndicated-loan spread? In particular, this work attempts to document the spillover effect of sovereign risk to private sector in the EMU.



Having said that, the reader might wonder why we put higher importance on the external public debt as against the domestic public debt in this study? The underlying reasons are the subject matter for the next section.

#### 2.1.4 External vs. Domestic public debt

In general, the contemporary literature mainly focuses on the significance of external public debt against the domestic public debt in evaluating its impact on a real sector in developing economies.<sup>49</sup> Specifically, Eaton and Gersovitz (1981) put forward this notion in their seminal study and argue that sovereign's willingness to repay the debt to foreign creditors is more important due to the consequence of a reputation cost. However, ample literature suggests that this assumption is ambiguous by nature. In particular, other studies argue that if a public debt is traded in secondary markets then the question of selective (discriminatory) default on the external public debt by debtor government lose its attraction. In other words, when a sovereign is not able to easily distinguish or cannot make a clear cut distinction between the levels of public debt being external or domestic then the benefits of repaying the debt is inclined towards domestic lenders as against external creditors (see: Basu, 2010; Broner et al., 2010 and Gennaioli et al., 2014 among others). If for a moment we forget the arguments of Eaton and Gersovitz, then even in the light of these studies, we can clearly outline an implied conclusion that in fact the significance of external public debt occupies a primary place in the evolution of overall sovereign risk of default. That is, from both strands of literature, foreign creditors hold key position in a sovereign debt market.

In a similar vein, this conclusion is strongly confirmed by Agça and Celasun (2012) in the context of emerging markets. The study reports that "*domestic debt does not always increase the risk of a sovereign default.*" That is, it raises the government's willingness to repay domestic public debt in comparison to the external public debt. Even though, the domestic public debt increases the total public debt levels and reduces the ability of its sovereign to repay the outstanding debt and other implicit guarantees. Besides, in reality it increases the government discipline to requite domestic lenders to assist local economic agents and in turn the overall economic activity. Therefore, the domestic public debt holds lesser significance than the external public debt in the overall evolution of sovereign default risk due to the fact that the government holds a sovereign authority on its domestic economic agents. For

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<sup>49</sup> By external public debt we mean the sovereign debt owed to foreign creditors (that is, issued in foreign capital markets) and by the domestic public debt we mean sovereign debt owed to domestic creditors (that is, issued in local fund markets).

instance, a sovereign can take an action to increase the inflation and in turn decrease in nominal terms the overall domestic public debt if the debt contract was executed in the domestic currency (Borensztein et al., 2013).

Furthermore, the significance of external public debt in comparison to the domestic one is confirmed by Packer and Suthiphongchai (2003). In particular, the study outlines that credit rating agencies normally give higher ratings to domestic public debt instruments as compared to the external public debt instruments in relation to a respective sovereign. That is, the ability of government: to tax, to expropriate domestic assets, and to print new money to service its domestic debt (for example, the inflation tax) enables the international rating agencies to give higher ratings to the domestic public debt instruments than to the external ones. In practice, it basically means that the money re-circulates within the same economy and just changes hands in doing so whereas, this is not the case with the external public debt. Hence, the debtor government's inability to do this in the case of foreign creditors and the eventual transfer of natural resources (that is, the purchasing power) to external lenders forces the rating agencies to classify these sovereign debt securities as more susceptible to default.

In a similar vein, Kohlscheen (2010) reports that in fact it's the default on external public debt that triggers the failure of repayment of domestic debt and not the other way round. Also, the study confirms already established fact in the sovereign debt literature that the domestic debt servicing does not significantly affect the debt rescheduling terms and the output volatility in the overall economic activity. The importance of external public debt is also evident with the notion that the increase in its level basically means that the funds are flowing into the economy from around the world as against going out of the economy which renders the domestic currency strong for a short period of time. Consequently, this situation will weaken the domestic currency in the long run. For instance, firstly to attract foreign funds, the debtor sovereign has to offer higher interest rates which leads to the reduction of its assets value. Secondly, with more inflow against outflows of funds render the domestic currency strong for a short time period which adversely affects the exports and increases imports, in turn leaves a higher trade deficit for the debtor government.

However, Reinhart and Rogoff (2011b) advocate the importance of the domestic public debt in the context of sovereign debt and default literature. The study reports that even with historically higher share in the total public debt (mainly in emerging economies), the domestic public debt is not been given due importance in the empirical literature. Reinhart and Rogoff

argue that in fact it's the adverse effect of higher domestic public debt that leads the debtor government to default on its external public debt at lower levels. The study outlines the significance of domestic debt by manifesting that when a debtor government defaults on its domestic public debt the fiscal duress in the local economy is at the worst possible condition because a sovereign's decision of failure to honor the external public debt, on the contrary, is strategic by nature. Consequently, the default event on the domestic public debt is rare as compared to the default on external public debt. These findings are substantiated by Presbitero (2010). The study outlines the increase in the overall domestic public debt levels in recent times<sup>50</sup> as compared to the external public debt and calls for an increased attention from policymakers and the academics in this regard.

In the light of brief review, it is not unfair to say that there exists a debate among researchers regarding the significance of external, domestic and total public debt in the context of sovereign debt literature regarding its consequence on the real sector especially in emerging markets. However, we wonder regarding the arguments in favor of the higher significance of the external public debt against the domestic one because in the context of euro zone, the member states cannot use any of the policy actions mentioned before in order to lessen the adverse effect of domestic public debt. In other words, we attempt to highlight the fact that in the EMU an individual sovereign cannot take action to (i) increase the supply of currency on its own (ii) raise the inflation rate beyond the limits allowed. Besides, the only potential options available in this respect are to play with the fiscal tools, i.e. to increase the tax rate or in an extreme case the expropriation of private assets. In this vein, it is quite engaging to analyze the significance debate of both the external and domestic public debt in the euro zone.

Therefore, in addition to evaluate the impact of the external public debt on the borrowing costs of private firms, in this chapter, we also examine the effect of the domestic and total public debt in the domain of euro area economies. Moreover, we analyze the influence of recent austerity measures adopted by euro area member states to lessen the adverse effect of turbulent times. In this regard, let us briefly review the onset and evolution of the recent sovereign debt crisis in the context of euro zone.

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<sup>50</sup> Mainly in developing countries

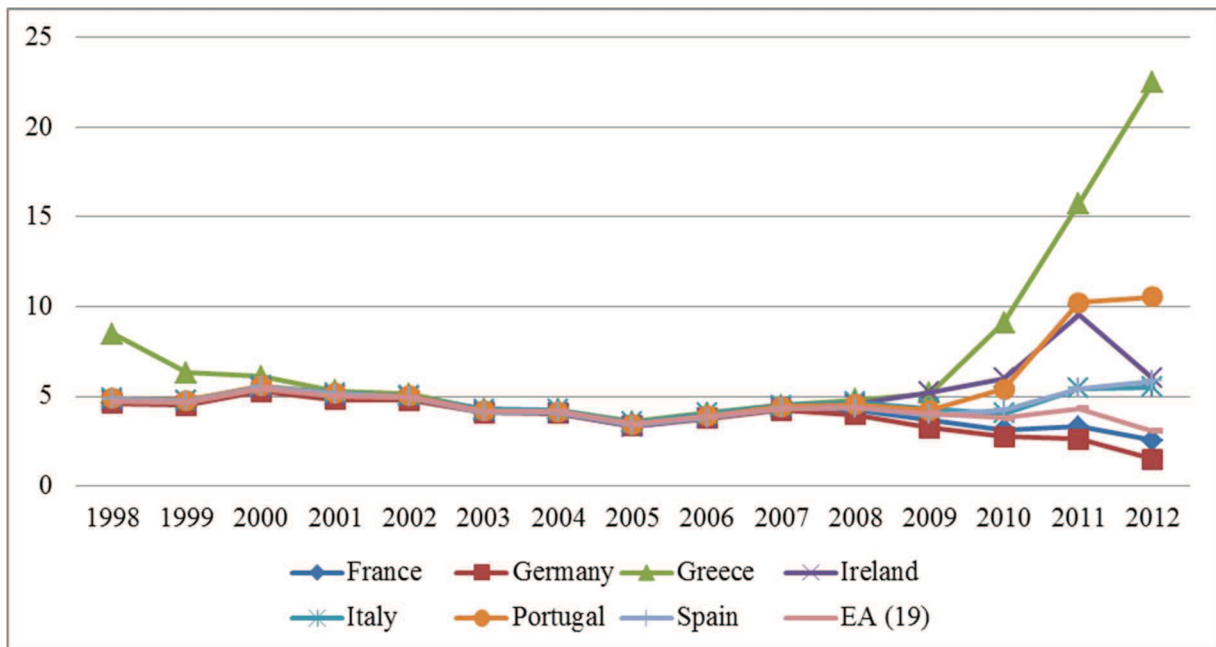
## **2.2 Euro area economies**

Why sovereign debt risk problem that traditionally concerns with emerging markets is now more important in advanced economies and especially in the euro area region? This is because of a trivial reason that recent global financial crisis transforms into the euro zone sovereign crisis. With the occurrence of global financial crisis, the phenomenon of sovereign debt sustainability has shifted from emerging markets to advanced economies. In particular, developed economies in order to cope up with the adversities of recent financial crisis have taken different initiatives such as providing fiscal stimulus packages and the transformation of private debt into public which leads to the increase in overall sovereign debt levels. Moreover, the public debt situation exacerbates due to reduction in the overall aggregate demand that leads to the lowering of total tax revenues (Nelson, 2013).

In this respect, Aiginger (2013) reports that the root cause of recent crisis was inherent since the inception of the European Monetary Union. The so called “convergence criteria” in order to become the member of EMU does not take into account fiscal differences among countries and mainly focuses on monetary policy issues. It is important to note that the idea of European Union was mainly a political issue which enables central bankers to integrate diverse financial networks into a single unified system through the introduction and control of a single currency that is the euro, and a single monetary policy for all member states in the region. In turn, it helps to lower the cross border transaction costs and to increase the bilateral trade like under a single federation of individual states (for instance, in the case of USA).

However, this idea lacks to introduce a coherent framework for fiscal aspects of included states. The member countries with their individual sovereign status exercising separate fiscal policies and tax structures lead to the commencement of public debt crisis episode in the euro zone. In reality, the said union just needed a “common shock” which it receives in the form of the US subprime crisis that reveals underlying inherent weaknesses present in the EMU which were not given due significance by the policy makers. Specifically, lack of competitiveness in peripheral states exploits the benefits of convergence of interest rate (especially, the reduction in spreads of sovereign securities) at par with core member countries because of the launch and subsequent adoption of the euro in the monetary union (Lin and Treichel, 2012). Ironically, diverse reactions to a common shock gradually generate a bigger problem for the euro zone, in general.

Besides, it is rational to accept the fact that with the introduction of a single currency and monetary policy (controlled by a single central bank—the European Central Bank, hereafter, ECB), the member states did avail the benefit through reduced interest rates and lower transaction costs. Specifically, with the convergence of yields on government securities the interest rates and currency risk premium among these states went down that leads to higher spending especially in peripheral economies. Thus, it results in the availability of cheap credit, reduced transaction costs and increased competition. As a consequence, regional financial markets got integrated and grew with rapid pace due to lower yields and spreads on government bonds and with higher market liquidity within the euro zone. This can be observed through the help of figure (I.1).

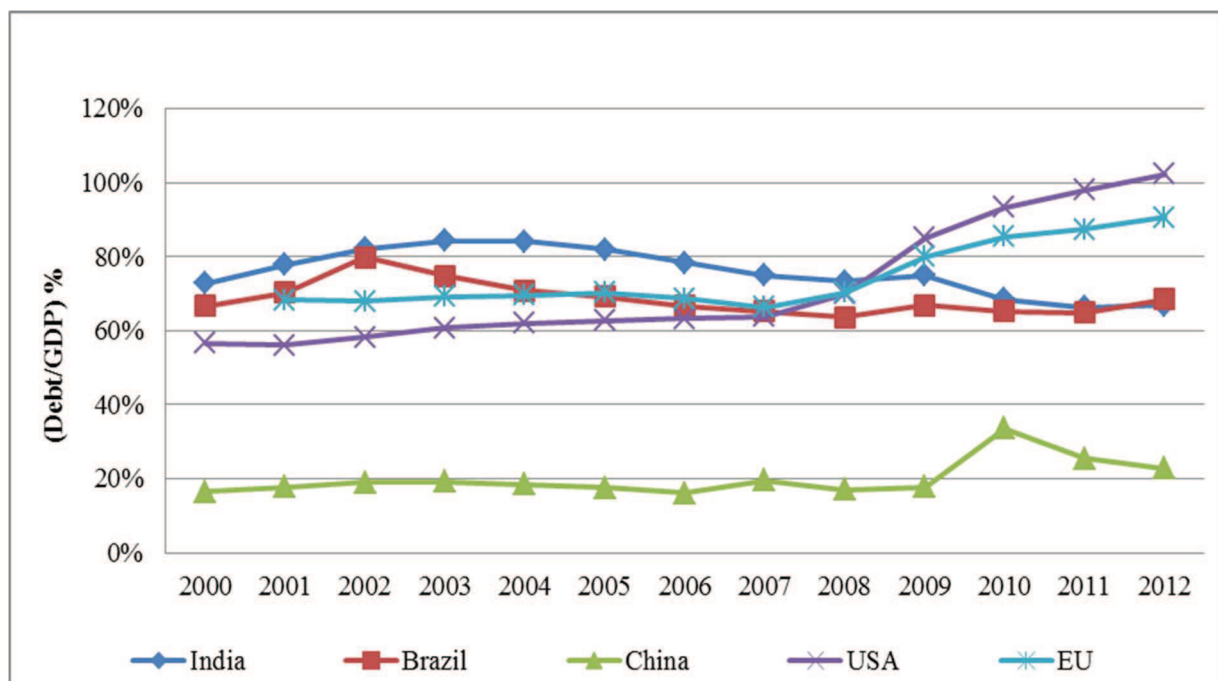


**Figure I.1: Sovereign long term interest rates in percentage (Data source: OECD)**

As evident in the figure that interest rates on government bonds started to converge since 2000 and the capital markets got integrated but for a short period of time (that is, till 2007). This assembly of yields on government securities of euro area member states provide opportunity to peripheral countries that quantifies in terms of fall in nominal rates making it equivalent with more financially stable euro zone countries such as Germany and France. In turn, this situation generates a signal in international capital markets that sovereign risk among euro area member states is same and there exists no significant difference among peripheral and core countries of the euro zone.

Hence, this led to the increase in capital flows into the monetary union and with availability of cheaper credit, the competition between financial players incited which resulted in even higher levels of availability of cheap funds. Consequently, there is increased debt level for almost every economic agent in the member states in the euro zone.

Nevertheless, the occurrence of the US subprime crisis tested the so called “financial and fiscal sustainability” condition of EMU states. The “common shock” renders the euro area financial system fragile. In addition, with higher public debt levels, lower economic growth and reduced tax revenue, fiscal sustainability also loses its grounds. This can be observed through figure (I.2). The figure shows general public debt levels in relation to GDP for the European Union (EU), the USA, Brazil, India and China.

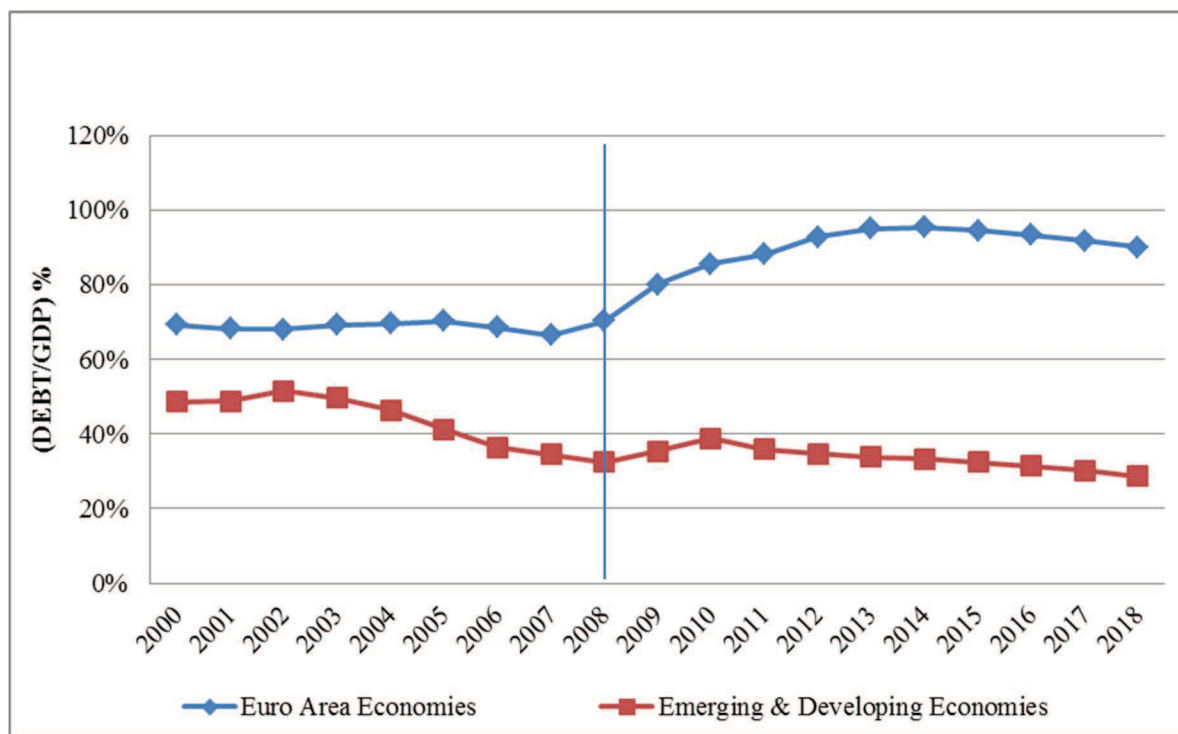


**Figure I.2: General government gross debt to GDP (Data source: IMF)**

From the figure, we can discern that public debt to GDP levels of the USA and the European Union is higher than India, Brazil and China. It is evident in figure (I.2) that after the financial crisis (2007-2008) there is a sharp increase in general debt levels of advanced economies as compared to developing markets. In particular, it validates the effect of financial support programs (i.e. fiscal packages) provided by sovereigns to respective troubled banking sector (that are running balance sheet losses due to the sub-prime crisis) in order to stabilize the financial system and to revive economic growth in the euro area. Moreover, subsequent recessionary period in developed economies led to the reduction in tax revenues and

economic growth and further, make it more problematic for these sovereigns to counter act the increased level of public debt, efficiently.

In order to better observe the shifting of higher sovereign debt issue towards advanced economies and especially to euro area member states, we plot the general public debt level of emerging and euro zone economies as distinct groups. Figure (I.3) shows public debt levels of the said groups. It can be seen in figure (I.3) that after the recent financial crisis, public debt level in euro zone countries increases rapidly. That is from 2000 till 2008 it hovers around 70% of GDP but after the crisis it inflates abruptly. In particular, in 2011 it jumps to 88% of GDP and following the IMF forecast it tops at around 95% of GDP in 2015 with subsequent easing in coming years.



**Figure I.3: Gross general government debt in the euro area alongside emerging & developing economies (Data source: IMF)**

Furthermore, figure (I.3) manifests that even before the commencement of recent financial crisis (that is, since the year 2000), sovereign debt levels in all emerging and developing economies were lower as compared to euro area economies. However, the situation becomes worse after the realization of spillover effect of the US sub-prime crisis in the sovereign debt sector of the euro zone. On the other hand, the general debt level of emerging economies continues to fall gradually mainly due to high economic growth levels and lower financial integration with the US inter-bank market. In addition, the IMF forecast for these markets

continue to follow similar trend and will reach around 28% of GDP in the year 2018. As pointed out by Mody (2009), the differentiation in sovereign risk among member states in the euro zone started after the bail out of Bear Sterns by the US government in March 2008. This action acts as a trigger in capital markets that change risk aversion of lenders regarding advanced countries especially for euro area governments. Keeping this in mind, even domestic economic agents with in distressed member states of the euro zone started to differentiate the potential risk inherent in their local governments.

In a similar vein, Bofondi et al. (2013) in the context of Italy report that after the tensions started in the sovereign sector of euro zone (that is, during the recent debt crisis) the local corporates prefer banks outside Italy to take out loans as the domestic bank lending increases less than the foreign (that is, cross-border) bank lending. This behavior is mainly due to the fact that local banks charge higher premium on loans as compared to foreign banks by almost 15-20 basis points (hereafter, bps). Hence, the condition in capital markets (especially in syndicated-loan market) within the euro area started to show the adverse effects of prevalent crisis situation (Chui et al. 2010). Against this background, let us briefly review the conditions of syndicated-loan market in the euro zone.

### 2.2.1 Syndicated-loan market

The syndicated-loan market<sup>51</sup> is one of the fundamental avenues for corporates (both financial and non-financial) to acquire funds in recent times. Non-financial private firms' participation grows rapidly in syndicated-loan markets in advanced economies from almost \$400 billion per quarter in 2002 to approximately \$1.8 trillion in 2009 as compared to \$1.5 trillion in international bond markets (Chui et al. 2010). In particular, one of the primary reasons of growth in syndicated-loan market is the advent of sophisticated financial markets that helps to provide transparent information regarding borrowers in different regions (that is both in the emerging and developed economies). In this vein, these advanced financial markets also assist in the formation of lead arranger / managing agent of the syndicated-loan contract that leads to draw loans of higher maturity (Dennis and Mullineaux, 2000).

In the euro zone, syndicated-loan market is considered to be one of the main avenues of financial market integration. Particularly, as far as syndicated-loan market is concerned, the euro area is alike the emerging market because major participants are mainly foreign banks

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<sup>51</sup> In fact, syndicated-loan market is a hybrid market that contains characteristics of both the capital market and the relationship loan market (Dennis and Mullineaux, 2000)



and further foreign lenders (and cross border) investment exceeds more than 60 percent of the total syndicated-loan activity. Besides, domestic banks play a supporting role in syndicated-loan commitments in these economies. Thus, syndicated loans have emerged as a major source of funding for financial and non-financial firms. Due to a simple reason that the syndicated-loan contract can be arranged promptly and provides alternate avenue to capital markets that is bonds and equities (Gadanecz, 2004).

In this context, the participation of foreign (and cross border) lenders increase rapidly in syndicated-loan market since 1995, especially with the onset of the EMU. This can be observed in figure (A.1) in Appendix A. As outlined by Gadanecz (2004), with the introduction of euro, the syndicated-loan market becomes integrated in the euro zone especially at the mandated arranger level. As can be observed in table (A.1) in Appendix A, the total share of the euro zone arranger banks increased from 59% to 72% mainly reporting the fact that banks in the euro area are mainly engaged in the set-up of loan commitments for regional borrowers but not from the same member state.

Moreover, the share of banks to arrange syndicated-loans for borrowers of same country in the euro zone increases from 39% to 42% after 1999. In addition, the rest of syndicate bank members decreases from 43% to 38% in joining the facility for domestic borrower. In particular, it shows the significance of foreign (and cross border) banks presence in the euro zone syndicated-loan market as after 1999 it accounts for 58% at mandated arranger level and almost 62% at syndicate participants' level.

Furthermore, as expected it should be noted that the syndicated-loan literature mainly focus on emerging markets while evaluating the impact of sovereign defaults on real sector (see: Arteta and Hale, 2008; Das et al., 2010 and Agça and Celasun, 2012 among others). In addition, as pointed out by Gadanecz (2004) that the syndicated-loan market is an indicative avenue that manifests the structural changes in capital market in the euro area . Therefore, in the current chapter we mainly focus on analyzing the impact of sovereign debt level on the borrowing cost of foreign syndicated-loans contracted by non-financial private firms in the euro zone before and during a recent crisis period. In a similar vein, Borensztein et al. (2013) report that the increase in sovereign risk of emerging markets adversely affects domestic economic agents. The study finds that with a sovereign default the creditworthiness of local domestic agents goes down. Also, with an increase in total public debt levels the probability of technical insolvency of a sovereign augments which forces the culprit government to either

raise the inflation (i.e. the inflationary tax) and or to increase the tax rates (i.e. to increase the public revenue level) that adversely affects local economic activity in a country.

Taking this into consideration, it is not unfair to point out another limitation of a contemporary empirical literature that lacks to examine the impact of increasing sovereign risk on the private sector borrowing cost in syndicated-loan market among advanced economies during recent crisis period. This chapter is an attempt to fill this void by evaluating the impact of recent sovereign debt crisis on borrowing costs of private sector firms in the euro zone. In this context, we also attempt to determine the impact of policy actions adopted by euro zone member states to lessen the effect of recent debt crisis on the real sector. As can be expected, the recent turbulent period put all these conditions into question. With higher public debt levels, advanced economies struggle to sustain the economic activity and follow austerity measures to come out of the said crisis situation. In this respect, euro zone member states focus on the policy issue of fiscal consolidation to reduce the unsustainable public debt levels and to put the economic activity back on track. In this context, the rational question is that how fiscal consolidation efforts affect overall economic activity in the euro zone especially during the public debt crisis period?

Therefore in this chapter, we extend our hypothesis by not only evaluating the impact of recent debt crisis on the borrowing cost of private firms but also treat the issue of how austerity measures assist the distressed euro region in re-instating the overall economic activity. In the light of afore-mentioned discussion let us briefly review the austerity measures adopted by euro area member states.

### 2.2.2 Austerity measures

The related literature in advanced economies mostly focuses to analyze how fiscal policy adjustments affect the government borrowing cost while evaluating the fiscal deficit and public debt levels influence on sovereign debt securities (see: Alesina et al. 1992, Engen and Hubbard, 2005, and Ardagna et al. 2007 among others). By contrast, the empirical literature evaluating the scope of sovereign risk spillover to private sector is rather scant in advanced market economies (that is, higher public debt levels impact on borrowing cost of private firms). On that ground, we are aware of only one recent contribution by Agça and Igan (2013) that analyzed the fiscal consolidation effect on the borrowing cost of corporate sector in advanced economies.

In this context, Agça and Igan (2013) study the effect of fiscal consolidation on the cost of corporate credit in 16 advanced countries for the period 1990-2011. The authors show that fiscal consolidation<sup>52</sup> efforts principally aim to reduce high public debt levels. These measures affect the borrowing cost of firms in real sector through two different ways: that is, positively and negatively. Specifically, fiscal consolidation measures increase the borrowing cost of private firms due to the presence of demand channel as proposed by Keynes.

According to Keynesian view, the austerity measures halt aggregate demand and in turn reduce the economic activity in short run. Thus, fiscal consolidation increases corporate loan spread as creditors do not see austerity activities credible enough to improve the expected economic conditions. So, by taking into consideration the said recessionary period, lenders increase the cost of credit to debtor firms as a short term measure. On the other hand, fiscal consolidation actions decrease borrowing cost of private firms due to the presence of the credibility channel. Particularly, austerity measures generate growing expectations that these efforts will positively assist the economy in long run by stimulating growth and in turn negatively affecting private firm's loan spread. Therefore, such fiscal consolidation activities reduce sovereign's default probability on the outstanding debt that leads to lower the overall public debt. Hence, through the effect of credibility channel, the risk premium demanded by investors goes down that lowers the interest rates on government debt and thus narrows the spread on syndicated-loan commitments for private firms (Alesina and Perotti, 1997).

In addition, Agça and Igan (2013), mainly evaluate the short-term effect of fiscal consolidation on credit cost of corporates while reducing public debt levels. Besides, this short-term evidence is not definitive in nature. Moreover, the study mainly includes domestic credit market view point with syndicated-loans from local banks. In general, these findings are largely driven by small domestic firms that lack access to international credit markets due to inherent information asymmetries or high degree of exposure to local economic conditions. However, the proponents of fiscal consolidation argue that cuts in government spending or increase in tax rates or both helps the sovereign with high public debt problem to show the lenders in capital markets that it follows a rational policy mix to revive its economy. By doing this, the sovereign in distress hopes that the creditors will react by lowering risks related to its default which leads to reduce the cost of borrowing for its domestic economic agents and hence assists in rejuvenating the economy with availability of credit on acceptable terms.

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<sup>52</sup> That is abrupt tax hikes and simultaneous government spending cuts

Whereas, opponents of austerity measures call to exercise prudence in this situation due to the presence of a multiplier recessionary effect prevalent in the economy.

### **2.3 Hypotheses**

In the light of above discussion, this study attempts to evaluate in the context of euro zone, the effect of sovereign risk spillover on the borrowing cost of private sector corporate especially during the recent crisis period. More precisely, we hypothesize that the increased external borrowing by a sovereign in advanced economies tends to adversely change the perceived credit risk. With ballooning total government debt levels and subdued economic growth, the sovereign probability of default rises and hence developed economies fall into the conundrum of public debt crisis. Particularly, the increased sovereign debt risk channelizes to domestic economy and in turn affects the credit worthiness of private sector firms (that is it adversely impacts firm's ability to service the outstanding debt in timely manner).

Therefore, this chapter analyzes not only the effect of external but also the domestic and total public debt risk on private firm's borrowing spread and its ability to access foreign credit. Specifically, we premise that high sovereign debt risk posit increased threat to the internal economy (and to its private sector) as it increases the probability of sovereign default. Consequently, it negatively affects the real output and growth rates in the economy. In this respect, on the one hand it is difficult for a debtor government to stabilize and recover from the public debt crisis situation due to high interest payments of respective outstanding debt<sup>53</sup> and simultaneous transfer of resources and purchasing power to foreign creditor countries. On the other hand, the situation exacerbates with the increased adversity in rolling over of outstanding loan agreements as they become due. Moreover, the vulnerability in public sector of debtor government amplifies, if it receives any adverse output shock on its economy.

In similar vein, Jeanne and Rancière (2011) validate this vulnerability in the domain of emerging markets. The study reports that countries with higher external public debt levels are more likely to be affected by sudden stop of capital flows from international credit markets as compared to governments with higher domestic public debt. As a consequence, the default risk of respective sovereign increases due to external public debt rather than due to domestic debt. In other words, with domestic public debt, sovereign in reality owes to its local economic agents, that is, if government services its outstanding domestic debt, funds will just

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<sup>53</sup> Especially regarding external public debt

re-circulate inside the local economy. Therefore to service the domestic public debt, government can use its sovereign authority either to: refinance the debt or to impose harsher taxation policies (i.e. in order to increase the tax revenues) or to flood the economy with the increase in money supply by printing more currency.<sup>54</sup> This enables the debtor government to effectuate inflation tax to reduce the price of outstanding domestic debt. However with external creditors (that is, the foreign credit) this is not the case. Furthermore, the external public debt effect would be severe than the domestic debt on real economic growth because the current and future economic resources are being transferred along with the purchasing power to foreign creditor nations which will be detrimental in long run to the overall domestic economy.

In this context, while keeping in mind the hypotheses outlined in previous sections, we update the conjectures of current study as follows: on the one hand, we attempt to evaluate the impact of high level of sovereign debt (external and domestic) on the syndicated-loan spread of private non-financial firms in the euro zone. On the other hand, we make an effort to analyze the effect of fiscal consolidation activities adopted by euro area member states on the spread of syndicated-loan commitments for private firms. This enables us to determine the efficiency of such austerity measures towards reviving economic growth in the distressed euro zone and the consequent reduction of public debt levels especially during recent crisis period. In this respect as outlined in section 2.1.4, it is quite interesting to evaluate the importance of both the external and domestic public debt on the real sector in the euro area. As we have outlined that the arguments regarding the significance debate in the emerging markets for both types of public debt effect on the real sector is not at par in the euro zone.

Besides, recently a few studies treat the issue of sovereign risk spillover on corporate sector in the euro zone (see: Augustin et al., 2016 and Andrade and Chhaochharia, 2012). In this vein, Andrade and Chhaochharia focus on the debt and equity market interdependence and show that increase in sovereign credit spreads simultaneously decreases the equity value of financial and non-financial firms. Thus, our study befits Andrade and Chhaochharia results by focusing on direct spillover effects of recent crisis on real sector in the euro zone through distortions in respective debt markets.<sup>55</sup>

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<sup>54</sup> Although the latter action is inflationary in nature and cannot be applied on individual member state level in the EMU

<sup>55</sup> On the other hand, Augustin et al., (2016) only focuses on Greek event of default by treating its shock on rest of euro zone firms

### **3 Data & Empirical Methodology**

#### **3.1 Data**

The data utilized in this chapter is collected from different sources and this section gives an overview of our total sample data variables.

##### **3.1.1 Loan and firm specific variables**

Information related to our dependent variable i.e. the syndicated-loan spread is from SDC Platinum™ database. In particular, we focus on the real sector of economy and follows syndicated-loan issuances by private (non-financial) firms in euro area countries. Furthermore, the data on loan characteristics consist of: loan spread (in basis points) at issuance, maturity (in years), total loan package amount (in US\$), loan package currency, name and sector of the borrower firm and their primary SIC codes.<sup>56</sup> We obtain 5112 loan issuances by non-financial private firms for the period of 2005-2011 for 14 euro area countries.

In addition, the current study uses syndicated-loan fixed spread over given benchmark rate (which is mainly Euribor) inclusive of all fees. Moreover, we use primary SIC code and borrower company name to manually match syndicated-loan issuances and obtain fundamental financial statements data from World Scope and DataStream databases. As a result, the total number of observations is reduced due to the fact that we do not necessarily observe loan issuances by every firm in each year or sometimes we get multiple issuances from a single firm or no issuances at all by any firm in a specific year. Therefore, we use weighted average of syndicated-loan spread for single firm of a country on annual basis. We follow similar process regarding the syndicated-loan maturity variable. Hence, as a measure of private firm's risk premium, we use natural logarithm of syndicated loan spread inclusive of all fees.

Moreover, in line with the related literature (see: Qian and Strahan, 2007; Chava et al., 2009 and Bae and Goyal, 2009 among others), we use the following three variables as firm-level controls: profitability ratio (net income divided by total assets), leverage ratio (total debt divided by total assets) and size (natural logarithm of total assets). After controlling for the

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<sup>56</sup> Standard Industrial Classification (SIC) codes

firm-specific heterogeneity that affects syndicated-loan spread, our sample finally consists of 906 observations for 14 euro area countries.<sup>57</sup>

### 3.1.2 Sovereign debt risk

Our main variable of interest is the ratio of external public debt to GDP which we obtained from Reinhart and Rogoff (2011b). The database calculates sovereign external debt through the Quarterly External Debt Statistics (hereafter, QEDS-World Bank). In addition, we use the domestic and total public debt to GDP data from ECB data warehouse web site to validate the expected relationship between our dependent and independent variables as a robustness measure.<sup>58</sup> In addition, the study utilizes these variables to assess the effect of external versus domestic sovereign debt on the syndicated loan spread for private (non-financial) firms in the euro zone. The variables are in annual frequency as a percentage to related GDP levels for each sample country for the period of 7 years (that is, 2005-2011).

### 3.1.3 Macroeconomic control variables

To examine and evaluate how the syndicated-loan spread varies with the different types of public debt, we control for several macroeconomic variables (exists in the related literature) that might affect the relationship between our focused dependent and independent variables.

For this, we select a set of macroeconomic control variables similar to that of Agça and Celasun (2012). These controls are: real GDP growth and its volatility (primarily controlling for the business cycle effect on public debt and real output levels, in turn affecting the credit risk of corporate sector); political risk (mainly gauging the uncertainty emanating from political instability in a specific country);<sup>59</sup> creditor rights (focusing to control for the effect of presence of legal institutions for creditor rights protection and information sharing on the real sector);<sup>60</sup> the international competitiveness (in order to cater the specific country's ability to meet its foreign debt payments through net export earnings as and when due); private credit to GDP ratio (because it affects the demand for the foreign syndicated-loan from the private

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<sup>57</sup> Except, Estonia, Latvia, Lithuania, Slovak Republic, and Slovenia

<sup>58</sup> That is, the total public debt to GDP, the external public debt to GDP and the domestic public debt to GDP ratios.

<sup>59</sup> In particular, we mainly use the International Country Risk Guide (ICRG) political risk variable. Whereas, we also use as a proxy for Political risk, the weighted conflict index variable from Cross-National Time Series data archive (CNTS) of Michigan State University, for robustness purpose.

<sup>60</sup> In specific terms, we use the credit depth of information index from the World Bank, as a proxy for creditor rights protection for our focused euro area countries. Besides, we also measure creditor rights protection through the strength of legal rights index (World Bank) as a robustness measure.

sector firms); government budget balances to GDP (in order to evaluate whether it will affect the credit cost of private sector firms); change in real exchange rate (as the syndicated-loan package amount is in US dollars); and to control for shocks from global financial markets, we use the volatility index of S&P 500 (VIX)<sup>61</sup> to evaluate how its change affects our focused relationship between sovereign debt risk and spread on syndicated loans of private sector firms.<sup>62</sup>

In addition, according to the related literature (see: Dittmar and Yuan, 2008 and Arteta and Hale, 2008 among others), we also control for the sovereign creditworthiness of euro area countries by introducing sovereign bond yield spread (of 10 years maturity because our dependent variable mainly include term loans) as a robustness measure to validate our focused relationship between the impact of external sovereign debt on private sector syndicated-loan spread. In particular, the risk related to the creditworthiness of sovereign plays an important role in determining the cost of credit for public and private sector corporates. Therefore, to examine the true nexus between our dependent and independent variable, we control for respective country's risk within corresponding debt markets in the euro zone.

### **3.2 Research Methodology**

We follow the multivariate Ordinary Least Square (OLS) regression model prevalent in the related literature of syndicated loan as a tautological sense mainly in emerging market economies.<sup>63</sup> In order to evaluate the effect of external public debt on foreign borrowing cost of private sector firms in advanced economies, we use similar empirical specification as followed by Agça and Celasun (2012). In contrast to Agça and Celasun, we focus our attention towards advanced market economies due to the high level of sovereign debt prevalent in euro area countries. Furthermore, we assess the impact of domestic vs external and total public debt on the syndicated-loan spread of private firms in the context of euro zone. In addition, this study treats the effect of austerity measures on syndicated-loan spread of private firms followed by euro zone member states.

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<sup>61</sup> As USA is a major trade partner of the euro zone and also because syndicated-loan packages are in US dollar

<sup>62</sup> The data variable sources are reported in Appendix A, table (A.2), whereas table (A.4) contains number of observations by country used in this study

<sup>63</sup> See: Edwards, 1984 & 1986; Eichengreen and Mody, 2000; Qian and Strahan, 2007; Arteta and Hale, 2008; Bae and Goyal, 2009; Das et al., 2010; Agça and Celasun, 2012 and Agça and Igan, 2013 among others



Hence, our analysis caters recent debt crisis spillover effect on the real sector which is gauged through syndicated-loan spreads of private firms in the euro zone. Moreover, we assess the effect of adopted fiscal consolidation efforts. The European Union follows these consolidations in order to revitalize their economies that are suffering due to increased public debt levels. For this purpose, we use the following estimation:

$$YS_{ijt} = \alpha_1 SD_{jt} + \alpha_2 X_{jt} + \alpha_3 L_{ijt} + \alpha_4 W_{ijt} + \varphi_j + \gamma_t + \varepsilon_{ijt} \quad (1)$$

Whereas,  $YS_{ijt}$  is the spread in natural logarithmic form of syndicated-loan package borrowed by firm  $i$  in a country  $j$  in year  $t$ .  $SD_{jt}$  represents the public debt to GDP level in country  $j$  for year  $t$ .<sup>64</sup> In addition,  $X_{jt}$  is a vector of macroeconomic control variables of country  $j$  in year  $t$ .  $L_{ijt}$  shows a matrix vector of loan specific control variables (loan size and maturity).  $W_{ijt}$  is a vector of firm-specific control variables (including profitability ratio, leverage ratio and firm size) for firm  $i$  in country  $j$  in year  $t$ .  $\varphi_j$  caters country specific fixed effects and  $\gamma_t$  is a time specific effect variable.  $\varepsilon_{ijt}$  represents syndicated-loan specific error term and we use robust standard errors clustered at a country level.

Furthermore, in order to gauge the effect of austerity measures on syndicated-loan spread of private firms in the euro zone, we modify specification (1) as follows:

$$YS_{ijt} = \beta_1 FC_{jt} + \beta_2 X_{jt} + \beta_3 L_{ijt} + \beta_4 W_{ijt} + \varphi_j + \gamma_t + \mu_{ijt} \quad (2)$$

In equation (2), the dependent and all the other control variables are same as in specification (1).  $FC_{jt}$  shows fiscal consolidation variable which is calculated as a percentage change in the total public debt to gdp level.<sup>65</sup> In this context, a positive marginal change in the fiscal consolidation variable basically means lower austerity measures (that is lower fiscal consolidation episode) and a negative marginal change means a higher austerity measures (that is higher fiscal consolidation episode). The said nature of this indicator is due to the fact that an increase in the total public debt basically means either increase in government spending or reduction in tax revenue or both that relates to lower fiscal consolidation and vice versa. So, if there is a presence of Keynesian aggregate demand channel then we expect an increase in syndicated-loan spread with higher fiscal consolidation episode that is it would be a negative regression coefficient (i.e. the dependent and independent variables show inverse

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<sup>64</sup> It takes different forms, i.e. the external public debt, the domestic public debt and the total public debt

<sup>65</sup> As suggested by Agca and Igan (2013)

relationship). However, if there is an evidence of the presence of credibility channel then we'll expect a decrease in syndicated-loan spread with higher fiscal consolidation efforts that is a positive regression coefficient (i.e. the dependent and independent variables show direct relationship). Moreover,  $\mu_{ijt}$  represents syndicated-loan specific error term and we use robust standard errors clustered at a country level.

Finally, our sample consists of an un-balanced panel data set. This is due to the fact that, we do not necessarily observe syndicated-loan issuances by every firm in each year or sometimes we get multiple issuances from a single firm or no issuances at all by any firm in a specific year. In such a case, it is advised to pool the dataset using the country and time control dummy variables to neutralize their heterogeneous effect for robust results (Baltagi et al., 2000).<sup>66</sup> In addition, regarding the relationship outlined above, it is safe to conclude in the light of contemporary literature that the problem of endogeneity between the dependent and explanatory variable does not exist. In particular, following the “sovereign ceiling” theoretical notion, it is quite rational to deduce that the spread of syndicated-loan of private firm does not cause change in external public debt levels of sovereign.<sup>67</sup> Besides, it is quite taxing to demonstrate a true relationship between the sovereign public debt and borrowing cost of private firms due to the presence of variety of macro-economic variables that influence both the interested variables. In this context, we include several control variables that exist in the related literature which influence our primary relationship that is, the current study includes not only control variables on macro level but also includes control variables on syndicated-loan and firm-specific level to establish a rational causation between our explanatory and dependent variables.

## **4 Empirical Analysis**

### **4.1 Descriptive Statistics**

Table (A.3) in Appendix A, reports the descriptive statistics of our data variables used in this chapter to evaluate the effect of external, domestic and total public debt on the syndicated-loan spread of private firms in euro area countries.<sup>68</sup> Panel I in table (A.3), gives an overview of the sample data. Our dependent variable—foreign syndicated-loan spread varies from a minimum of 3.0 bps to a maximum of 1100 bps. Whereas, the average duration of syndicated-

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<sup>66</sup> Using the multivariate OLS estimation method

<sup>67</sup> See: Cantor and Packer (1997) and Borensztein et al. (2013) among others

<sup>68</sup> Appendix A includes all the supporting tables of this chapter

loan is about 10 years (that is, classified as term loans) and the average loan size is US\$ 428 million.

Furthermore, our main explanatory variable, the external public debt to GDP varies from 0.3 percent to 1019 percent with an average of 182 percent.<sup>69</sup> The extremely high value of external public debt to GDP reports the commencement of severe recession in Ireland in 2008-2009 due to a dramatic decline in the investment level of its construction sector.<sup>70</sup> As the main pillars of the Irish economy are construction and financial sectors and since, its banking system was highly leveraged with house mortgages, the spillover effect of the US sub-prime crisis adversely hit its economy. Consequently, the Irish government agrees to guarantee its ailing banking system liabilities amounting to € 400 billion that is more than twice of their overall GDP level.<sup>71</sup>

In addition, the private sector credit to GDP varies from a minimum of 73 percent to a maximum of 13501 percent which is really erratic in nature. This extremely high value of domestic credit to private sector is reported in Slovenia in 2005, just when the country prepares itself to enter the euro zone. Particularly, this shows the government policy to keep its banking system in domestic hands by making it less prone to the global financial shocks. That, eventually in 2005, leads its financial sector to give away “free money” to the domestic sector.<sup>72</sup> As mentioned earlier, for Slovenia we have only single data observation which is very erratic in nature. Therefore, we drop it from our regression analysis which is reported in the next section.

On the other hand, panel II in table (A.3), reports descriptive statistics of sub-samples segmented according to the median value of our variable of interest i.e. the external public debt to GDP level. The syndicated-loan spreads are higher and the respective duration of loan is shorter than the overall sample indicating the increased pressure on private firm’s loan characteristics due to the high external public debt. This, in turn shows direct relationship between borrowing costs of private firm and the corresponding external public debt. Moreover, the division of sub-samples validates the Slovenian financial sector condition in

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<sup>69</sup> There is a difference between Reinhart and Rogoff and ECB sources regarding the external public debt data because Reinhart and Rogoff includes all the central, local government and any other public source data whereas, ECB mainly reports only the central government data in its calculation

<sup>70</sup> That is, 1019%, we treat it as an outlier case

<sup>71</sup> «The Irish crisis» by Phillip Lane, World Financial review, October, 2013 (available at <http://www.worldfinancialreview.com/?p=874>)

<sup>72</sup>“Slovenia bailout” by Nicole Lindstrom, June 2013 (available at <http://blogs.lse.ac.uk/europpblog/2013/06/24/slovenia-bailout/>)

2005 as it can be seen that the erratic value of the domestic credit to private sector (that is, 13501% to GDP) is within below median external public debt sample.

While evaluating the private firm-specific variables, the data reports that values do not differ much and remain almost the same in the overall sample and also in below-above median sample of the external public debt. That in turn, manifests that the structural composition of private sector firms do not vary with the external public debt. Furthermore, the real GDP growth and real stock price index growth also report the effect of high external public debt, because it varies considerably between above and below median sample validating an inverse relationship between the economic growth and external public debt.

Hence, in general, the overview of our descriptive statistics validates the overall economic situation in euro zone member states.

## **4.2 Regression results**

### **4.2.1 Sovereign external debt and private sector borrowing cost**

Table (I.1) reports the multivariate OLS regression results that assess the relationship between sovereign external debt and private sector borrowing cost. In particular, it manifests the impact of external public debt on foreign syndicated-loan spread of private firms in the euro zone. The dependent variable in all regressions is the natural logarithm of the spread of foreign syndicated-loan issued by non-financial private firms in euro area countries. In addition, all regressions include country specific effects, controlling the heterogeneity prevalent among countries within the euro zone (Torój, 2009). Furthermore, year effects are also included to cater the time varying global factors affecting all the countries in the euro area. Moreover, we control for firm-specific, syndicated-loan specific and other macroeconomic factors in order to gauge a rational relationship between our dependent and independent variables.

**Table I.1: Impact of sovereign debt risk on syndicated-loan spread of private firms**

	I	II	III	IV	V
External public debt to GDP	0.139*** (0.027)	0.161*** (0.010)	0.140*** (0.029)	0.193*** (0.060)	0.134*** (0.033)
External public debt to GDP*creditor rights		-0.038** (0.017)			
Budget deficit			0.489 (4.975)		
Sovereign spread				48.17*** (8.250)	
Terms of trade index					-4.044 (2.295)
Exports growth					-0.517 (1.407)
Current account to GDP					3.251 (1.891)
Real exchange rate volatility					2.211** (1.116)
Loan size	-2.108*** (0.672)	-2.099*** (0.658)	-2.109*** (0.670)	-2.165*** (0.672)	-2.092*** (0.688)
Loan maturity	2.902 (5.702)	2.938 (5.670)	2.938 (5.636)	3.473 (5.893)	2.969 (5.803)
Leverage ratio	12.37 (12.33)	11.66 (12.10)	12.29 (12.44)	8.456 (11.41)	11.98 (12.13)
Profitability ratio	-35.14 (38.59)	-36.01 (40.17)	-35.10 (38.52)	-43.26 (39.33)	-37.96 (37.45)
Size	-1.920 (1.501)	-1.888 (1.486)	-1.888 (1.371)	-1.869 (1.308)	-1.639 (1.484)
Political risk	-9.664*** (2.199)	-8.949*** (2.250)	-9.430*** (2.469)	-4.128* (2.080)	-8.108*** (2.428)
Real GDP growth	-12.26* (6.794)	-12.50* (6.844)	-12.48* (5.843)	0.013 (9.693)	-9.532 (8.039)
Domestic credit to private sector (%GDP)	-0.389 (0.709)	-0.238 (0.745)	-0.450 (1.069)	-0.832 (0.559)	-0.0311 (0.757)
Creditor rights index	-8.809 (11.49)	-2.243 (12.33)	-9.101 (11.10)	-3.621 (10.32)	-5.920 (9.738)
R-squared	0.322	0.323	0.322	0.335	0.325
Total number of observations	886	886	886	879	886

Note: The table reports multivariate ordinary least square regression (OLS) of specification (1) in section 3.2. The dependent variable is foreign syndicated-loan spread of private firms in natural log form. Robust standard errors are clustered on country level and reported in parenthesis, whereas \*\*\*, \*\* and \* denote significance level at 1, 5 and 10 % respectively. Column (I) reports the baseline regression, whereas column (II) indicates regression including the interaction between external public debt and the creditor rights. Column (III), (IV) & (V) show a measure of robustness, evaluating the effects of budget deficit, sovereign creditworthiness and the international competitiveness, respectively. The creditor rights index used is "credit depth information index" (ECB). Time and country fixed effects are also included.

Table (I.1) column (I) reports the baseline regression results. It shows that external public debt has direct and significant effect on the dependent variable. The coefficient of external public debt to GDP is highly statistically significant (at 1 percent level) indicating that higher level of sovereign external debt increases the borrowing cost for private firms in the real sector of euro zone economies. In particular, a one unit increase in external public debt increases the private sector syndicated-loan spread by almost 0.14 units. The loan size control variable is also statistically different from zero. In particular, it shows that as the syndicated-loan package amount increases its related spread decreases. Therefore, it reports that with one unit increase in the total syndicated loan amount its respective spread decreases by almost two units. Hence, the spread decreases with larger syndicated-loan size and shorter maturities.

Furthermore, the political risk proves to be highly statistically significant on syndicated-loan spread at 1 percent level. Since, the ICRG's political risk index is descending by nature that is, with lower ranks the risk of political instability is higher and with higher ranks its lower (that is, it ranges from 0-100), the negative regression coefficient suggests a direct relationship between higher political uncertainty and syndicated-loan spread of private firms and vice versa. The results in column (I) and in fact all the columns of table (I.1) indicate the significant effect of political risk on the private sector's cost of credit.<sup>73</sup> In particular, increase in the political risk of a country raises the syndicated-loan spread of private sector firms. Our baseline regression also validates the inverse relationship between the real economic growth and syndicated-loan spread as indicated in the descriptive statistics section.

In addition, the creditor rights index is insignificant in our baseline regression. It is really important to control for the creditor rights as reported by Qian and Strahan (2007). The authors find that countries with stronger creditor rights protection results in syndicated-loans with longer maturities and lower spread.<sup>74</sup> In order to assess this effect in the euro area, we introduce in column (II), table (I.1), the interaction term between indicators of creditor rights index and the external public debt. Our variable of interest remains unchanged and the coefficient on the interaction between creditor rights index and the external public debt is negative and statistically significant. It shows that countries with weak creditor rights suffer more due to the increased level of external public debt on the borrowing cost of private sector

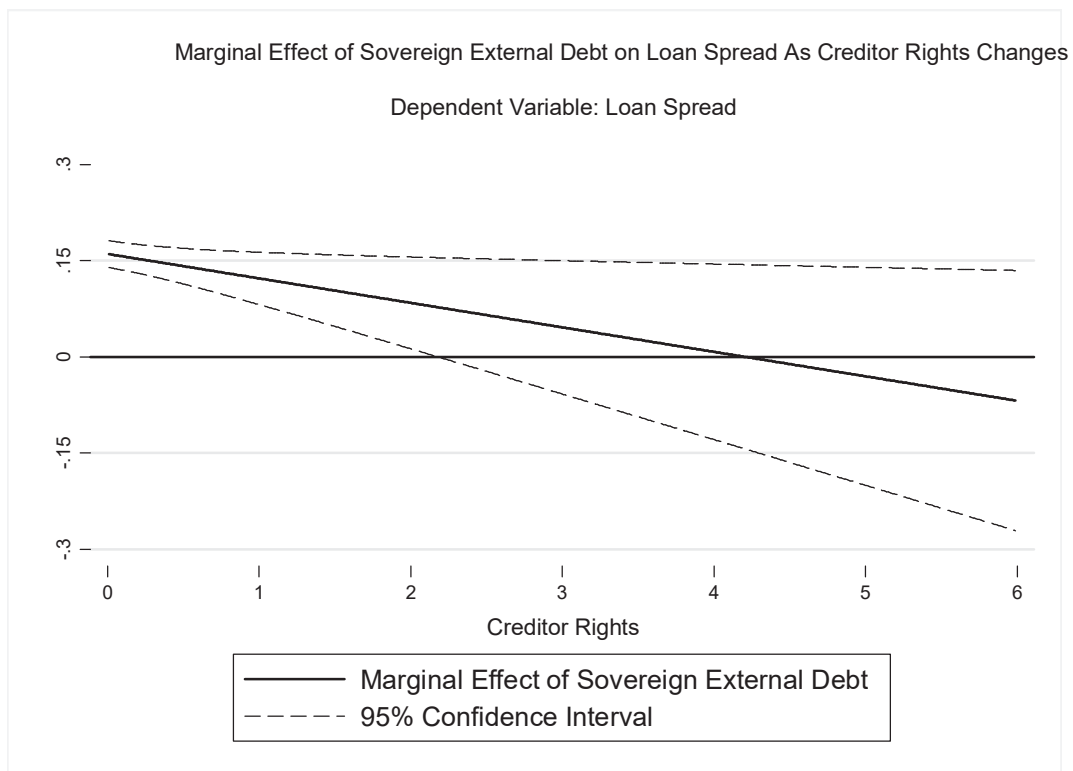
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<sup>73</sup> Furthermore, as a robustness measure instead of ICRG we also use the CNTS political risk indicator but our focused results remain unchanged.

<sup>74</sup> Similar results were also reported by Esty, 2004; Djankov et al., 2007 and Bae & Goyal, 2009; in the context of emerging markets.

firm (that is, the negative coefficient shows the inverse influence of creditor rights index on the relationship between the external public debt and syndicated-loan spread). In other words, it indicates that there is a higher risk to foreign creditors' extending loan to private sector firm in a country where creditors protection laws are weak (and vice versa) and where prevalent external public debt is already high in relation to the gdp levels.

This effect can be explained lucidly with the help of depicting the said relationship in a graphical form. Therefore to get a clear picture of the said condition, we plot this estimated marginal effect of the external public debt on syndicated-loan spread of private firms, conditional upon the change in the level of creditor rights protection prevalent in a debtor country.



**Figure I.4: Marginal effect of external public debt on syndicated-loan spread of private firms as creditor rights changes**

Figure (I.4) shows the results with 95% confidence interval that creditor rights protection impact disappears from the relationship between the external public debt and syndicated-loan spread of private sector firms when a country offers more protection rights to the creditor in extending loan to its private sector (that is, in our case it is greater than the 2<sup>nd</sup> rank out of

6).<sup>75</sup> In other words, it reports that severity of the effect of external public debt on the borrowing cost of private sector firms due to weak creditor rights protection is significant till a certain threshold level (that is, rank 2 and vice versa) but after that when a country provides increased information and legal protection to foreign creditors regarding its domestic economic agents then the effect of creditor rights on high levels of external public debt diminishes. It is quite interesting result in the context of relationship between sovereign debt risk affecting the borrowing cost of private firms. Because it validates, on the one hand, the importance of presence of legal institutions that protects creditor rights and the availability of credit information sharing regarding private sector corporates in euro area countries. On the other hand, it indicates that after a certain level of creditor rights protection, its marginal influence on the increased effect of sovereign external debt on the borrowing cost of private sector dissipates. Hence, we can say that the moderating effect of creditor rights protection is statistically significant conditional upon the high levels of external public debt on the syndicated-loan spread. In particular, the creditor rights index within itself does not play an important role on the borrowing cost of private firm in euro zone economies but with the external public debt levels it lessens or deepens this adverse effect on the real sector's cost of credit.

Next, we use some robustness tests. In column (III), table (I.1); we assess the effect of change in the public debt on syndicated-loan spread. In particular, we want to evaluate whether it's the level or change in a government debt<sup>76</sup> that affects the syndicated-loan spread. For this, we introduce the budget deficit variable in our baseline regression. Our results remain unchanged after controlling for the budget deficit, as external public debt's effect on syndicated-loan spread is statistically significant and direct. However, the budget deficit variable is insignificant and does not affect the syndicated-loan spread.

Furthermore, in column (IV) table (I.1), we introduce the sovereign bond spread (i.e. 10 years maturity) as a measure to control for the sovereign creditworthiness in order to test the robustness of relationship between our dependent and independent variables. It can be observed that our focused nexus remains unchanged that is, statistically significant at 1% level with expected direct relationship. Moreover, the relevant country risk is also statistically

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<sup>75</sup> This is due to the fact that our measure of creditor rights i.e. the creditor rights index ranges from 0-6 ranks (0 being the weakest and 6 being the strongest creditor rights protection rank) in euro area member states

<sup>76</sup> That is: whether its stock or flow of public debt?



different from zero indicating the importance of sovereign creditworthiness in the borrowing cost of private sector firm.

In particular, results in column (IV) table (I.1) manifests that the cost of credit of private sector firms in the euro zone is not only affected by the external public risk but also by other risks related to the public sector. Specifically, the inclusion of sovereign creditworthiness variable in the baseline regression mainly aids to capture the portion of risk attributed through the overall public debt and risk from other sources such as lower sovereign credit ratings. In addition, the statistically significant external public debt variable shows the effect of sovereign risk on the borrowing cost of private firms but the statistically significant sovereign creditworthiness variable gauges the latent effect from other spillover channels such as through the crowding-out effect. That is the increased level of funds borrowed by the sovereign in foreign capital markets reduces the amount of funds available to borrow by its private sector firms in those credit markets. Furthermore, it also manifests the potential effect of increase in the near future taxation rates on the corporate sector because government will require more funds to service its public debt and to increase its creditworthiness.<sup>77</sup> Thus, it provides impetus to evaluate the total and domestic public debt impact on the borrowing cost of non-financial private firms.

In the light of contemporary empirical literature (such as Arteta and Hale, 2008), we introduce in column (V) table (I.1), the international competitiveness effect in our baseline regression. The statistically significant direct relationship between the private firm borrowing cost and external public debt remains unchanged validating the robustness of our empirical results.

Thus, we can summarize our results from table (I.1) that in euro zone economies, the higher external public debt adversely affects the borrowing cost of non-financial private firms' leading to reduce the real economic growth. Moreover, with the presence of weak creditor rights protection in any euro zone country the stated effect between the external public debt and syndicated-loan spread of private firms magnifies disproportionately as against the countries with better creditor rights protection. In this respect, our results validate the theoretical framework of Corsetti et al. (2013) which they termed as a "sovereign risk channel". The study builds a model that manifests the transmission channel link of sovereign risk spillover to the private sector cost of borrowing in the economy.

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<sup>77</sup> As a robustness measure we also use the aggregate euro area sovereign bond yield spread but our results remain unchanged.

#### 4.2.2 Importance of external versus domestic & total public debt

Despite the importance of external public debt in the sovereign default and its respective risk spillover to the real sector, in existing literature<sup>78</sup> the attention given to the domestic public debt is minimal in nature. Reinhart and Rogoff (2011c) argue that the dynamics of sovereign default and its related risk revolves around the domestic public debt and not around the external public debt. The study argues that the external public debt only accounts for a small percentage of total GDP levels especially in the context of emerging markets. In a similar vein, Cordella et al., (2010) argue that over emphasis on the external public debt underestimates and overlooks the real threat coming from the total and domestic public debt levels that in turn hurts the real economic growth in return. This ongoing debate of different treatments and findings of the two types of public debt (that is, the external and the domestic) and our hypothesis outlined in section (2.3) regarding the respective significance debate in the context of euro area furnish the primary motivation for the current section of this chapter. In particular, we examine the importance of domestic public debt against external public debt on foreign syndicated-loan spread of private firms in recent crisis episode in the euro zone. Furthermore, in this context we analyze the impact of total public debt on the borrowing cost of private non-financial firms.

For this, we use measures of the total, domestic and external public debt from the ECB data warehouse to assess the potential relationship on the borrowing cost of non-financial private firms. In addition, it acts as a robustness measure to our results reported in table (I.1).

In this regard, table (I.2) reports the regression results between the total public debt and domestic versus external public debt levels on the syndicated-loan spread of private firms in euro area economies. Column (I) table (I.2) indicates the effect of total public debt on our dependent variable. The coefficient on total public debt is positive and statistically significant at 10% level. It manifests that the increase in total government debt level as a share of GDP increases the uncertainty and risk in the euro region, hence raising the borrowing cost of private firms.

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<sup>78</sup> Especially in emerging markets, see: Eaton and Gersovitz, 1981; Eaton, 1996; Cole and Kehoe, 1998 and Kletzer and Wright, 2000 among others

**Table I.2: The effect of external versus domestic and total public debt on syndicated-loan spread of private non-financial firms**

	I	II
Total public debt to GDP	4.440* (2.125)	
External public debt to GDP		0.124** (0.051)
Domestic public debt to GDP		0.569 (3.433)
Loan size	-2.168*** (0.680)	-2.260*** (0.672)
Loan maturity	3.071 (5.421)	2.676 (5.424)
Leverage ratio	19.34 (12.79)	20.13 (13.60)
Profitability	-44.48 (42.15)	-35.91 (40.77)
Size	-1.746 (1.446)	-1.762 (1.531)
Political risk	0.001 (0.009)	0.001 (0.011)
Real GDP growth	-9.378 (8.423)	-19.51* (9.458)
Private credit to GDP	0.332 (0.873)	0.816 (0.932)
Creditor Rights	-9.061 (5.261)	-3.529 (6.931)
Real exchange rate volatility	72.59 (204.3)	141.2 (251.1)
VIX	7.607* (3.730)	13.03*** (4.029)
R-squared	0.309	0.308
Total number of observations	886	886

Note: The table reports multivariate ordinary least square regression of private sector syndicated-loan spread on the domestic versus external public debt and total public debt effect. The dependent variable is foreign syndicated-loan spread of private non-financial firms in natural log form. Robust standard errors are clustered on country level and are reported in parenthesis. Whereas \*\*\*, \*\*, \* denote significance level at 1, 5 and 10% respectively. Column (I) indicates the effect of total public debt and column (II) reports external versus domestic public debt effect on the syndicated-loan spread. Time and country fixed effects are also included.

In addition, as a robustness measure we control for the global financial volatility through the introduction of VIX variable. Its coefficient is also positive and statistically significant at 1% level. The result suggests spillover effect of financial uncertainty from global capital markets to euro zone economies. Column (II) in table (I.2), reports the main regression results of our interest in this section that assesses the importance of domestic versus external public debt effect on the borrowing cost of private firms in euro zone member states.

In line with the results in table (I.1), the external public debt reports direct and statistically significant effect on the syndicated-loan spread, whereas domestic public debt does not significantly affect the private firm's borrowing cost in foreign markets in the context of euro area. In fact, there are two opposite rationales behind the domestic public debt effect on syndicated-loan spread. On the one hand, first rationale suggests that the domestic public debt does not always increase the sovereign risk of default as outlined in the related literature<sup>79</sup> and validated by our results. On the other hand, the second rationale states that higher levels of domestic public debt reduces the government's ability to service its outstanding debt and in turn indirectly adds to the increased risk of sovereign default, hence raising the borrowing cost for the real sector in the economy. However, in the current chapter we do not find the effect of domestic public debt statistically significant on the borrowing cost of private firms.

Thus, on the basis of these results it can be deduce that in fact in the context of euro zone, the total public debt's statistical significance is due to the portion of high levels of external public debt.

#### 4.2.3 Austerity measures effect

In this section, we attempt to evaluate the euro area austerity measures effect on the cost of credit of private sector. In particular, we analyze the impact of fiscal consolidation on the foreign syndicated-loan spread of private firms in euro area member countries. Through the last two sections, we validate the increasing uncertainty of high external public debt (that is, sovereign risk) on the private sector. Therefore, now we try to examine how euro zone countries efforts (that is, the fiscal consolidation policy measures) to reduce the corresponding sovereign debt levels affect the borrowing cost of private sector in the EMU.

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<sup>79</sup> See: Kohlscheen, 2010 and Ağca and Celasun, 2012 among others

In this context, there are two different points of view exist in the related literature.<sup>80</sup> According to the Keynesian view, fiscal consolidation efforts (that is, either increasing taxes or reducing government spending or doing both) hamper the aggregate demand. Therefore, it reduces the economic activity and in turn increases the volatility in real output. Thus, the said condition leads to raise the borrowing cost of private firms.<sup>81</sup> In other words, foreign lender's price the fiscal consolidation effect in the cost of credit and charge higher syndicated-loan spread on private firms prevalent in such countries.

On the other hand, the opponent view suggests the credibility channel. The proponents of credibility channel<sup>82</sup> argue that fiscal consolidation efforts enhance the credibility of government as a sincere sovereign. The related literature reports that such sovereigns are motivated to control the high public debt levels in order to reduce their respective default risk premium. This in turn lowers the syndicated-loan spread of private firms. According to this channel, fiscal consolidation efforts increase governments' ability to repay its outstanding public debt with the expectation that the overall public borrowing will decline. Thus, it gives a positive signal to the lenders of funds in international capital markets that results in the lowering of crowding-out effect for private debtors and hence reduces the spread on syndicated-loans.

In order to evaluate this relationship, we attempt to examine the fiscal consolidation effect on private sector borrowing costs in the euro region especially during recent debt crisis. To measure the fiscal consolidation effect, we calculate the percentage change in the total public debt as a share of GDP. Therefore, a positive percentage change in the total public debt indicates lower fiscal consolidation episode whereas, a negative percentage change shows the increased fiscal consolidation effect on the economy.

In this regard, table (I.3) presents our results of how syndicated-loan spreads vary according to fiscal consolidation efforts in the euro area especially during sovereign debt crisis period. While controlling for the same macro-economic, syndicated-loan and firm-specific variables, column (I) in table (I.3) shows the fiscal consolidation effect on the cost of credit of private firms. As mentioned earlier, our fiscal consolidation measure is descending in nature that is, a negative change in total public debt to GDP indicates higher fiscal consolidation (that is either the increase in taxation or decrease in government spending or both: reduces the total public

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<sup>80</sup> See: Alesina and Perotti, 1997

<sup>81</sup> Keynesian demand channel

<sup>82</sup> See: Alesina et al. (1990)

debt). Therefore the regression coefficient in column (I) shows a direct influence and is statistically significant at 10% level.

**Table I.3: Fiscal consolidation effect on syndicated-loan spread of private firms in the euro zone**

	I	II
Fiscal consolidation	-0.026* (0.014)	-0.038*** (0.009)
Fiscal consolidation * euro zone crisis		1.030*** (0.190)
Loan size	-2.235*** (0.658)	-2.202*** (0.638)
Loan maturity	2.597 (5.623)	2.901 (5.449)
Leverage ratio	19.13 (13.51)	16.53 (12.34)
Profitability ratio	-37.07 (39.74)	-37.14 (41.50)
Size	-1.945 (1.658)	-1.943 (1.644)
Political risk	0.002 (0.010)	0.005 (0.010)
Real GDP growth	-17.51** (7.744)	-13.45* (8.399)
Private credit to GDP	0.994 (0.992)	1.126 (1.031)
Creditor Rights	-8.154 (20.79)	-0.893 (6.390)
VIX	14.02*** (2.065)	11.02*** (2.387)
R-squared	0.303	0.309
Total number of observations	886	886

Note: The table reports multivariate ordinary least square regression of fiscal consolidation effect on the syndicated-loan spread of private sector. The dependent variable is foreign syndicated-loan spread of private non-financial firm in natural log form. Robust standard errors are in parentheses and clustered on country level. Whereas, \*\*\*, \*\*, \*, denote significance level at 1, 5 and 10% respectively. Column (I) indicates fiscal consolidation effect on the borrowing cost of private non-financial firm. Column (II) shows the effect of fiscal consolidation in euro zone sovereign debt crisis period (2010-2011). Fiscal consolidation indicator is measured as a percentage change in the total public debt levels as a share of GDP. Time and country fixed effects are also included.

In particular, it reports a significant effect of austerity measures on syndicated-loan spread. In other words, the result validates the Keynesian view that in short term lenders increase the cost of credit during fiscal consolidation episode. That is, creditors in international credit markets do not treat government's austerity measures significant enough in the overall betterment of economic condition.

In addition, to better assess the effect of austerity measures on the syndicated-loan spread and in turn on the economic growth in the euro area, we divide our sample into crisis period that is, dummy variable taking the value of "1" for the period of 2010-2011 and "0" otherwise.<sup>83</sup>

Furthermore, we introduce the interaction term to gauge the effect of fiscal consolidation episodes in the euro area sovereign debt crisis on the syndicated-loan spread of private firms. The results are presented in column (II) of table (I.3). Column (II) indicates interesting results as both the fiscal consolidation and its interaction term with euro crisis period are statistically significant at 1% level. However, the regression coefficients show different signs. In particular, the fiscal consolidation effect remains statistically significant and unchanged during the period preceding the euro crisis following the aggregate demand channel effect of the Keynesian view. However, fiscal consolidation episodes in the euro crisis period report the presence of credibility channel.<sup>84</sup> Specifically, the positive sign of regression coefficient of interaction term mainly suggests that with higher fiscal consolidation efforts the syndicated-loan spread goes down (an inverse relationship). That is, during sovereign crisis period, the austerity measures followed by euro zone member states reduce the respective risk of sovereign default and in turn lower the borrowing cost of private firms. Hence, the results show that during recent crisis period the fiscal policy stance generates different outcomes. Thus, this chapter reports that fiscal consolidation efforts by euro zone member countries reduce the respective risk of sovereign default and in turn lowers the syndicated-loan spread during public debt crisis episode.

To sum up the impact of austerity measures on the borrowing cost of private sector in the euro zone, it can be outlined in the light of reported results that: on the one hand, fiscal consolidation efforts increase the syndicated-loan spread as creditors in international capital markets price the recessionary effect on the short term basis (that is, the presence of

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<sup>83</sup> European Sovereign debt crisis started in 2010 (Popov and van Horen, 2013)

<sup>84</sup> That is, the expectation channel (Alesina and Perotti, 1997)

Keynesian channel).<sup>85</sup> On the other hand, during euro crisis period the same fiscal consolidation measures acts as a credibility channel. In turn, it principally manifests that lenders in international credit markets take into account the austerity measures adopted by governments in order to reduce the high public debt levels and lowers the premium on borrowing cost of private sector in the euro zone. Hence, the investors anticipate better economic performance in the long term thanks to fiscal consolidation measures adopted during the crisis period.

#### 4.2.4 Economic significance

It is equally important to note that our results are not only statistically significant but are also economically meaningful. In this regard, table (I.4) reports the economic significance of our selected explanatory variables on the dependent variable. In particular, results in table (I.4) presents that: how changes in our estimates when the regression specifications are assessed at the sample mean of independent variables affect the change in conditional mean of the overall syndicated-loan spread?

It can be observed that external public debt significantly affects the syndicated-loan spread in euro area countries. Specifically, with a one standard deviation increase in external public debt to GDP the syndicated-loan spread increases by almost 47% which is in the magnitude of around 89 basis points. Thus, a conditional mean of syndicated-loan spread evaluated on the specification of column (I) of table (I.1) is 280 basis points. Therefore, a non-financial private firm with average sample characteristics of syndicated-loan size of US\$ 428 million having maturity of 10 years pays an additional borrowing cost of approximately US\$ 51 million over the tenure of syndicated-loan contract.

Furthermore, countries with strong creditor rights protection reduces the adverse effect of external public debt to GDP by 18% on the conditional sample mean of syndicated-loan spread evaluated on the specifications in column (II) of table (I.1). Therefore, for a one standard deviation change in creditor rights protection associated with external public debt, the syndicated-loan spread reduces by almost 34 basis points. In particular, this validates our results reported in figure (I.4) regarding the marginal effect of creditor rights (that lessens/deepens) on the relationship between external public debt and the syndicated-loan spread of private firms in the euro zone.

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<sup>85</sup> That is before the commencement of euro crisis period.



**Table I.4: Effect of one standard deviation (SD) increase in selected variables on syndicated-loan spread**

Variables	I Change in spread (%)	II Change in spread (basis points)
External public debt to GDP	46.6	89
External public debt to GDP with creditor rights	-18	-34
Fiscal consolidation euro zone crisis period	12	22
Fiscal consolidation before EZ crisis period	-2	-4
Loan size	-12	-23

Note: The table reports change in the syndicated-loan spread due to one standard deviation (SD) change in the statistically significant selected variables from tables (I.1 & I.3). These changes are calculated on the conditional sample mean of the forecasted syndicated-loan spread, evaluated after taking into account the regression results of significant coefficient estimates. The effect of external public debt of one SD increase is evaluated with the conditional sample mean of syndicated-loan spread (that is, 280 basis points) as presented in column (I) of table (I.1). Furthermore, the negative effect of one SD change in the external public debt with creditor rights index is evaluated at the conditional sample mean of syndicated-loan spread (that is, 157 basis points) as showed in column (II) of table (I.1). Whereas, the effect of fiscal consolidation efforts in the euro zone crisis period and preceding the crisis period on the change in conditional mean of syndicated-loan spread is evaluated on the estimates presented in column (II) of table (I.3).

In addition, we observe the importance of fiscal consolidation effect on the borrowing cost of private sector in euro area countries. On the one hand, during euro crisis period, a one standard deviation change in fiscal consolidation (that is, a change in the total public debt to GDP) reduces the syndicated-loan spread by 12% which is around 22 basis points. Thus, the results quantify and validate the presence of expectation or credibility channel due to the fiscal consolidation efforts in euro zone member states especially in the crisis period. For a typical syndicated-loan, in our sample with 10 years maturity and loan size of US\$ 428 million, this reduction in spread corresponds to around US\$ 10 million in the borrowing cost (that is, in interest expense) over the tenure of syndicated-loan. On the other hand, during the period preceding the euro crisis, fiscal consolidation efforts increase the syndicated-loan spread showing the presence of a Keynesian demand channel effect. However, this additional cost is negligible, in essence. Particularly, a one standard deviation change in fiscal consolidation increases the loan spread by only 2% which is around 4 basis points in magnitude.

Hence, these findings: on the one hand, suggests the presence of both the credibility and Keynesian demand channel in euro area countries in public debt crisis and preceding the crisis

period, respectively. On the other hand, results validate the significance of the role of fiscal consolidation efforts in order to lessen the adverse effect of sovereign debt crisis in the euro zone. In particular, our results indicate that lenders (in the international capital market) appreciate the fiscal consolidation efforts (during the recent crisis period) that are pursued by euro area member countries through the reduction in private sector's borrowing cost of respective euro zone economies.

## **5 Conclusion**

The onset of sovereign debt crisis in euro area countries, since 2010, attracts the attention of policy makers (Popov and Van Horen, 2013). With high levels of external public debt the spillover risk to real sector increases in advanced markets especially in euro zone economies. In particular, it will not be unfair to say that the related empirical literature on the relationship between sovereign external debt and private sector cost of credit focuses only on emerging markets. In this chapter, we examine the impact of high external public debt level on the borrowing cost of private firms in foreign syndicated-loan market. With a sample of 5112 syndicated-loan issuance transactions covering 14 euro area countries for the period 2005-2011, we analyze the spillover effect of external public debt on the private sector in the euro area that leads to different policy implications.

Our results suggest that foreign stress on sovereign can have extensive impact on the private sector's cost of credit. In particular, the study documents a direct and significant relationship between the external public debt levels and syndicated-loan spreads of private firms. The nexus leads to validate that increased levels of external public debt raises the risk related to sovereigns and in turn it augments the riskiness of private sector in euro area member states. Consequently it affects private firm's access to foreign capital markets and hence increases the syndicated-loan risk premium. In addition, it suggests that the increased participation of government in international credit markets with already high debt levels crowd-out the access of private firms in those markets.

Furthermore, due to the increased significance of prevalent legal and contractual environment for creditors in overall syndicated-loan market as reported by Bae and Goyal (2009), we also analyze this effect in the current chapter. In this context, our results manifest that countries with weak creditor rights protection receive larger adverse shocks from the external public debt on its private sector cost of credit. In addition, we suggest that till a certain level (that is,

our results report this threshold to be rank 2<sup>nd</sup> out of 6 in the creditor rights index) in euro area countries the marginal effect of external public debt on real sector conditional upon the creditor rights index exists. However, after the said stage it abates from the syndicated-loan spread. In other words, after a certain threshold level a debtor country accepts high credit terms and provides almost absolute legal protection to creditors. Therefore, even if the respective external public debt levels are high, the moderating effect of creditor rights protection becomes insignificant and lenders do not raise risk premium conditional on high public debt levels. These results confirm the empirical findings of emerging market studies (see: Arteta and Hale, 2008; Das et al., 2010 and Agça and Celasun, 2012 among others).

In a similar vein, while evaluating the effect of euro crisis on its private sector, we also assess the effect of its total public debt and domestic versus external public debt on the borrowing cost of private firms. Our results show that domestic public debt does not significantly affect foreign syndicated-loan spread. Besides, the total public debt level found to be statistically significant, indicating the dominant effect of external public debt in the overall sovereign default risk spillover towards private sector's cost of credit.

A lucid impact of recent euro crisis is documented for private sector by analyzing the austerity measures effect on its syndicated-loan spread. The austerity proponents support the idea that with fiscal consolidation efforts, the respective sovereign debt and consequent default premium goes down. Thus, the creditors in international capital markets take this to account and in turn reduces the borrowing costs of private sector's credit. However, the opponents of austerity measures warn about the ominous recessionary impact of such consolidations on the real sector of the economy. In particular, our results suggest that during the period preceding euro crisis, fiscal consolidation efforts are associated with higher cost of credit to private firms. Whereas, in euro crisis period these efforts increase expectations of better economic performance and hence reduce the syndicated-loan spread of private firms in the EMU.

The main findings of our results can be outlined as follows:

- External public debt is adversely associated with the borrowing cost of private firm in euro area economies. In particular, an increase in one standard deviation around the sample mean of external public debt raises the syndicated-loan spread by 89 basis points (that is, 47% increase in the base mean value as reported in table (A.3) Appendix A).

- Countries with weak creditor rights protection are subject to higher effect of sovereign risk spillover to private sector as compared to countries with strong creditor rights protection. However, in euro area countries, creditor rights protection play an important role until a certain threshold level and after that its moderating effect on the relationship between external public debt and syndicated-loan spread dissipates.
- Total government debt significantly affects the borrowing cost of private sector. Whereas, we do not find any significant relationship between domestic public debt and the foreign syndicated-loan spread.
- During sovereign debt crisis period, fiscal consolidation efforts significantly affect the economic growth and in turn reduce the spread of private sector syndicated-loans. In particular, one standard deviation change around its conditional mean reduces the syndicated-loan spread by 22 basis points (that is, 12% decrease in the mean value as reported in table (A.3) Appendix A). Thus, it validates the strong presence of credibility channel in euro area economies during recent crisis episode. However, our results of fiscal consolidation also suggest the presence of aggregate demand channel and show an increase in syndicated-loan spread preceding the euro crisis period. Nevertheless this rise in the borrowing cost is quite negligible, that is, there is only 4 bps increase in risk premium of syndicated-loans for private firms.

Therefore, in the light of these results, the next rational step is to identify and analyze the potential transmission channels of sovereign risk spillover to real sector in euro zone member states during recent crisis episodes.



## **Chapter II**

### **Euro zone sovereign crisis spillover to real sector: Is banking sector liquidity risk a major conduit?**

*“.....But perhaps most importantly, the financial crisis demonstrated that liquidity is the most vital component of a properly functioning financial system – it is the essential lifeblood of banks and other financial institutions, and, by direct extension, the essential lifeblood of all other parts of the corporate and governmental world.” (Erik Banks, 2013)*

#### **1 Introduction**

The wake of recent global financial crisis that transforms into public debt crisis in the euro zone adversely affects respective banking and real sectors. With abrupt increase in public sector risk premia and lower economic growth the uncertainty regarding sovereign's ability to honor its outstanding debt increases that leads to generate concerns for its domestic economic agents. In this context, we attempt to analyze the spillover effects of recent sovereign crisis on real sector in the euro zone by inquiring whether this adverse effect transmits through the banking channel.

In this regard, the recent empirical literature on the euro zone while evaluating the impact of sovereign debt crisis on real sector primarily focuses on the international capital market effect.<sup>86</sup> On the contrary, another strand of literature evaluates the sovereign-bank nexus during recent crisis period in the euro zone. The extant studies show that with the onset of said crisis banks change their liquidity management strategy and become more reluctant in extending loans. Hence, sovereign risk negatively affects the liquidity creation capacity of banks (i.e. on and off-balance sheet activities) which leads to constrict the credit conditions

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<sup>86</sup> See: chapter I for details. Moreover, in the context of emerging markets, Agca and Celasun (2012) report similar results. Whereas: Andrade and Chhaochharia (2012) and Bai and Wei (2012) treat sovereign risk spillover to non-financial firms in euro zone

and urges banking sector to increase its liquid assets base.<sup>87</sup> Thus, the existing literature primarily analyzes a sovereign-bank or a sovereign-real sector nexus which is limited by nature because it lacks to cater the realistic transmission effect of recent sovereign crisis on economic agents in the euro zone.

In this respect, the current chapter suggests that in order to deepen our knowledge regarding the consequence of recent euro crisis, the interconnectedness of credit risk between public, financial and real sectors should be simultaneously examined. In addition, it not only assists in catering the potential adversity but also enables policy makers to design effective measures to mitigate the undesirable influence of recent crisis period on the financial and real sectors in the euro region. Thus, to better understand the sovereign-bank-corporate<sup>88</sup> nexus in detail, we attempt to broaden our analysis and try to explain the sovereign risk spillover effect on real sector through the introduction of a transmission channel which, we conjecture, in this case is the liquidity risk of banking sector. In this context, we hypothesize that the potential conduit of this spillover effect is the inherent liquidity creation process (i.e. volatility in liquidity risk) of the euro area banking sector. This conjecture fundamentally holds its ground in the fact that an overwhelming amount of related literature shows the significance of banks liquidity risk not only during the global financial crisis episode but also in tranquil period (see: Ivashina and Scharfstein, 2010; Cornett et al., 2011 and Santos, 2011 among others).

Therefore, on the one hand, the banking sector (traditionally) acts as a transmission mechanism to advance the increased sovereign risk to non-financial corporate sector (i.e. the real sector) of the economy. On the other hand, it acts contrary to the former as a re-transmission channel i.e. shifting or transferring the risk emanating from the distressed real sector to the respective sovereign sector. In other words, in current study we strive to manifest that the vessel of transmission of sovereign debt risk to real sector, is the banking sector liquidity risk which is measured by constructing a liquidity creation index following the methodology of Berger and Bouwman (2009).

Hence, in this chapter we try to analyze the spillover effects of sovereign crisis on non-financial corporate sector through banks liquidity creation channel in the euro area. The existing empirical literature mainly treats the sovereign-bank or bank-corporate nexus separately while gauging the spillover effects of vulnerability in the said sectors.

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<sup>87</sup> See: Cornett et al., (2011) for details

<sup>88</sup> By corporate we mean non-financial firm

Consequently, this study attempts to fill this gap by treating government, bank and corporate nexus as continuous structural system which is empirically impossible to truncate in order to effectively examine its potential relationship.

In addition, this work contributes to explain in detail how such transmission takes place during euro crisis period. The sample includes panel data of twelve euro zone countries for the period 2005-2012. In order to test our simultaneous equations model, we follow the Three Stages Least Square (hereafter, 3SLS) estimation approach that provides robust results by simultaneously treating the inherent endogeneity and cross-equation correlation of error terms. Our results show that sovereign risk significantly transmits to the liquidity creation process of euro area banking sector and then to the real sector. In particular, banking sector liquidity risk acts as a conduit that propagates uncertainty towards non-financial firms and re-channels it back to the government sector. Finally, interesting results are observed in the non-financial corporate sector that absorbs the negative shock on its loan spread and do not re-transmit similar adversity towards banks during recent crisis period.

The rest of this chapter proceeds as follows. In section 2, we provide in detail the underlying theoretical framework for the transmission of sovereign risk on financial and real sectors that furnish basis to outline our hypotheses. Section 3 describes empirical methodology outlining the 3SLS estimation method. Moreover, section 4 briefly discusses the data and its descriptive statistics whereas; section 5 presents and analyzes our estimation results. Finally, section 6 concludes the chapter.

## **2 Literature review**

### **2.1 The Framework**

The recent study by BIS (2009), reports that banking sector prosperity is a key determinant that influences the financial health of government and non-financial corporate sectors. In this regard, we hypothesize that the liquidity risk of banks acts as a fundamental transmission channel of risk spillover between government and non-financial firms especially in the crisis period, and vice versa. In particular, our conjecture stipulates that the volatility in sovereign bond spread transfers to non-financial firm's cost of borrowing (loan spread) through banks liquidity risk.



In this context, on the one hand, the distressed sovereign adversely affects banking sector liquidity creation process and on the other hand, the vulnerable economic conditions lead to increase the non-performing loans in turn exacerbate the banks liquidity risk (for instance, in the case of recession). Particularly, deterioration in sovereign bond value exposes banks (that hold these government securities) to unfavorable funding conditions in two ways.

In the first scenario, for example, banks with excess liquidity places the cashflow in these almost risk-less sovereign securities (while earning a minimal return). As soon as these securities morphs from risk-less to risky status (i.e. the case of recent euro crisis), it results in the decrease in its underlying value directly affecting the bank's capital base and its liquidity position due to increase in the probability of default from sovereign on its debt obligations. In the second case, if banks use these risk-less securities as collateral to fulfill their funding needs in the interbank market then this also adversely affect its capital and liquidity base due to increased margin call as the underlying value of these assets deteriorates. As a result, banks face liquidity problems and in an extreme case are forced to sell their assets. Consequently, such large asset sale induces a fall in the relative price of banks assets leading to the downward liquidity spiral. Thus, increasing banks default probability and triggering the suppliers of funds to demand higher premium on respective debt securities (Brunnermeier and Pederson, 2009).

In a similar vein, an adverse fluctuation in the economic activity (i.e. the real sector output) advances to the sovereign sector through the same channel. This can be observed when the economy is in recession: resulting a decrease in the overall aggregate demand for products and services that leads to reduce the return on corporate assets and hence its profitability. In this context, borrowers (non-financial firms) experience difficulties in servicing and repaying their outstanding debt to banks in timely manner resulting in higher corporate defaults that advances to generate liquidity problems for the creditor bank (i.e. the increase in non-performing loans).

With increased uncertainty in the financial markets, a general fear of financial turmoil erupts influencing the depositors (i.e. the individual, households and corporates) to behave abruptly in order to protect them-selves by withdrawing their savings from banks (for example, like a bank run situation).<sup>89</sup> This renders the bank illiquid i.e. bearing a higher liquidity risk. Hence, these tensions in the banking sector contribute to accentuate the fear about the increase in the

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<sup>89</sup> As it recently happened in the case of Northern Rock

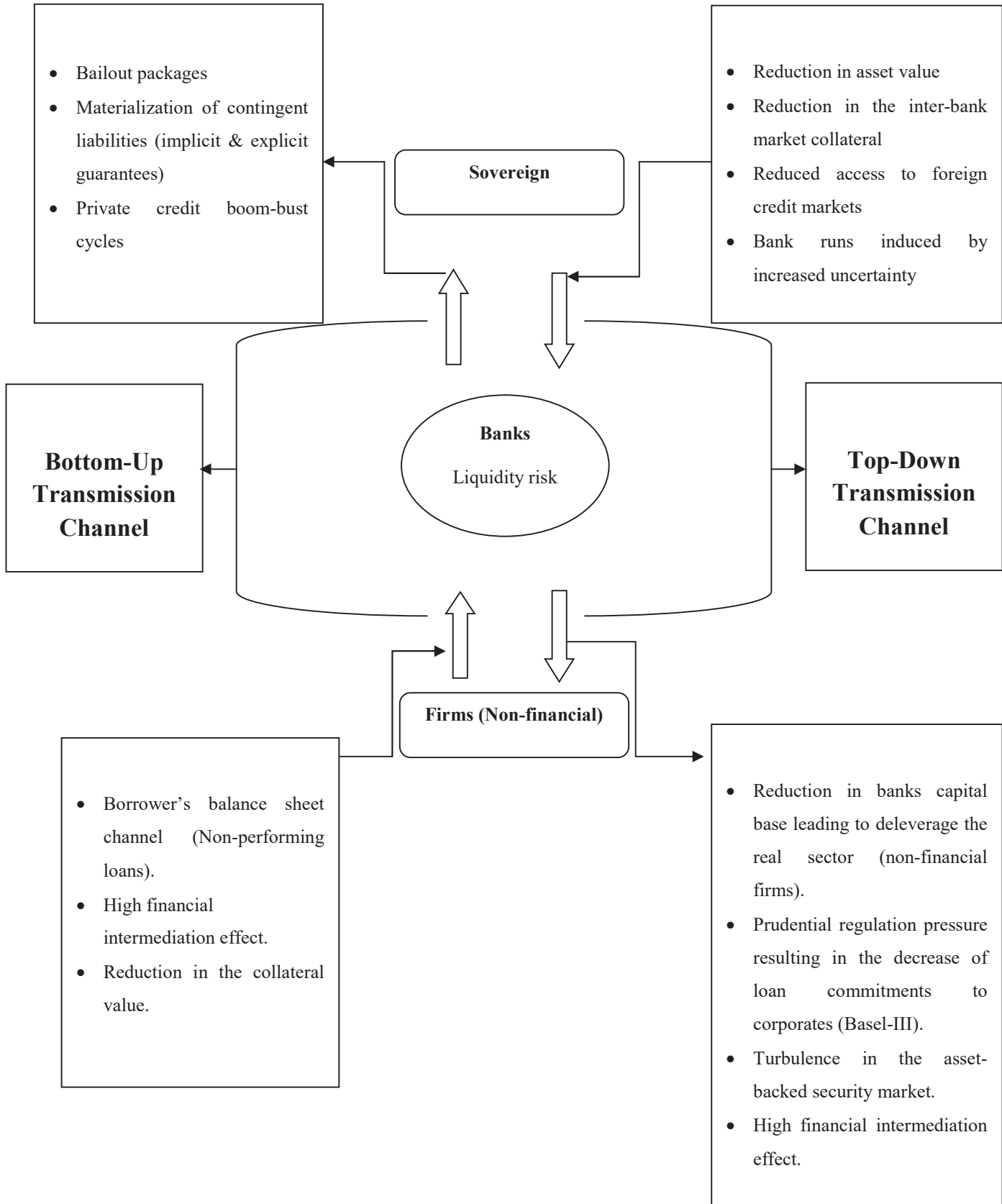
probability of default of related sovereign due to the potential injection of huge amounts of liquidity to its ailing banking sector (Balteanu and Erce, 2014).

The above discussion highlights the systemic importance of certain financial institutions that weighs highly on the contingent and implicit government liabilities. In this scenario, investors often bet that a State will not allow a large bank to fail, even if it is not always true in practice (for instance: the case of Lehman brothers default in 2008). In turn, when the financial institutions believe that what may be the circumstances of their aggressive risk taking the government will jump to support and safeguard its financial system, it gives birth to the adversity of “Moral Hazard” (Goddard et al., 2007). Thereafter, the sovereign bail-out packages raise the gap between public expenditure and revenue leading to increase the budget deficit. Consequently, the total public debt level increases. Hence, it will negatively influence the capacity of government to service its outstanding obligations. In particular, sovereign’s probability of default will increase which results in higher premium demanded by lenders in international credit markets on government debt securities.

This link can be shown through the help of figure (II.1). As shown in the figure, we treat the stated framework in two directions: i.e. the top-down and the bottom-up transmission channels. By top-down transmission, we follow the pass-on effect of distressed sovereign towards the banking sector and then to the real sector of the economy. On the other hand, by bottom-up transmission, we focus on the transfer of real sector vulnerability (i.e. ailing corporates) through the banking system to the respective sovereign. In order to simplify the mechanism we divide both the channels into two levels: top-down transmission is being treated as a nexus between sovereign  $\Leftrightarrow$  banks and then from banks  $\Leftrightarrow$  non-financial firms. Along the same lines, bottom-up transmission is manifested as transfer of distress from non-financial corporate sector  $\Leftrightarrow$  banks and then from banks  $\Leftrightarrow$  sovereign.<sup>90</sup>

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<sup>90</sup> We only divide this loop to enable ourselves to explain the framework in lucid terms because ideally it operates simultaneously and it is potentially difficult to set apart or truncate the stated mechanism into different stages.



**Figure II.1: The Framework**

## 2.1.1 Top-Down Transmission

### 2.1.1.1 Sovereign to Banks

The said relationship is not new in the field of sovereign default literature, especially in the context of emerging markets. In fact, there is ample theoretical and empirical evidence present which manifests the link between sovereign default and the banking crisis and vice versa. But for simplicity in this section, we treat the risk transmission from sovereign to banking sector and in section 2.1.2.2 we focus on the causal effect.

In general, most of the related literature is in accord that the sovereign and banking crises befall together. In his work, Sturzenegger (2004) study this conundrum and evaluate whether its the sovereign default that generates the distress in banking sector or the other way around. The study manifests that in fact it is the occurrence of sovereign default episode that originates the increase in probability of default for the banking sector (i.e. the banking crisis) rather than the later affecting the former.

In other words, the situation when ailing banks bailed out by the sovereign that increases the level of government spending and in turn raises sovereign default probability (with lower tax revenue due to stagnant economic activity) does not prove to be statistically significant. Moreover, other studies find similar results showing that sovereign default leads to the reduction in asset value of banks that hold the government securities on their balance sheet in turn triggering large capital losses (see: Noyer, 2010 and Gennaioli et al., 2014 among others).

Another direct effect of the sovereign default on banking system is the reduction in value of these securities that are used as collateral in the interbank market which result in the increase of liquidity risk.<sup>91</sup> In other words, a trivial way to manage bank's liquidity is achieved by engaging in the interbank market mainly to fulfill the short term liquidity needs (for example, through repo transactions).<sup>92</sup> For which banks normally utilize the "risk-free" assets i.e. the government securities as collateral (which are assumed to be risk-less) to secure the required amount of money to replenish their liquidity needs. However, reduction in value of such assets leads to increase the counter-party risk and uncertainty with in the financial markets

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<sup>91</sup> In addition, it is important to note that banks also use these government securities to secure liquidity funding from the central bank

<sup>92</sup> Repurchase agreement--repo

which increases the margin call of the said transactions, in turn advances directly to generate liquidity shocks to debtor banks.

In a similar vein, the sovereign turbulence transmits to the domestic banking sector through an indirect channel also. The sovereign default results in lower economic activity which in turn negatively affects the profitability of banks. Particularly, the credit rating of defaulted sovereign deteriorates in international capital markets leading to exacerbate its effect on banks liquidity situation due to either reduction in the access or total exclusion of the domestic banking sector from foreign credit markets (Reinhart and Rogoff, 2011a).<sup>93</sup> As a consequence, with reduced profitability and huge capital losses, banks become hesitant to grant credit to the corporate sector which besets the credit crunch situation.

In this context, we wonder whether the said situation is valid within the euro area countries that suffer due to the sovereign debt crisis. Another inquisition in this regard is that may be this scenario is not followed in its entirety in each and every financial market. Therefore, our curiosity lead to premise that ailing banks in the euro zone which already absorbed the effect of the US sub-prime shocks and are now suffering due to sovereign vulnerability, may not necessarily act in the stated traditional manner. In other words, the banks may strive to redeem themselves from the said situation and alternatively attempt to generate and create liquidity for short to medium term. By taking into consideration the prevalent level of liquidity exposure, banks charge higher interest rate to the borrower firms in order to lessen the effect of recent crisis on their balance sheet.

However, this will prevail if the bank-corporate nexus is strong enough i.e. when firms are highly dependent on banking sector to fulfill their working capital, medium and long-term funding needs. In other words, this strategy mainly depends upon the increased degree of financial integration. Ideally, we can observe the aforementioned situation in the case of euro zone, where bank's lending channel is a primary source for non-financial firms to fulfill their funding needs (Kaya and Meyer, 2014).

In addition to the lower economic activity, another indirect spillover effect of sovereign crisis on banking sector is the run on its deposit base. In particular, with increased uncertainty regarding the strength of financial system, the depositors panic and demand their money back out of the fear that their bank (that generally holds huge amount of these ailing sovereign

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<sup>93</sup> In chapter I of the current thesis a similar finding in the context of sovereign crisis effect on non-financial corporate sector is reported

securities) is going to bankrupt and thus leads to aggravate the bank's liquidity situation and hence results in a bank run.

The transmission effect of sovereign risk towards banking sector is extensively outlined in the study conducted by International Monetary Fund (i.e. IMF, 2008). The study shows that banks that hold large amount of government debt securities (for example: sovereign bonds) suffer huge losses which negatively affect the risk premium of such banks, in turn raising the interest rate on their borrowings. This effect is exacerbated by the lack of increase in the return on banks asset. That is, in order to absorb the capital losses and to cover the increased borrowing cost, banks charge higher rates on corporate loans and credit lines. As a consequence, it leads to augment the frequency of non-performing loans (NPL's) due to increased funding costs to firms, thus raising the default probability of economic agents in the real sector.<sup>94</sup>

#### *2.1.1.2 Banks to Non-financial sector*

A potential nexus that plays an important role in the transmission of sovereign risk spillover to real sector is banks' exposure to liquidity risk. As mentioned in existing literature, during the US sub-prime crisis, it's the banks liquidity risk that results in the reduction of credit supply to corporate sector (simultaneously increasing firm's borrowing spread) and in turn decreases the overall economic activity (Cornett et al., 2011). Here, we argue that may be the effect of bank's exposure to liquidity risk depends upon the market fundamentals. What we are trying to imply, is that, for instance the said condition is true in the US market, where we have observed empirical evidence on this issue even when there are other capital market avenues for the US financial and non-financial firms to satisfy their funding needs, but whether is it right to generalize this fact to all the other advanced economies? We conjecture that the magnitude of negative shock from sovereign risk to non-financial firm depends upon the degree of financial intermediation and that in the euro area we may or may not observe this behavior in a similar manner as experienced in the US market. In other words, we cannot with surety say that banks will reduce the creation of liquidity as soon as the value of sovereign debt securities that it holds in balance sheet deteriorates.

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<sup>94</sup> In addition, this study wonders regarding the efficiency of capital adequacy requirements implemented by the prudential regulation authorities which treat these types of securities as "risk-free". However, in practice this regulatory treatment is in disagreement with the recent sovereign debt crisis in the euro area.

The assumption that this chapter attempts to invoke is that, we do not know for sure if banks act only in this manner. May be the affected bank tries to take exposure against short or medium term liquidity risk and increases the liquidity creation at a higher cost to debtor firms. It will not only generate liquidity cycle but also enables bank to lessen the effect of sovereign crisis. On the other hand, may be banks follow the traditional way as observed in the related literature. In this study, we attempt to provide a pedagogical explanation to the said conundrum.

Along the same lines, this liquidity risk that linked the financial and non-financial sector is generally realized in bank's exposure to (or inability to) grant corporate loans or lines of credit.<sup>95</sup> In general, it operates in two distinct ways. First approach, as outlined in the previous section that the reduction in lending capacity of banks due to higher exposure to distressed sovereign securities (i.e. banks bearing balance sheet losses), results in a decline of its capital base which in turn negatively affects the amount of funds available to banks to grant loans. As a consequence, banks become vulnerable that adversely affect their cost of funding, which leads them to increase the interest rate on corporate loans and act hesitantly either to grant credit or to honor their assured commitments to firms in terms of granted credit lines.<sup>96</sup> This eventually renders non-financial sector unable to renew its demand for credit from banks, in-turn deteriorating firms' capacity to operate efficiently. Consequently, it results in the reduction of economic output that adversely influences firm's ability to service its outstanding debt. As a result, it raises probability of default and hence corporates borrowing spread. Moreover, the added pressure is exerted by regulators who urge banks to recapitalize their balance sheets, which advocate banks to back-down from loan commitments to corporate sector (Boot et al., 1993).

Moreover, Diamond and Rajan (2005) confirm the liquidity risk transmission from banks to the real sector. In particular, Diamond and Rajan manifest that banks fund their illiquid assets with short-term liabilities. This technique generates a constraint on the liquidity position of banks. The study reports that due to any unforeseen circumstances, if depositors or investors demand their funds back then the bank will probably de-leverage and conduct a credit

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<sup>95</sup> In fact, in modern banking models, the liquidity risk mainly generates from higher exposure to the unused credit commitments (i.e. the off-balance sheet), the withdrawal of whole sale funding and losses from other sources of short term funding, in contrast to the loss of demand deposits as outlined in the classical model of Diamond and Dybvig (1983). Similarly, Berger and Bouwman (2009) in their study also confirm this and report that about half of the liquidity created by commercial banks comes from exposure towards these off-balance sheet commitments.

<sup>96</sup> Artus (2013) reports that after the default of Lehman Brothers, the credit volume to non-financial firms declines almost by 1% of total GDP funding in the context of USA.

rationing strategy. This render banks in difficult position to roll-over the existing debt of non-financial corporates. As a consequence, vulnerability from financial system transmits to non-financial firms through reduction in the credit availability leading to reduce the overall economic activity.

Besides as mentioned earlier, we outline this as a limitation of the existing literature that assumes the outcome of banking sector vulnerability is to opt only for credit rationing strategy towards non-financial firm. What we attempt to emphasize is that if banks are obliged to honor the demand deposits from its depositors then it is not necessary that they will abruptly cut down the process of liquidity creation to the real economy. In fact, banks have other sources such as existing cash and cash equivalent reserve or they can acquire needed liquidity from external markets for instance from: interbank market, money market funds, central bank and international capital markets.

However, taking into consideration the effect of sovereign crisis in the euro zone, one can argue that all these funding avenues have already been adversely affected. So, banks have no other choice but to halt the liquidity creation process. In particular, these effects are ambiguous by nature. For instance, it can be argued that with the liquidity injection by European Central Bank, banks in the EMU revert back to their primary role of providing liquidity to the real sector but at higher rates. On the other hand, it is not necessary that customers demand back the deposits as soon as any negative shock hits banking industry may be due to the presence of deposit insurance schemes (Fungáčová et al., 2010).

Moreover, BIS (2009) outlines that customer deposits are in fact considered as “stable” in comparison to other funds such as interbank and money market funds which are termed as wholesale funding. In this context, we attempt to determine whether the euro crisis has transformed the nature of “stable” funding into “unstable” funding and banks are forced to reduce their exposure to liquidity risk by decreasing its liquidity creation process towards non-financial firms.

In other words, we hypothesize that there may be alternative outcomes to alleviate distress in financial markets due to the crisis situation. For instance, there may be an option through which banks come out of this situation by increasing their liquidity creation process for short to medium term basis and consequently charge higher interest rates to corporates. However, this scenario is applicable only when non-financial firms are highly dependent on bank’s funding and are financially strong, as in the case of euro zone. This will not only help banks



to breakeven but also to lessen the effect of distress crisis situation. In this context, banks shift their investment focus from ailing sovereign debt securities which are used to be “risk-free” and increase their share of investment percentage towards creating liquidity to non-financial firms. Eventually, the financial system opt to shift back to its traditional operation of banking i.e. accepting deposits and utilizing them to grant credit to the borrower firms but in this scenario at higher interest rates.

This in-turn creates a unique situation. On the one hand, firms can now satisfy their funding needs (i.e. short-medium term) at the cost (opportunity cost) of higher interest rate enabling them to operate at the required production capacity levels and generating adequate output to meet the aggregate demand in the economy. On the other hand, the situation exacerbate, if due to the crisis effect the economy goes into recession<sup>97</sup> which explicitly affects earning capability of individuals, house-holds and firms leading to the reduction in aggregate demand and hence, the overall economic activity.

As a consequence, it will be ominous for firms in real sector to cope up with the difficult financial conditions and are likely to file for bankruptcy. Since, on one hand, firms are not been able to generate the optimal bottom line (i.e. profitability) while, on the other hand, now the firms have to service higher borrowing cost on debt. Therefore, the volume of nonperforming loans for banks will increase, transferring the vulnerability from distressed real sector to banks.

In this context, for banks the situation becomes severe. On one hand, banks are already bearing negative shocks from sovereign sector (i.e. the weak financial conditions). On the other hand, as they make an effort to create liquidity in order to lessen the adverse effect of crisis situation, this action may not enough to revive the economy due to recessionary trend. In other words, if the attempt of banking sector to generate liquidity does not prevail then with higher NPL's and ailing sovereign bonds, financial institutions probability of default increases.

Along similar lines, as outlined by ECB (2007) second approach, is linked to the functioning of asset backed securities market. In particular, banking sector provides required liquidity and support to special purpose vehicle (SPV) companies in the securitization structure. In this regard, the factor that plays a fundamental role in generating the exposure of such SPV's is

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<sup>97</sup> For instance, a direct impact of recent sovereign debt crisis on the real sector, as reported in chapter I of the current thesis

the in-ability of the firms to roll-over their liquidity support i.e. lines of credit from the sponsor banks.<sup>98</sup>

The importance of above mentioned approaches are outlined by Hawtrey (2009). The author manifests the resilience of Australian banking system against the negative effect of the global financial crisis. In particular, his results show that the dependence of Australian banking system on the intermediation model<sup>99</sup> of acceptance of deposits and approval of loans proves to be less risky, as compared to the securitization model of approval of mortgage loans and the sale of securities which are secured by such loan collections. Thus, as compared to the US and UK financial systems, with prudent liquidity risk management the Australian banking system was less influenced and absorbed the negative shock with minimal transfer to its real sector (i.e. non-financial firms) in the recent crisis period.

Moreover, Santos (2011) in the context of the US market confirms this stated transmission channel of ailing banks liquidity risk spillover to corporate sector. Santos finds that during the US sub-prime crisis (2007-2009), generally, banks charge higher interest rates on corporate loans and specifically, banks that suffered larger losses charge even higher rates. In addition, the study reports that banks with higher exposure to securitization market (i.e. higher credit commitments to ailing SPV's), charge increased interest rate on corporate loans as compared to banks with lower exposure. As a consequence, the borrowing cost of corporate sector suddenly increases, which adversely affect firm's cash flow situation and thus declines production level that directly reduces the economic activity. In a similar vein, Ivashina and Scharfstein (2010) show that bank lending to real sector declined by 68% during the US sub-prime financial crisis and report that it is driven by the supply side and not from the demand side (i.e. it is generated through the banking sector to the non-financial corporates rather than from the decrease in demand for funds by corporates to banking sector).

In this context, we conjecture that the spillover effect of sovereign risk towards the economic activity in the euro zone, mainly depends on the degree of financial dependence (financial intermediation) of the non-financial corporate sector on banks. The adverse effect of sovereign risk spillover on the borrowing cost of non-financial firms is amplified in economies where financial intermediation is exercised at higher levels. For instance, non-financial corporates primarily satisfy their funding requirements through banking sector, as

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<sup>98</sup> This chapter does not include SPV firms in the econometric estimation due to its specialized nature of operations as compared to non-financial firms.

<sup>99</sup> The "classical model" as put forward by Diamond and Dybvig (1983)

compared to the economies in which there are more avenues for non-financial firms to finance their funding needs such as liquid capital markets (Santos, 2011; Kaya and Meyer, 2014). Therefore, it can be surmised that banking sector exposure to liquidity risk can act as a major conduit of spillover between sovereign and real sectors in the EMU.

## 2.1.2 Bottom-Up Transmission

### *2.1.2.1 Non-financial sector to Banks*

Most of the literature evaluating the effects of real sector vulnerability to financial sector emphasizes on non-financial borrower defaults and delinquencies with rather myopic consideration of these debtor firms balance sheet conditions. In particular, irrespective of default and delinquency of the debtor firm, the balance sheet mainly provides basis to gauge potential creditworthiness of the borrower. That is, the strength of financial statements of a debtor firm directly affects the cost and terms of credit. Furthermore, it influences the demand for borrowing by non-financial firms to the financial sector and hence, affects the overall economic activity (Salas and Saurina, 2002).

In this respect, Salas and Saurina (2002) suggest that weak macroeconomic conditions and the reduction in gdp growth rate immediately affect the financial position of borrower firms. As a consequence, the lender bank feels constraint in getting funds back that results in the increase of problem loans. So, the banking sector suffers an adverse shock to its liquidity position from the non-performing loans. In-turn, banks allocate a higher portion of the stock of liquid assets towards absorbing the shock stemming from such impaired loans (Antoniades, 2013). Moreover, bank's exposure to liquidity risk also exacerbates by vulnerable macroeconomic conditions and low growth. Thus, this vulnerability to banking sector stems from the demand side as against the supply side which we discussed in section 2.1.1.2.

In general, this nexus represents the basic macroeconomic theory. Particularly, with feeble macroeconomic conditions the profitability of firms (including banks) goes down. This reduces net worth of debtor firms. Now lower net-worth ideally accompanied by increase in the probability of default on outstanding loans. Eventually, it increases the volume of non-performing loans to banks. As a consequence, the banking sector probability of default due to exposure to liquidity risk abruptly increases hence, directly reducing the capacity of financial sector to generate loans. Therefore, the adverse developments in non-financial borrower

firm's balance sheet, due to weak macroeconomic conditions, spillovers to the banking sector and worsen its cash flow condition, thus resulting in credit crunch situation in the economy.

In this regard, Bernanke and Gertler (1989) put forward the above parlance into a notion they call "external finance premium"<sup>100</sup> for borrower firms. Specifically, the study argues that external finance premium is directly dependent upon the net worth and hence on the creditworthiness of borrower firm. Thus, higher the net worth of borrower firm lower is the premium demanded by a lender bank. So, it can be outlined that as weak macroeconomic conditions adversely affect debtor firm's revenue and profitability it decreases its net worth. Implying that any negative shock that reduces the credit worthiness of a debtor firm raises its cost of borrowing (i.e. loan spread) ultimately declining the expected expenditure firms plan to incur and in-turn reduces the aggregate demand. Hence, the banking sector charges higher interest rate on loans to debtor firms with weak financial position. In this context, the magnitude of increase in the interest rate of firms is higher where debtor firms mainly rely on local banks to meet their funding needs.

In practice, we observe the said situation while analyzing the US and European financial system. In case of the US, with presence of highly developed capital market, non-financial firms have alternative sources in addition to the domestic banking sector to fulfill their funding needs. However, this privilege is not adequately available in the case of euro zone, where non-financial firms primarily focus on local banking system to meet their credit requirements (Kaya and Meyer, 2014). This augments the importance of corporate-bank nexus within the euro area not only in the crisis period but also in tranquil situation. The significance of this nexus is confirmed by Artus (2013).

In this respect, Artus (2013) manifests that during crisis period the cost of borrowing for non-financial firms becomes higher in international credit markets as compared to the interest rate charged on loans by local banking sector. In such a situation, the borrower firms stall their reliance on those credit markets and moves to local banking sector (i.e. mainly to community banks) to fulfill their funding needs. This ultimately raises demand for funds hence it leads to increase constraints on domestic banking sector that has already suffering from higher exposure to liquidity risk.

Specifically, this can be observed through the increased stress on already agreed lines of credit with banks. For instance, in case of tension in international credit markets, non-

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<sup>100</sup> External finance premium is defined as a difference between costs of externally and internally raised funds.

financial firms rely heavily on the local banking sector which increases constraints on bank's exposure to liquidity risk. Consequently, it not only raises liquidity risk exposure of domestic banking sector but also increases the cost of credit for debtor firms with higher demand for against lower supply of funds (see: Gatev and Strahan, 2006; Ivashina and Scharfstein, 2010; Cornett et al., 2011 and Artus, 2013 among others).

The other path through which real sector vulnerability advances to banking sector is associated with the role of borrower firm's asset base as collateral. In addition to be used in the production of economic output, debtor firm's asset base act as a fundamental factor in securing needed loans to fulfill funding requirements (Kiyotaki and Moore, 1995).<sup>101</sup> In their study, Kiyotaki and Moore construct a model relying on the assumption that lenders (i.e. banks) cannot force debtors (i.e. firms) to repay loans, so in order to obtain credit, the requirement of firm's asset base as collateral act as a primary pillar in the debt contract.

Along the same lines, borrower firms with higher value asset base can fulfill their financing needs with ease as compared to borrower firms with lower value asset base. Thus, the value of firm's asset base as collateral plays an important role in extension of loans and the overall terms of credit. Hence, any negative shock (whether financial or macroeconomic) that reduces the value of such collateral will generate a constraint on banks cash flow position. In turn, this adverse shock drives banks to charge higher risk premium that results in increased cost of borrowing for debtor firms and hence the emergence of credit crunch situation in the economy. As a result borrower firms are unable to replenish and satisfy their financing requirements which lead to decline the production process and thus the overall economic output (Holström and Tirole 1997).

Therefore, the above discussion outlines the assumption that even such bank loan contract (i.e. bank loans backed by debtor firm's assets as collateral) should be treated as illiquid, because the relationship of bilateral debt contract between bank & non-financial firm is based on the underlying asset value which is subject to change due to an adverse shock in respective financial markets (Pollin, 2009).

#### *2.1.2.2 Banks to Sovereign sector*

With rapid With rapid growth in size of bank's balance sheet, utilization of derivative products, and higher leverage in banking operations—the banking crisis increased steadily in

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<sup>101</sup> Berger and Udell (1998) provide an extensive overview on this issue.

recent decades. This situation leads to increase the frequency of government intervention in financial markets especially after the great recession period (Reinhart and Rogoff, 2011a).

There are ample studies in existing literature that focus on the transmission of banking sector vulnerability to sovereign sector (see: Reinhart, 2009; Reinhart and Rogoff, 2011b and Arellano and Kocherlakota, 2014 among others). However, the evidence on risk spillover order between banking and sovereign crises is not concrete. In fact, related literature is not in accord whether it's the domestic banking crisis that adversely spillovers to the government sector that proves to be a major cause of sovereign default or the distress in sovereign transmits to banks that generates the banking crisis. In this respect, there exist two opposite views. On the one hand, some studies state that the ailing banking sector vulnerability transfers to government sector that leads to the onset of sovereign crisis (Arellano and Kocherlakota, 2014). On the other hand, rest of the work argues that in fact the vulnerability in sovereign sector spillovers to banks that causes a crisis in financial sector. Since, sovereign-bank spillover nexus is already discussed in section 2.1.1.1 of this chapter, therefore in this section we focus to succinctly review existing spillover channels from banking sector to the respective sovereign.

In this context, the government primarily acts to maintain the sustainability of its domestic financial system (i.e. following the Keynesian view of public sector intervention in financial market). To support the weak banking system, sovereign provides bail out / rescue packages that adversely affect government's ability to meet its outstanding debt especially to external lenders. Specifically, the fragile banking sector with increased NPL's and inadequate capital base needs to strengthen its balance sheet and to lessen its exposure to liquidity risk. So, to resolve this situation the government injects liquidity (i.e. funds) into the financial markets that generate positive signal to domestic economic agents which eases the constraints and restores confidence especially in the interbank market.<sup>102</sup>

As a consequence, this increased government spending leads to adversely affect the level of budget deficit. Thus, it renders the government with higher level of public debt which induces not only sharp increase in its borrowing cost but simultaneous decrease in the value of sovereign securities that result in the onset of recent debt crisis. Furthermore, the situation exacerbates with vulnerable macroeconomic conditions (i.e. stagnant economic growth,

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<sup>102</sup> For instance, a bank runs on Northern Rock (UK) or a default by Lehman Brothers (US) that induces government intervention in the financial markets (IMF, 2008).

higher unemployment and lower productivity) that leads to reduce tax revenue making it difficult for public sector to withhold negative shock from its domestic banking sector (Candelon and Palm 2010).

In this respect, the above effect is partially responsible for recent sovereign debt crisis in the euro zone (Nelson, 2013). Particularly, governments in developed countries have been forced to intervene by implementing various rescue plans to prevent panic in financial markets and to restore investor confidence. These financial measures include capital injections, liquidity inflows and better fiscal austerity framework. Consequently, a sovereign with already high level of public debt began to struggle in order to service and repay its outstanding debt.<sup>103</sup>

In addition, the sovereign condition exacerbates with the realization of contingent liabilities in the form of deposit insurance and any implicit or explicit guarantees to domestic financial institutions. On the other hand, with adverse macroeconomic conditions government revenue reduces that advances to increase fiscal deficits. Consequently, it raises public debt level which negatively affects sovereign ability to service its outstanding debt and results in deterioration of credit ratings for government securities in international markets (Reinhart, 2009).

In a similar vein, Noyer (2010) confirms distress in banking sector and simultaneously outlines increase in uncertainty about government's weak financial condition. Precisely, the report manifests that sovereign credit default swaps (CDS) premium tends to increase when national banking sector is under pressure. This effect is fueled by links created between sovereigns and banks, through the introduction of bailout packages to distressed banks. Moreover, the situation exacerbates when fragile sovereign endorses any other contingent liability, directly or indirectly, associated with these ailing financial institutions. As a result, in turbulent times with higher public spending and lower tax revenue, government becomes illiquid or insolvent, or both, just like its domestic financial institutions.

Besides, countries that experience private credit boom-bust cycle are affected more from risk spillover of its distressed banking sector. In particular, sharp increase in private credit augments tax revenue created by the boom phase and this transitory revenue temporarily ameliorates the fiscal position. In turn, this effect renders the economic policy makers to increase public spending and reduce tax rates. Nevertheless, as soon as the volatile boom phase ends, it manifests weakness in underlying public accounts making it difficult for

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<sup>103</sup> For instance, Greece in 2010 was unable to service its outstanding public debt

sovereign to bail-out its distressed financial sector. For instance, this situation is recently experienced in Ireland.<sup>104</sup>

To sum up, the ailing financial system adversely affects sovereign ability to service its outstanding debt that leads to higher spread on sovereign debt securities. Specifically, when the uncertainty in domestic financial system is high, governments are forced to inject required cash flow. Eventually, a sovereign is faced with liquidity shortages itself and has no choice but to access international capital markets in order to acquire required funds but at higher interest rates (i.e. government debt with “junk” status)<sup>105</sup>. As a consequence, it generates doubt within international investors about the State’s solvency condition. Therefore, it results in the deterioration of sovereign credit rating. Finally, this magnitude is higher for a sovereign who fails to build up adequate liquidity reserves during good macroeconomic periods.

## **2.2 Hypothesis reasoning**

In the light of above discussion, it is not unfair to say that most of the contemporary literature either focuses partially on the top-down or on the bottom-up transmission channel. Precisely, we did not find any study which takes into account simultaneously the spillover effect of vulnerability between the said sectors. Consequently, in the current chapter we try to fill this gap by taking into consideration recent sovereign crisis effect on real sector through banking sector vulnerability as a transmission channel and evaluate its related causal relationship in the euro zone. Particularly, this transmission channel is showed as volatility in bank’s probability of default through its exposure to liquidity risk. In this respect, we attempt to conjecture that the fragility in banking sector due to sovereign distress is transferred to real sector through its exposure to liquidity risk during recent public debt crisis in the EMU.

As outlined in previous sections, there is a considerable debate exist between empirical researchers regarding the risk transfer between sovereign-bank and bank-corporate nexus. For sovereign-bank link, on one hand some studies argue that it’s the ailing financial system that

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<sup>104</sup> Ireland is a recent example in this context, see: Honohan (2011).

<sup>105</sup> Recent example of government debt being downgraded to « junk » is when Standard & Poor’s downgrade the Greek debt to junk status in April, 2010 (“Cuts to debt rating stir anxiety in Europe” see: Ewing & Healy, 2010 (The New York Times, April 27, 2010; available at: [http://www.nytimes.com/2010/04/28/business/global/28drachma.html?\\_r=0](http://www.nytimes.com/2010/04/28/business/global/28drachma.html?_r=0))



generates sovereign crisis, while, others conjecture that the banking crisis is caused by spillover effect of debilitated health of its sovereign sector.<sup>106</sup>

In a similar vein for bank-corporate nexus, some authors argue that its the feeble banking system that transfers financial uncertainty towards the real sector and on the other hand, others report that in fact its the corporate sector vulnerability that spillover's to financial sector and triggers banking crisis as a consequence.<sup>107</sup>

This chapter is an attempt to address these issues and to provide a novel approach to view the existing problem as a continuous structural system of interconnectedness of fragility among sovereign-bank-firm nexus. In other words, this chapter attempts to bridge a void created by separately evaluating these sectors and to appraise the impact of recent sovereign debt crisis on real sector through banks in euro area economies. In addition with higher sovereign risk, distress in the euro zone banks increased related to its liquidity exposure.

Therefore, to better understand the nexus between spillover effects of recent euro crisis on real sector, we contribute to explain in detail how such transmission occurs. To do this, we propose to use a channel inherent in the traditional function of commercial banks, namely its liquidity creation process. In particular, one of the primary roles of bank is to provide a service to domestic economic agents regarding the demand for and supply of funds to meet their respective liquidity requirements. In this context, banks furnish credit to real sector for the sustenance of economic activity by taking into consideration its own exposure to liquidity risk which a commercial bank generates while transforming liquid liabilities (i.e. certificate of deposits, short-term bonds, demand deposits) into illiquid assets (i.e. loan contracts).<sup>108</sup>

In particular, we argue that losses in bank's capital base due to the reduction in value of sovereign securities that it holds as liquid asset negatively affect its risk premium and hence increase the interest rate on bank's liabilities. On the other hand, this effect exacerbates as the return on bank's asset decline simultaneously with weak macroeconomic conditions. As a result, it renders banking sector vulnerable leading it, not only, to increase cost on corporate loans but also to withdraw from already committed assurance to supply funds in the form of

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<sup>106</sup> See: Sturzenegger (2004); Reinhart (2009); Reinhart and Rogoff (2011a); Noyer (2010); Gennaioli et al. (2014) and Arellano and Kocherlakota (2014) among others.

<sup>107</sup> See: Diamond and Rajan (2005); Ivashina and Scharfstein (2010); Cornett et al. (2011); Santos (2011); Salas and Saurina (2002) and Antoniadou (2013) among others.

<sup>108</sup> See the seminal paper of Diamond and Dybvig (1983) for details.

lines of credit to non-financial firms. Consequently, it increases distress in domestic credit market and thus leads to higher probability of default on loans by the corporate sector.

Along the same lines, we assume that the magnitude of such distress will be higher in economies where fundamental source to fulfill funding requirements for corporate is the local banking sector. In other words, the sovereign spillover effect on real sector is ideally larger for countries where the dependence of non-financial firms on bank credit is higher to satisfy liquidity needs as compared to other economies where there are alternative funding avenues available. In this context, the euro area is a prime example.

So far, we have observed in the related literature that as soon as the banking sector is adversely influenced by the spillover effect of sovereign crisis it started to de-leverage and consequently reduce the volume of credit to non-financial firms (Angelini et al., 2013). However, we argue that may be banks in the euro zone do not necessarily follow this traditional strategy of strict credit rationing as stated in existing literature. In other words, we conjecture that banking sector may strive to alleviate distressed situation by proactively generating liquidity cycle for a short to medium term at higher borrowing cost for much needed funds to non-financial firms.

In this manner, banks not only attempt to lessen the effect of recent sovereign crisis in its balance sheet but on the other hand, make an effort to generate return on its assets by indulging aggressively towards its core banking activity which is accepting deposit and using the funds to create liquidity in the market. In particular, the banking sector honors its fundamental role of liquidity creation that is going to be beneficial in two folds: on one hand it helps financial market to recoup during crisis period and on the other hand, it assists in reviving the overall economic activity.

Therefore, we hypothesize that banks in order to come out of and lessen the said crisis situation strive to generate and create liquidity for short to medium term by charging higher interest rates on the extension of loans needed by debtor firms. In other words, banking sector attempts to abate the negative effect of recent crisis on its debt spread by exploiting two effects: first, the healthy non-financial corporate sector and second the higher financial intermediation advantage in the context of euro zone.

In this context, we treat the interconnectedness of sovereign-bank-firm as a structural framework that is in operation simultaneously. That is, it is not empirically prudent to

disentangle the nexus into different levels such as bank-sovereign/sovereign-bank effect<sup>109</sup> or bank-real sector/real sector-bank effect.<sup>110</sup> Hence, in order to improve our understanding of fiscal and monetary policy applications especially during crisis period (for instance: recent euro crisis), we have to take into account the full cycle effect due to its intricate complex nature. Therefore, we treat this framework as a continuous loop which is in operation within the economy. In this context, we suggest that abrupt volatility in one sector (such as government) transfers to the other (that is, real sector) through the intermediary channel of banks liquidity risk which generates an incessant cycle of risk spillover in the economy.<sup>111</sup>

Moreover, we suggest that the degree of financial dependence act as a fundamental factor for policy makers because not only, on one hand, it helps in the growth of the financial markets but on the other hand, if any negative shock hits the economy it multiplies that adverse effect on both the real and sovereign sectors with rendering the banking sector as vulnerable as possible.<sup>112</sup>

In fact, to our knowledge this chapter is a maiden attempt to comprehensively study not only the vulnerability spillover between three intertwined sectors of the economy (i.e. sovereign, bank and non-financial firms in the euro area) but also quantitatively treats the issue on micro-economic level (by simultaneously controlling for related macro effects). In this context, we attempt to address the following questions:

- How the adverse effect of sovereign debt crisis transmits to real sector with high level of financial dependence (i.e. increased reliance of non-financial firms on bank credit)?
- How the disturbance in bank's financial position impede their role as a major provider of liquidity (i.e. availability and cost of credit) to real sector in the light of increased turbulence in sovereign debt market in the euro area?

Whether, as a consequence of euro crisis, banking sector adopts strict credit rationing strategy or attempts to withstand by generating liquidity towards the real sector?<sup>113</sup>

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<sup>109</sup> See: Reinhart and Rogoff (2011a); Balteanu and Erce (2014)

<sup>110</sup> See: Borio et al., (2001); Laeven and Majnoni (2003); Marcucci and Quagliariello (2008)

<sup>111</sup> See: figure (II.2)

<sup>112</sup> Bolton and Jeanne (2011) show that sovereign debt crisis affects higher to countries that are highly financially integrated.

<sup>113</sup> That is, banking sector itself pursue to break shackles of the crisis effect

### **3 Empirical Methodology**

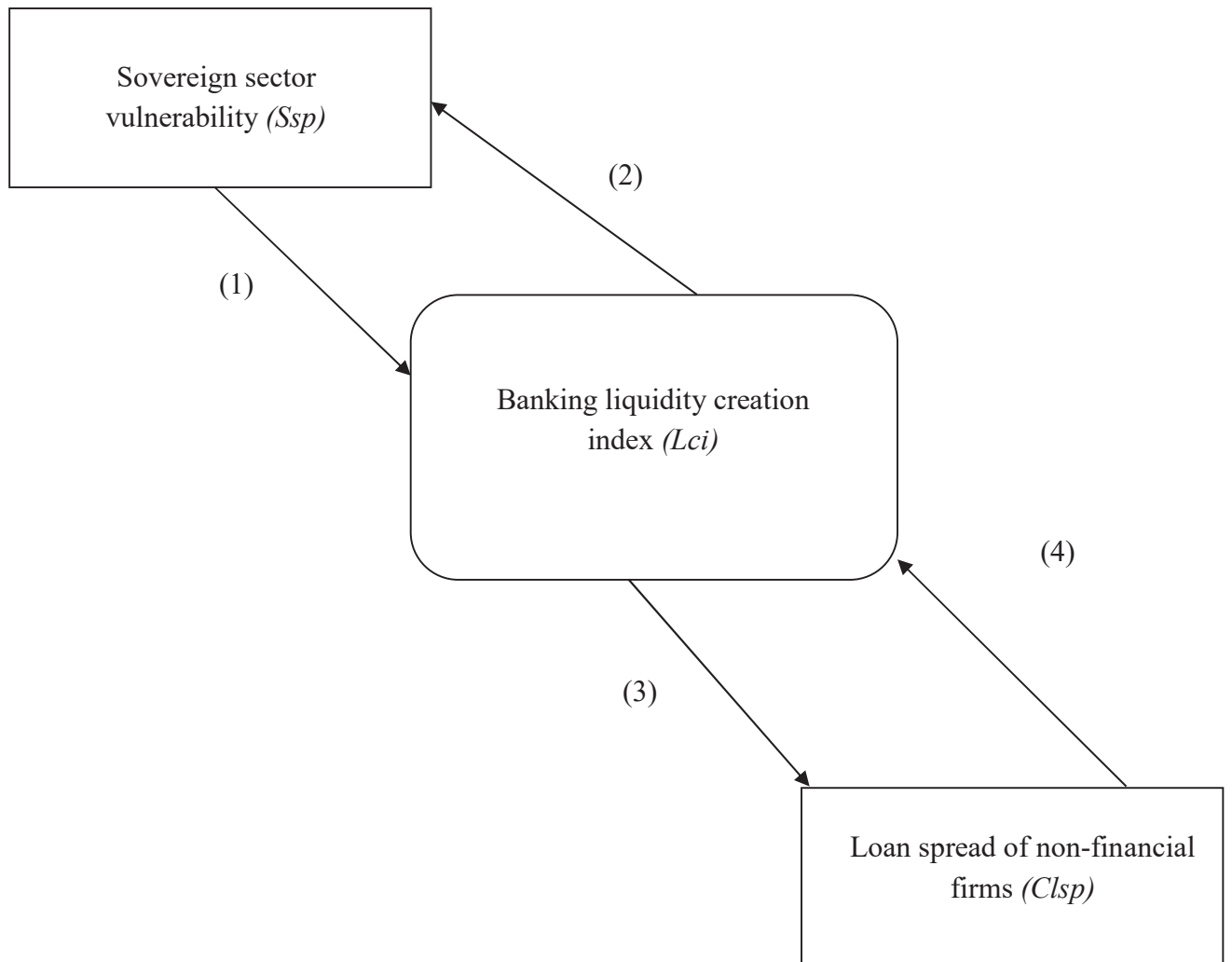
As outlined in section 2, existing literature lacks to take into consideration the simultaneous effects of default risk spillover within the said sectors of the economy. The contemporary studies mainly focus either on the spillover effect between sovereign-bank/bank-sovereign or bank-corporate/corporate-bank nexus separately. Along the same lines, Balteanu and Erce (2014) study the causal relationship between sovereign and banking crises, separately, in the emerging countries. In their work, the authors' focus on the event analysis methodology by taking into account the occurrence of default event in relation to sovereign debt and banking crises. The results obtained by Balteanu and Erce are restricted in nature due to the application of event analysis framework. As, this methodology is limited in its approach because it does not treat the identification of causal relationship and is subject to inherent weaknesses regarding research design and sample size (Basdas and Oran, 2014).

In a similar vein, while evaluating the relationship between sovereign default, domestic banks and other financial institutions, Gennaioli et al. (2014) empirically find that the sovereign debt crisis causes and generates the banking crisis. In doing so, they follow pooled ordinary least square estimation (OLS) method by taking into account change in private credit from banking sector as dependent variable and uses dummy variables to identify sovereign default period from Standard & Poor's data as main variables of interest with macro control effects. In fact, the study does not take into account the potential endogeneity effect between sovereign default and growth in private credit from banking sector and pooled OLS estimation, therefore, provides biased results with inconsistent estimates (Wooldridge, 2002).

In this respect, the main variables which we included in order to evaluate the stated system of sovereign risk spillover to corporate sector through banks liquidity risk as outlined in section 2.1 are: sovereign bond spread (the euro area government bond spread of ten years maturity with respect to German Bunds of the same maturity), liquidity creation index of banking sector within the euro zone (following the methodology put forward by Berger and Bowman, 2009)<sup>114</sup>, and syndicated-loan spread of non-financial firms in the euro area. Our assumed relationship between these variables of interest can be portrayed as a simultaneous structural framework that is continuous in nature and can be shown with the help of figure (II.2).

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<sup>114</sup> Refer to Appendix (B) for discussion regarding the motivation to use this indicator and the related importance of banking sector exposure to liquidity risk as a potential conduit of vulnerability spillover



**Figure II.2: Relationship between risk spillover components of stated continuous structural framework**

In figure (II.2), links (1) and (2) manifest the sovereign-bank nexus and its causal effect, whereas links (3) and (4) represent bank-corporate relationship and the assumed reverse causality. The main objective of current chapter is to evaluate the spillover effect of sovereign debt crisis on real sector through the transmission channel of bank's liquidity risk as a continuous structural process. Therefore, in order to evaluate this process, we use a system of simultaneous equations with Three-Stages Least Squares (3SLS) estimation method.

The basic structure of our system of simultaneous equations can be expressed as:

$$\begin{aligned}
 Ssp_{it} &= \theta_1 + \beta Lci_{it} + \alpha M_{it} + \mu_{1it} & (1a) \\
 Lci_{it} &= \theta_2 + \vartheta Ssp_{it} + \lambda Clsp_{it} + \gamma B_{it} + \alpha M_{it} + \mu_{2it} & (1b) \\
 Clsp_{it} &= \theta_3 + \beta Lci_{it} + \delta L_{it} + \Phi F_{it} + \alpha M_{it} + \mu_{3i} & (1c)
 \end{aligned}
 \quad \left. \vphantom{\begin{aligned} Ssp_{it} \\ Lci_{it} \\ Clsp_{it} \end{aligned}} \right\} \mathbf{I}$$

Equation (1a) manifests the relationship between banking sector liquidity risk and yield spread of sovereign securities in relation to German bunds (in the euro zone). Whereas  $Ssp_{it}$  represents the sovereign bond spread of euro area countries with respect to German government bonds of 10 years maturity.  $Lci_{it}$  shows the effect of liquidity creation index of euro area banks. The vector  $M_{it}$  includes different macro-economic control variables as used in the existing literature such as; GDP growth, US/Euro exchange rate in log form and inflation measured as Producer Price Index (PPI).

Equation (1b) reports the banking sector exposure to liquidity risk as the heart of our simultaneous equation system which is influenced by both the sectors i.e. sovereign and non-financial corporate. In addition to variables specified in equation 1(a), in equation 1(b),  $Clsp_{it}$  represents vulnerability of euro area non-financial corporate sector through its syndicated-loan spread. The syndicated-loan spread relates to banks that are situated in the same region (i.e. the lead bank is located in the euro zone) in basis points (bps) over the benchmark rate which in our case is normally the Euribor rate. In addition, the vector  $B_{it}$  includes different control variables at individual bank level as outlined in related literature such as; Return on Assets (ROA), Provision for losses, interbank ratio, and total assets in log form (Cornett et al. 2011).

Equation 1(c) outlines the assumed spillover effect of sovereign crisis through banks vulnerability which is measured as liquidity creation index on non-financial firm's borrowing spread. Along the same lines, variables specified in addition to equations 1(a) and 1(b) are, vector of syndicated-loan related control variables  $L_{it}$ , and  $F_{it}$  vector of different control variables at individual firm level as mentioned in the existing literature (Agça and Celasun, 2012). The vector  $L_{it}$  includes different controls regarding loan size (i.e. the log form of total

loan amount), loan maturity (in years) and loan utilization purpose.<sup>115</sup> Furthermore, the vector  $F_{it}$  includes control variables at firm level such as: leverage ratios (total debt to EBITDA, total equity to total assets); firm size (log form of net asset value); liquidity ratio (change in current ratio on annual basis); profitability ratio (change in firms net margin on annual basis) and its market valuation ratios (historical volatility of firm shares and its price earning multiple). Whereas:  $\theta_1$ ,  $\theta_2$  and  $\theta_3$  represent the equations intercepts. In addition, the subscripts “ $i$ ” and “ $t$ ” represent the country and time dimensions, respectively. Whereas:  $\mu_{1it}$ ,  $\mu_{2it}$  and  $\mu_{3it}$  are error terms of the simultaneous equations system. The sources and description of all the variables used in this chapter are reported in table (B.1), Appendix (B).

In system (I):  $Ssp_{it}$ ,  $Lci_{it}$ , and  $Clsp_{it}$  are three endogenous variables of interest and rest of control variables are assumed to be exogenous. One way of estimating the system (I), graphically portrayed in figure (II.2), can be through the utilization of OLS by estimating each equation individually. However as mentioned, our variables of interest are endogenous i.e. they become explanatory variable in one state and the dependent variable in the other state, so the joint determination of the spillover risk effect for these sectors violate the orthogonality condition {for example;  $E(Lci_{it}, \mu_{1it}) = 0$ }, and the ordinary least square estimation method lacks to resolve endogeneity problem. Therefore, the OLS do not provide unbiased and consistent results in this regard.

In addition, if this might be the case then we also have the option to use the instrumental variable (IV)/two-stage least squares (2SLS) estimation method to evaluate our system of simultaneous equations. In fact, even though the 2SLS method efficiently caters the endogeneity problem it deals with the system of equations as one equation at a time, which does not fulfill the objective of current chapter. Particularly, we aim to treat and evaluate risk spillover between said sectors of economy as an instantaneous process for which the 3SLS is an appropriate econometric approach that estimates all the coefficients of linear equation system simultaneously in a single process. Besides, the 3SLS estimation method is more efficient than the 2SLS because it also treats the correlation between cross-equation error terms that are present in the system. Having said that, the 3SLS method of simultaneous equation estimation has the capability to evaluate the system as a transmission channel but the results are not strictly robust in nature because it relies on the assumption that all the equations in system being correctly specified.

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<sup>115</sup> Refer to table (B.5) in Appendix (B) that lists different purposes for which the syndicated-loan is contracted

According to the economic literature, there is an instantaneous correlation present between the equations of system mentioned, which contaminate the hypothesis of orthogonality among residual variance-covariance matrix. So, the OLS and 2SLS methods provide spurious estimators. Therefore, we follow the 3SLS method to estimate this system because it remedies the problem of having a correlation among the equations. This is due to the fact that the 3SLS econometric approach pre-estimates the variance-covariance matrix (not assuming it as a diagonal) and uses it as a known variance-covariance matrix for generalized least square estimation method. In addition, this framework is suitable to apply for a panel data estimation which is most likely to be the candidate, in our case, that renders this type of individual correlation.<sup>116</sup>

## **4 Data, descriptive statistics and correlation inference**

### **4.1 Data**

This chapter takes into consideration a sample covering different types of data: governments, banks, non-financial corporates, syndicated-loans and other macro-economic control variables. These data observations are mainly extracted from the following databases: DataStream, Bank Scope, and SDC Platinum. In addition, macro-economic control data is fundamentally extracted from the websites of Euro-Stat, Federal Reserve Bank of St. Louis (USA) and from World Development Indicators (WDI). In particular, for sovereign risk data we use government bond spread of euro area countries with respect to German Bunds (of ten years maturity) which is obtained from the OECD website.

Along the same lines, our sample data is constructed to create a cross-section and temporal panel covering twelve euro zone countries for the period 2005-2012. Furthermore, our micro data sample is comprised of balance sheets and income statements of euro area commercial banks and non-financial firms. As far as non-financial firms are concerned, we include those enterprises that borrowed syndicated-loan from euro zone banks and are listed in most relevant euro area equity indices for each country. The data sample in this regard addresses the financial characteristics of firms during the focused time period. In particular, the data is collected on an annual basis regarding financial statements of banks and non-financial corporates and also macro-economic control variables. Whereas, for the measurement of

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<sup>116</sup> See: Greene (2008), *Econometric Analysis*, chapter 15



banks liquidity risk we follow the methodology proposed by Berger and Bouwman (2009), to create a liquidity creation index for euro zone banking sector.<sup>117</sup>

Regarding the information about syndicated-loan markets: we include all syndicated loan transactions occurred during our focused period covering twelve euro area countries from SDC Platinum database. In particular, search criteria is refined by including only non-financial debtor firms that are situated in euro zone countries with lead arranger bank of syndicated financing from the same geographical region. Specific information regarding loan transactions that are included in current study constitutes: total loan amount, maturity, loan spread and purpose of its utilization.

Since, the goal of this chapter is to investigate spillover effects of sovereign vulnerability towards the borrowing spread of non-financial firms through the volatility in bank liquidity creation as a fundamental transmission channel: we strive to establish a relationship between these three components in the construction of our structural system of equations. To construct a coherent sample of panel data for our interested variables and to be consistent with the information related to our focused sample data-bank, we aggregate (weighted average)<sup>118</sup> the information regarding variables of banks, firms and loans on an annual basis. Therefore, we get sample data of banks, firms, and loans on a country level within the euro area for each year. This provides us a strong balanced panel data set to execute our estimation process.

In addition, our primary variables are calculated as follows: government bond spread of individual euro area countries of ten years maturity is obtained in relation to German Bunds of the same maturity in percentage points; banks liquidity risk creation index is calculated following Berger and Bouwman (2009) which consists of dividing all bank's assets and liabilities into three categories i.e. liquid, semi-liquid and illiquid, and each category is weighted by a coefficient reflecting the degree of its liquidity or illiquidity; and firms loan spread is obtained by excluding the benchmark Euribor rate from total interest rate charged on loan transactions by syndicated banks. The description and sources of all variables included in this chapter is reported in table (B.1), Appendix (B).

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<sup>117</sup> See table (B.1) in Appendix (B) for calculation method

<sup>118</sup> For banks and non-financial firms, the weightage is according to the total assets and for loans it's the total loan size

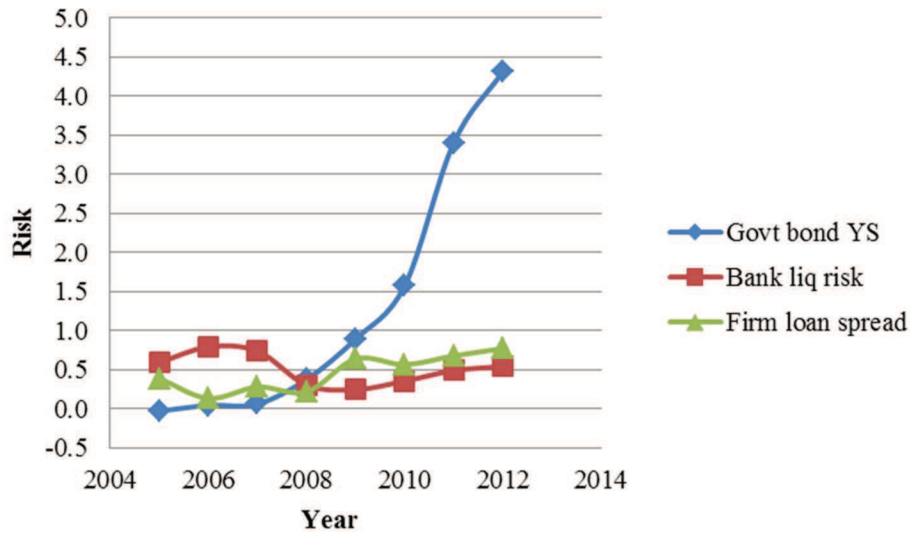
## **4.2 Descriptive Statistics**

Let us analyze the illustrative characteristics of our data variables. In this respect, table (B.2) in Appendix (B), reports descriptive statistics of all variables included in this chapter for the time period of 8 years i.e. from 2005 to 2012. By analyzing table (B.2), we can see that our interested covariates significantly vary through sample data-bank across 12 euro area countries. Specifically, government bond yield dispersions suggest a significant variation in its spread with respect to German Bunds which goes from almost -1% to 21% for our selected countries. Similar variations are reported for the liquidity creation index of banking sector which varies from -2.5% to 2.8% and non-financial firms syndicated-loan spread that varies from 33 to 515 basis points (bps). The values of our main variables of interest portray a realistic picture regarding our focused EMU countries for the period 2005-2012. As can be observe in table (B.2), in particular the sovereign bond of Finland reports minimum yield spread of -1% and sovereign bond of Greece reports maximum yield spread of 21% in relation to German government bond. In addition, the bank liquidity creation index and non-financial corporate loan spread follow similar trend.

In general, the overall prevalent situation of risk evolution in sovereign, bank and non-financial firm sectors in euro area countries can be depicted by the help of figure (II.3). As shown in the figure, we can observe that since the start of the US sub-prime crisis, sovereign bond spread of euro zone started to increase and after 2009 the surge in its yield spread is abrupt for the period 2010-2011 reporting the effect of sovereign debt crisis. This confirms the finding outlined in the study by ECB (2010), which reports that before the onset of global financial crisis (GFC), the euro area sovereign bond market was one of the most harmonized and unified financial market segment.

Furthermore, the increase in spread was not only limited to sovereign debt securities. As outlined in figure (II.3), non-financial loan spread also started to increase during the same time period and in fact mirrored the developments in sovereign spread especially till 2010. Nevertheless, the increase in corporate sector loan spread is not as sharp as the government sector of respective euro zone economies. In addition, our banking sector liquidity creation index shows mix signals. As can be seen in figure (II.3), it mainly follows the fundamental relationship against the risk evolution in corporate and government sector, i.e. banks generate more liquidity when the general risk levels are low in the said sectors and create less liquidity when the uncertainty in sovereign and non-financial sectors increases. However, since the

commencement of sovereign debt crisis in the euro zone, it acts in a peculiar manner showing increase in the liquidity creation process in respective member states. In particular, the observed differentiation among individual government bond spread within the euro zone commenced after the US government save Bear Sterns in March 2008 that outsets the change in global risk aversion for international debt markets (Mody A., 2009).



**Figure II.3: Risk evolution in government & real sectors with bank's liquidity risk in the euro zone**

Along the same lines, as can be observed in table (B.2) Appendix (B), our macro-economic control variables also vary significantly, i.e. the inflation volatility ranges between -4.7% to almost 6%; the GDP growth varies between -8.5% to 6.5%, and the real Euro/US dollar exchange rate varies from 1.2 to 1.47. Furthermore, syndicated loan-level variables report grant of short to medium term loans as maturity ranges from as low as 1 year to as high as 14.5 years. The average loan amount is approximately equal to \$1.17 billion with an average maturity of 6 years indicating concentration on medium-term period. In addition, the non-financial firm level information indicates that loan is mainly extended to medium-to-big firms bearing net asset values ranging from \$169,057 million to \$8,688,000 million. Therefore, to control for the heterogeneity among sample firms we introduce various factors that affect the financial health of these borrower firms which vary significantly: the growth multiple varies from 8 to 583 multiples; liquidity ratio ranges from -17% to 478%; profitability ratio goes from -15725% to 6614%; leverage ratio ranges between -15% to 21% and historical stock

volatility varies from 0.17% to 0.94%. Moreover, we use log form of the total net asset value to control for firm's size. Finally, we include syndicated-loan purpose as a control variable in current study in order to enable us to get a clear idea of which type of loan is mainly affected significantly during the recent crisis period. Table (B.5) in Appendix (B) describes the different types of loan categories used in this chapter.

As far as, bank-level control variables are concerned, we include banks: size, profitability, probability of default and interbank market effect. In addition: the return on assets varies from -7% to 8%; interbank ratio ranges from 23% to 317%; provision for loss compared to total portfolio goes from -1% to 33% and z-score ranges from -7 to 6.3 score regarding banks default. Particularly, banks in our sample are fairly big with an annual average of total assets approximately equal to 20 billion euro. Furthermore, average of interbank ratio is relatively high at 139.46%, indicating that most of the banks in our sample are active and act as custodian of deposit funds in euro area interbank market.

### **4.3 Correlation Inference between our main covariates**

The correlation across our variables of interest is reported in table (II.1).<sup>119</sup> The panel (I) in table (II.1) shows the correlation between our main covariates for the full sample time period. Whereas; panels (II) and (III) report the correlation among said variables for time period 2005-2009 and after 2009, respectively.

Let us first concentrate on the relationship between government bond spread, banks liquidity creation index and corporate loan spread for panels (II) and (III). The correlation table shows quite unorthodox relationships. We can observe in panel (II) that till 2009 our main covariates follow traditional inverse relationship i.e. as government bond spread increases banks liquidity creation index decreases, simultaneously, that is reducing its exposure to liquidity risk. Thus, banks follow credit rationing approach that leads to increase the risk premium on corporate loans. On the other hand, the surge in sovereign and real sectors vulnerability transmit a negative signal to banks making it difficult for them to follow liquidity creation process in a normal manner. However, as we shift our focus towards the information outline in panel (III), we can gauge an interesting inference for banking sector in the euro area.

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<sup>119</sup> As can be seen in table (II.1) the correlation across our variables is not very high, even then we use the variance inflation factor (VIF) approach (by taking into consideration results outlined in table (II.2) that reports less than 5). Therefore, we safely assume no significant multicollinearity among our interested covariates.

*Euro zone sovereign crisis spillover to real sector: Is banking sector liquidity risk a major conduit?*

	Over-all sample			Sample divided by time period					
	Panel I			Panel II (2005-2009)			Panel III (>2009)		
	Govt. bond spread	Bank liquidity creation index	Corporate loan spread	Govt. bond spread	Bank liquidity creation index	Corporate loan spread	Govt. bond spread	Bank liquidity creation index	Corporate loan spread
Govt. bond spread	1.000			1.000			1.000		
Bank liquidity creation index	0.070	1.000		-0.116	1.000		0.237	1.000	
Corporate loan spread	0.276	-0.065	1.000	0.082	-0.102	1.000	0.116	0.055	1.000

Now banks liquidity creation increases with a rise in government bond spread and simultaneously the interest rates on syndicated-loans of non-financial firms are also increasing. This manifests rather a peculiar behavior. In particular, according to correlation matrix, the vulnerability in sovereign sector does not bother the banking sector adversely enough to a level which triggers banks to start panic and to commence de-leveraging or reducing the liquidity creation process and eventually their exposure to liquidity risk towards the non-financial corporate sector. However, banking sector takes a prudent stance by increasing premium on borrowing cost to the real sector in advance anticipating financial difficulties in near future due to reduction in the fiscal space. Therefore, according to panel (II), banking sector in the euro zone suffering with effects of the sub-prime crisis<sup>120</sup> follows traditional liquidity creation behavior (i.e. orthodox liquidity management strategy), whereas, panel (III) manifests that banking sector adjusts its liquidity management behavior according to the type of crisis and strives to generate liquidity (at higher interest rates) even as banks feel imminent pressure from vulnerable financial condition of respective sovereign.

In addition, as already reported in macro-economic literature<sup>121</sup> that the sovereign debt crisis in euro zone mainly commenced from 2010 when Greece applied for financial support and ECB<sup>122</sup> started injecting liquidity (money supply) to member governments that are suffering with public debt problems. Therefore, we assume that the observed anomalous indication is due to the aforementioned liquidity stimulus from the ECB. This policy action, actually enable the banking sector, in those member countries that are plagued with huge public debt levels, to create liquidity despite a continuous surge in probability of default of banks consequent to a sharp decrease in value of respective sovereign securities.

In other words, what we suggest is that the financial system in euro area uses this rescue package not only to create liquidity in banks but also in non-financial sector which is subject to higher borrowing cost for corporates. This eventually leads to invoke a positive step towards reviving ailing member economies that are suffering with sovereign debt problems and to lessen spillover effect to the corresponding real sector. As a result, this may create a ripple effect in economy that triggers the aggregate demand which in turn enable sovereign to reduce its level of public debt through higher amount of tax revenue against earlier distressed period.<sup>123</sup> In addition, it aids

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<sup>120</sup> In this respect, BIS (2009) provides evidence that the US sub-prime crisis is more of a banking sector's liquidity crisis.

<sup>121</sup> See: Popov and van Horen (2013)

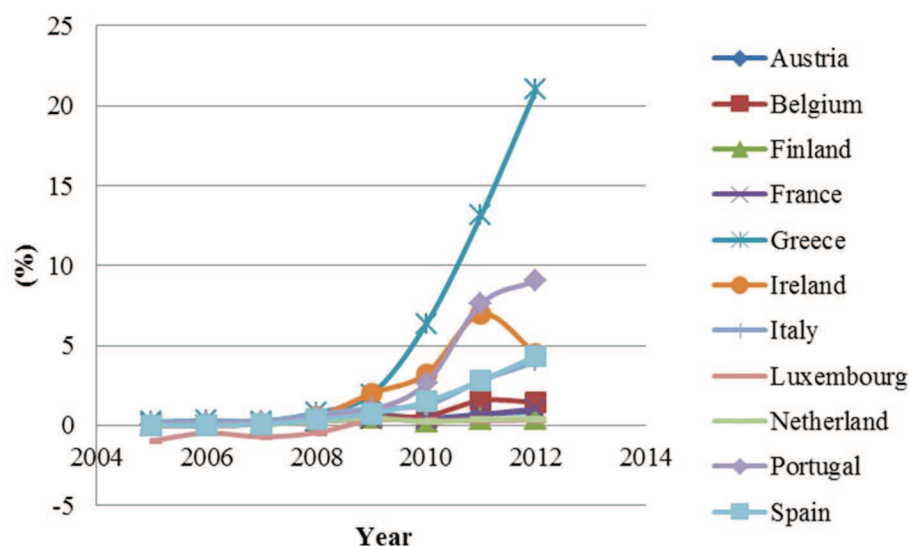
<sup>122</sup> In conjunction with IMF

<sup>123</sup> However, these arguments are subject to time interval for materialization

government to follow fiscal austerity measures (as proposed by ECB) in order to try to streamline the effects of stimulus packages in the euro area economic system.<sup>124</sup>

In a similar vein, for non-financial corporate sector, this increased creation of liquidity by banking sector assumes to affect in two ways: on the one hand, strict credit rationing strategy that banks traditionally follow in crisis periods becomes relaxed in a manner that needed liquidity is available to borrower firms in order to satisfy their funding needs. Therefore, the non-financial firms can operate in difficult economic periods and in turn make an effort to generate profits. On the other hand, the higher cost of borrowing affects debtor firms adversely, if liquidity injection multiplier effect<sup>125</sup> does not realize in its entirety. That is, if borrower firm fails to generate the desired returns after utilizing costly loans then the other side of coin poses harsher problems not only to debtor firms but consequently to the banking sector as well and eventually to respective sovereign.

In particular, when non-financial firms are not able to generate adequate returns on acquired loans in difficult economic conditions then costly debt repayment will lead to increase the default probability. Hence, it increases the volume of impaired loans to creditor banks that are already suffering with ailing government securities in their balance sheet. The inference we outline on the basis of correlation matrix in turn explains the anomalous behavior of risk evolution in the government, bank and real sectors that is shown in figure (II.3).



**Figure II.4: Euro zone's government bond spread with respect to German bunds**

Furthermore, figure (II.4) helps to understand the overall discussion in this section through risk evolution in sovereign sector in individual economies of euro zone with respect to German Bunds.

<sup>124</sup> Similar argument put forward by Alesina and Perotti (1997)

<sup>125</sup> That is, the fiscal stimulus package effect by ECB/IMF to generate aggregate demand in the EMU

It can be observed from figure (II.4) that the uncertainty in sovereign sector is at the highest in GIPSI region (i.e. Greece, Ireland, Portugal, Spain and Italy). Moreover, figure (II.4) shows since late 2008 the differentiation in individual sovereign bond spread started which is outlined by Mody (2009).

Coming back to table (II.1) panel (I) that manifests correlation nexus among our focused covariates for the overall sample time period. The first column mainly shows dominant effect of sovereign debt crisis period over the sample period of 2005-2009 in relation to liquidity risk creation by banks as previously discussed. On the other hand, the effect of liquidity creation on non-financial firm's loan spread follow a traditional relationship, describing the influence of panel (II) finding in the overall time period. Finally, these conjectures render us eager to evaluate the risk spillover of euro crisis on non-financial firms by mainly focusing on banks fundamental role of liquidity creation in respective financial markets in the EMU.

## **5 Estimation results, discussion& robustness**

### **5.1 Estimation results and discussion**

In this section we report our empirical findings. In particular, tables (B.3)<sup>126</sup> and (II.2) show estimation results for our system of simultaneous equations model through the OLS and 3SLS methods. In fact, our primary objective is to focus on the outcome of 3SLS estimations but for a base case and comparison, we start our empirical analysis by applying the OLS procedure to system (I).

In general, it can be observed in table (B.3), Appendix (B) that results are influenced by sovereign debt crisis effect between sovereign-bank and bank-sovereign nexus and dominated by the period preceding euro crisis between bank-corporate and corporate-bank nexus. The coefficients sign (-/+ ) reflects in accordance to the correlation matrix as described in section (4.3). Furthermore, in adherence to the parlance in section (3), the joint determination of our variables of interest in evaluating the spillover effect between said sectors do not comply with the orthogonality condition and thus the OLS estimates provide biased and inconsistent results. Therefore, we turn our attention to table (II.2).

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<sup>126</sup> Table (B.3) is reported in Appendix (B) for brevity reasons.



**Table II.2: Three Stages Least Square (3SLS) estimation of our structural system of risk spillover with-in government, bank and non-financial firm sectors**

	<b>Govt. bond spread</b>	<b>Bank liquidity index</b>	<b>Corporate loan spread</b>
Bank liquidity creation index	-1.981*** (0.678)		1.660* (0.874)
Govt. bond spread		-0.155** (0.065)	
Corporate loan spread		0.002 (0.001)	
<u>Macro-level controls</u>			
Real exchange rate	-0.198*** (0.051)	-0.307* (0.163)	0.273 (3.164)
Inflation (PPI)	0.197*** (0.047)	0.011 (0.018)	0.660** (0.257)
GDP growth	-0.371*** (0.085)	0.011 (0.029)	-0.110** (0.047)
<u>Bank-level controls</u>			
Return on asset		-0.074 (0.051)	
Provision for loss		-0.003 (0.013)	
Interbank ratio		-0.006 (0.001)	
Total asset		0.013 (0.056)	
<u>Loan-level controls</u>			
Loan spread			0.234 (0.224)
Maturity (yrs)			-0.596 (0.541)
<u>Purpose</u>			
General			1.855* (1.043)
Leverage Buy Out (LBO)			2.069* (1.093)
Project Finance (PF)			1.843* (1.074)
Recapitalization			2.28 (1.528)
Refinancing			1.831* (1.084)
Restructuring			1.968 (1.31)
<u>Firm-level controls</u>			
Net asset value			-0.154 (0.197)

Table (II.2) continued...

Historical share volatility	1.309 (0.965)
Stock turnover	-0.265 (0.456)
Leverage ratio	-0.326 (0.233)
Liquidation ratio	-0.022 (0.155)
Growth multiple	-0.081 (0.154)
Profitability ratio	0.002 (0.007)
Liquidity ratio	0.143 (0.531)

Note: The dependent variables of Simultaneous Equations Model (hereafter, SEM) are: government bond yield spread (Euro area sovereign bond yield minus German sovereign bond yield-10 years); Bank liquidity creation index of the euro zone banking system defined in table (B.1), Appendix (B) and the syndicated loan spread (bps) of firms located in the euro area with lead banker situated within the EMU. The three columns indicate the simultaneous equations model of our structural system framework which is estimated through the 3SLS econometric method, respectively. We use data sample of 12 countries due to the availability of all required data fields in our structural system. The list of countries included is outlined in table (B.6), Appendix (B). The definition of all variables included in the 3SLS estimation can be observed in table (B.1), Appendix (B). In short, the leverage ratio here is (Total debt/EBITDA); liquidation ratio (Total shareholders' equity/Total assets); growth multiple (Price Earnings ratio); profitability ratio (Net Margin-1 year percentage change); liquidity ratio (Current ratio-1 year percentage change); Return on assets (Net Income/Total assets). Robust standard errors are reported in parentheses whereas, \*\*\*, \*\* and \* represent significance at 1%; 5% and 10% level, respectively.

The table (II.2), shows the 3SLS estimation of our structural system of risk spillover between focused sectors of the economy mainly; government, bank and non-financial firm. The first column in table (II.2) describes the outcome of equation (1a) of our system (I), as mentioned in section (3), in which dependent variable is government bond spread. Whereas, in column two the dependent variable is banks liquidity creation index as expressed in specification (1b) and the last column shows the non-financial firm syndicated-loan spread as dependent variable which is outlined in equation (1c) of our system (I) in section (3). In addition, throughout the estimation of 3SLS regression method, we control for the macro-economic effects. Furthermore, we include bank-specific controls in equation (1b) and in addition, we incorporate firm-specific and loan-specific controls in specification (1c). This assists us to treat the rational effect of risk spillover between government, bank and non-financial corporate sectors in euro zone economies as a loop that is continuous by nature.<sup>127</sup>

<sup>127</sup> The R-square is not reported due to the irrelevance with the 3SLS estimation method. In fact, 3SLS does not compute R<sup>2</sup> from a true model in which the instruments were used. This means that the econometric software uses the real values of endogenous variables with estimated coefficients to calculate R-square in the original model. Precisely,

Table (II.2), first column shows the nexus between banks liquidity creation and sovereign bond spread. The relationship is negative (indirect) and the result is statistically significant at 1%. For instance, it shows that if banks liquidity creation increased by 1 unit the related sovereign bond spread decreases by 1.9 units. In the economic sense, when banking sector in euro area seems to generate more liquidity in financial markets then it depicts a healthy economic situation which enables respective sovereign to mainly focus on its fundamental role of providing support to public development projects and to collect without difficulty adequate tax revenue (from financial, real and house hold sectors of economy) in order to sustain its public accounts. As a consequence, it eases public spending in real sector, in turn that leads to lessen the pressure on sovereign risk and hence the yield spread on government bonds. In this respect, this indirect relationship, ideally, caters to our sample time period which is characterized by a reduction in banks liquidity creation process and simultaneous increase in sovereign risk (i.e. higher volatility in government bond spread as observed in recent debt crisis) due to potential bail-out spending in respective financial system in order to lessen vulnerability in banks before it transmits to other sectors (especially to the real sector).

In a similar vein, our macro-economic control variables also support this outcome significantly. All macro covariates are statistically significant at 1% and follow the expected signs. In particular, GDP growth reflects that as economy is in prosperous state perceived sovereign risk in international credit markets is at lower bounds and as there is an increase in inflationary trend then the interpretation of international investors deteriorates demonstrating a sharp rise in yield spread of related government bonds.<sup>128</sup> Furthermore, the real exchange rate shows expected sign and is also significantly different from zero mainly outlining that as the value of euro increases with respect to the US\$, the sovereign yield of euro area countries goes down and vice versa.

Similarly, second column in table (II.2) expresses relationship outlined in equation (1b) of System (I). The equation attempts to explain the effect of sovereign and non-financial corporate sectors vulnerability on banks liquidity risk condition. In particular, the sovereign risk spillover to banks follows traditional relationship. That is, as spread of sovereign debt securities increases, banks decrease its liquidity creation process. In turn, it shows that the banking sector in euro zone reduces

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the residual sum squares used for estimated R-square are computed from the original model after substituting the estimated values of parameters. Given that the former can be greater than the total sum squares leading to a negative R square.

<sup>128</sup> This finding supports results of Reinhart (2009), and Arellano and Kocherlakota (2014)

its exposure to liquidity risk towards real sector due to deterioration in the value of sovereign debt securities.<sup>129</sup>

Moreover, the estimated coefficient shows that as government bond spread increases by 1 percentage point banking sector liquidity creation decreases by almost 0.15 percent.<sup>130</sup> This result mainly explains that as vulnerability of sovereign sector increases, it reflects in the increased return demanded by international creditors. Consequently, there is a surge in spread of government bonds and thus deterioration in its value. So, banks have to adjust their exposure to liquidity risk by reducing liquidity creation in the financial and real sectors.

Thus, banks that hold these ailing sovereign securities face with reduction in their asset value generating a negative shock to its capital and liquidity base. Furthermore, bank use these securities primarily to manage its liquidity through interbank market operations. Now with the reduction in value of these collateral assets, banks are unable to raise required liquidity. Hence, it directly affects liquidity creation process of banks that results in reduction of its exposure to non-financial corporate loans in the euro zone. In relation to results obtained in specification 1(a), this result provides significant evidence of causal relationship between sovereign-bank nexus which is in contrast to findings reported by Sturzenegger (2004).

Along the similar lines, in table (II.2) column two, our second interest variable i.e. vulnerability of non-financial firms do not show statistically significant results. Nevertheless, it reports an unexpected positive (direct) relationship which is in line with our inference expressed in section (4.3) on the basis of correlation matrix (regarding sovereign crisis period). Specifically, the nexus between sovereign-bank and its causal effect follows traditional link as observed in current chapter and in existing empirical literature. However, as we shift our attention towards the last equation 1(c), some of the conjectures invoked in section (4.3) proved significant.

The last column in table (II.2) shows the results obtained by specification 1(c). It outlines the relationship between banks liquidity creation process and borrowing spread of non-financial firms in the euro area. Interestingly, it shows unorthodox results that are significantly different from zero. In particular, the banking sector attempts to create liquidity by charging higher interest rate spread on short-to-medium term loans towards non-financial corporate sector in the euro zone. Specifically, by generating 1 unit of liquidity syndicated-loan spread of firms increase by almost 1.66.

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<sup>129</sup> This result is in line with the findings of IMF (2008) study

<sup>130</sup> which is statistically significant at 1%

The economic significance of results obtained in the last column of table (II.2) is a novel contribution to the existing empirical literature on credit markets. Indeed, it is a delicate matter to determine ex-ante the variation in behavior of banks in terms of liquidity creation and respective premium charged on loans of borrower firms. In fact, the relationship is ambiguous as far as liquidity creation is concern. Because on the one hand, we cannot predict with surety that bank during the crisis period follows strict credit rationing strategy while simultaneously reducing liquidity creation and charging higher spread on borrowing rates of new loans. On the other hand there might be the case banks do not follow credit rationing but instead generate liquidity while entertaining the demand for loans but at high premium. In this regard, several tentative explanations could be possible.

Firstly, during the crisis period, banks behave hesitantly whether they should honor their financial commitments (for example, in the form of already contracted lines of credit) or generate new loans. Irrespective of whatever strategy banks follow, the opportunity cost of loans during the crisis period is high for real sector. In this context, our results manifest that any increase in the amount of liquidity creation has been accompanied with a sharp increase in interest rates on short-to-medium term syndicated-loans to non-financial firms in the euro zone.

Secondly, it is equally important to not overlook the terms of loan contract and credit standards that are imposed by banks in addition to interest rate charged.<sup>131</sup> This in-turn provides adequate information regarding the future demands for loans. Therefore, in order to streamline this effect, we control for the purpose of loans demanded by non-financial firms in specification 1(c). The results manifest statistically significant effect of loan purpose variable (i.e. for almost all types of loan covariates except for recapitalization and restructuring). In fact, these results provide evidence that during recent crisis period, non-financial firms mainly divert their attention on coping up with difficult economic conditions rather than focusing on the extension and growth of their business concern.

Finally, the hypothesis inferred in section (4.3), is the reason more likely to relate to our result in the third column of table (II.2), that is, during recent crisis period banks liquidity creation process increases as the interest rate on syndicated-loan to non-financial firms also increases. This result substantiates the policy action taken by ECB during sovereign debt crisis in the euro zone. In particular, with huge public debt and increasing sovereign bond spreads some of the member countries feel the distress, so the ECB started injecting the much needed liquidity (for instance:

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<sup>131</sup> That is, the qualitative characteristics of debtor firms and loan contract such as guarantees, commitments and conditions of utilization

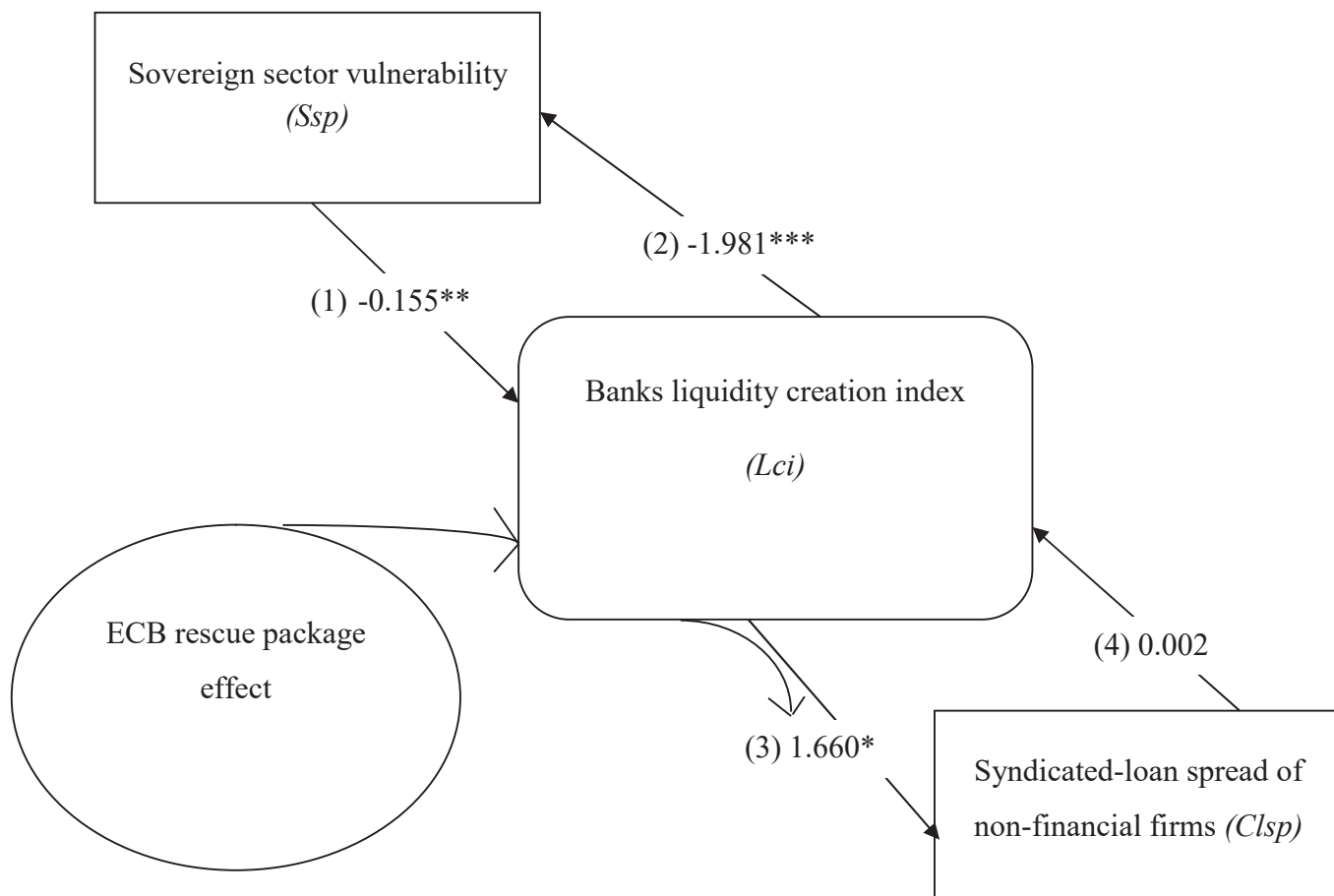
Greece is the first member country that requested aid in 2010). As we assumed in previous section that the rescue packages from ECB enables banking sector in those distressed member countries to generate liquidity in order to restore economic growth in the EMU, is in fact supported by our estimation results. In other words, the stimulus package from ECB is directed towards stabilizing the financial system of euro area, so that it can pursue rigorously its fundamental role of creating liquidity in financial and real sectors even at higher borrowing cost. In short, through the rescue packages banks attempt to revive growth in the said economies. As a consequence, results in table (II.2) last column, validate that liquidity creation by banking sector in the euro zone is accompanied by an increase in syndicated-loan spread for non-financial firms.<sup>132</sup>

In this vein, policy makers expect to generate a ripple effect through banks liquidity creation process so that ailing member economies start to recover slowly and in turn support respective sovereign to reduce its public debt levels through gradual increase in tax revenue. On the other hand, the ECB proposes to implement fiscal austerity measures in order to not only strive to lessen the effect of euro crisis but also to streamline the impact of this increased liquidity injection to keep in check inflation rate within the euro zone which is one of its main objective.

To sum up, we revert back to our primary goal of evaluating risk spillover effects of sovereign crisis on non-financial firms through the introduction of banks liquidity creation process as a potential conduit of transmission in this instantaneous structural system. By treating it as a continuous loop of uncertainty that transmits between the said sectors in economy, we are able to gauge concurrently its potential effect and causal relationship. This is achieved by modeling and specifying it as a simultaneous equations method and obtaining robust results with the 3SLS estimation approach that takes into consideration the full framework as a whole system. In particular, we observe that the recent sovereign risk in euro zone member states transmits to banking sector affecting its liquidity risk and then banks not only advance this vulnerability to non-financial corporates (i.e. the real sector) but also re-channel it back to the sovereign sector. An interesting result to observe in this regard is the role of non-financial firms in euro area economies. Particularly, non-financial firms not only tries to absorb the negative shock from banks by paying higher premium on loan spreads but also do not re-transmit an adverse feedback. Therefore, our results show that the causal effect of risk transfer from non-financial firms to banks in the euro zone in focused time period is not statistically significant.

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<sup>132</sup> This upshot is in line with the findings of Diamond and Rajan (2005), and Santos (2011) but in contrast to the results reported by Ivashina and Scharfstein (2010)



**Figure II.5: 3SLS estimation results evaluating risk spillover between components of our continuous structural system and the role of ECB (\*\*\*,\*\*, \* shows significance at 1%, 5% & 10% respectively)**

Therefore, in light of reported estimation results and discussion, we observe that in fact the banking sector not only passes risk spillover from sovereign to corporates but also re-channels it back to respective sovereign sector at an amplified rate. Consequently, banks act as a transmission channel that transfers sovereign sector uncertainty towards non-financial corporates. This makes the situation difficult for euro area member countries to recover from the recent crisis. However, keeping in mind other results, we are obliged to report that the banking sector in euro zone makes an attempt to generate liquidity towards non-financial firms (even though at higher cost). These results can be easily portrayed by the help of figure (II.5) which is similar to figure (II.2) but with the addition of our 3SLS estimated coefficients and the potential role of ECB against recent crisis in the euro area.

Hence, figure (II.5) manifests the potential route of transmission of risk spillover between the three-intertwined sectors of government, bank and non-financial firm. Furthermore, it graphically provides evidence regarding the causal relationship between sovereign-bank nexus and vulnerability spillover from banks to non-financial corporate sector. In other words, it depicts in visual manner

the liquidity creation process effect of banks towards real sector in the euro zone due to stimulus package support from ECB.<sup>133</sup>

## 5.2 Robustness

In addition to the above discussion and before concluding this chapter, we criticize our results by arguing that they are limited in nature. As the main objective of this study is to evaluate the importance of banking sector liquidity risk as a transmission channel that furnishes potential evidence of sovereign crisis risk spillover to real sector is not going to be substantiated unless we analyze and compare results discussed in previous section between different time periods, that is: comparison of time period with and without the existence of sovereign crisis in the euro zone. To achieve this goal, we divide our sample into of the period preceding the recent sovereign crisis (that is, before 2010)<sup>134</sup> and re-run the 3SLS estimation regression on our simultaneous equations model as mentioned in section (3) system (I). The table (II.3) shows results of the 3SLS regression for the sample data before 2010.

**Table II.3: Three Stages Least Square (3SLS) estimation of our structural system of risk spillover within government, bank and non-financial firm before the commencement of sovereign debt crisis**

	Govt. bond spread	Bank liquidity creation index	Corporate loan spread
Bank liquidity creation index	0.071 (0.067)		-0.483** (0.216)
Govt. bond spread		0.261*** (0.081)	
Corporate loan spread		-0.005** (0.002)	

Note: The dependent variables of the Simultaneous Equations Model (SEM) are: government bond spread (Euro area sovereign 10 year bond yield minus Germany's government bond 10 years yield); Bank liquidity creation index of the euro area banking system defined in table (B.1) Appendix (B) and the syndicated loan spread (bps) of firms located in the euro area with lead banker situated with-in the monetary union. The three columns indicate results obtained for the period before the onset of sovereign debt crisis in the EZ (i.e. before 2010) and estimated through the 3SLS method, respectively. For brevity, we only show the interested variables to compare it with our main results obtained in table (II.2). We use the data sample of 12 countries due to the availability of all the required data fields in our structural system. The list of countries included is outlined in table (B.6), Appendix (B). The definition of all the variables included in the 3SLS estimation can be observed in table (B.1), Appendix (B). Robust standard errors are reported in parentheses whereas, \*\*\*, \*\* and \* represent significance at 1%; 5% and 10%.level, respectively.

<sup>133</sup> For robustness, we replace almost all our covariates used in specifications 1(a) to 1(c) (all variables are reported in table (B.1), Appendix (B)), however our results do not change significantly.

<sup>134</sup> Popov and Horen (2013)



It is quite interesting to note that our bank liquidity creation index is not statistically significant while explaining the relationship with government bond spread whereas, it significantly (at 5% level) affects syndicated-loan spread of non-financial firms. In particular, the result mainly shows the pressure banking sector feels from the US sub-prime crisis in euro area economies. As put forward by Ivashina and Scharfstein (2010), and several other existing studies, that the US sub-prime crisis is in fact a liquidity crisis. Hence, banks in the euro region reacted by reducing their exposure to liquidity risk and decrease the creation of liquidity towards non-financial firms. Specifically, with a 1 percent reduction in liquidity creation, the borrowing cost of non-financial firm goes up by 48 bps. This provides evidence regarding prudent liquidity management by banks. This result manifests that the bank reacts in proactive manner and pursues credit rationing strategy while charging higher interest rates on syndicated-loans to corporate sector.

On the other hand, sovereign sector vulnerability proves to be statistically significant at 1% level in affecting banking sector liquidity creation process (specification 1b) with positive sign (that is, the direct relationship). This result is also quite unorthodox which in fact sheds light on the financial strength of euro area states prior to the commencement of recent sovereign crisis. In particular, it shows that as government bond spread increases by 1 percent then the banking sector liquidity creation increases by almost 0.26 percent providing the indication of rather low vulnerability in public debt sector of euro zone countries. In this context, the result suggests that before the onset of recent euro crisis, the banking sector is not worried about the financial health of its respective sovereign and engrossed itself in monitoring and providing liquidity to the rest of economic agents. In addition, macro-economic conditions in that period were not reached at an alarming stage which in turn does not generate negative signals for the banking sector to react in a prudent manner. Moreover, the statistical significance of syndicated-loan spread in explaining the relationship with banks liquidity creation process is also an anomalous result, indicating the presence of causality from non-financial firms towards banking sector.

In this respect, table (B.4) Appendix (B), shows the comparison of our interested variables for the period without and with sovereign crisis in the euro zone.<sup>135</sup> By observing both time periods, we can confidently validate the presence of banks liquidity risk transmission channel in explaining the sovereign risk spillover to non-financial corporate sector in euro area economies. It can be observed in panel II that since 2010, the increase in sovereign risk premia negatively affects the bank

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<sup>135</sup> These results are already reported in tables (II.2) and (II.3), however we re-furnish these in table (B.4), Appendix(B) for comparison purposes

liquidity creation process. Particularly, the effect is through reduction in the value of sovereign securities in turn directly influencing the overall balance sheet value of banking sector in the euro zone as discussed in extent in previous sections. To sum-up, with due and timely reaction by ECB and international credit institutions, the fragile sovereigns and respective banking and real sectors take a sigh of relief. With rescue packages these institutions make an effort to revive ailing economies (that is, the distressed euro area member states) through the primary function of financial industry i.e. the liquidity creation process.

## **6 Conclusion**

A plethora of existing literature mainly focuses to evaluate separately the relationship between sovereign-bank crisis and the transmission of banking sector vulnerability to real sector. The related literature also finds it difficult to make an accord whether its the sovereign crisis that causes the onset of banking crisis and lacks to properly gauge the causal relationship. Besides, the bank-corporate nexus also follow similar trend. In addition, the contemporary studies try to provide answers to the said conundrum by taking a rather myopic approach i.e. only treating two sectors at a time in empirical specifications. This chapter attempts to bring a meaningful empirical contribution to the existing studies by probing and invoking these questions under a setting of an advanced market (i.e. euro area economies) and simultaneously catering the effect of recent sovereign crisis situation.

The results suggest that the recent euro crisis effect transmits to real sector through banking sector's primary role of liquidity creation in EMU countries. Moreover, this study documents the existence of causality from banks towards sovereign sector during sample time period in the EZ. The sovereign-bank nexus leads to validate that the increased vulnerability in sovereign sector negatively affects bank's ability to create liquidity and thus augments the uncertainty in the financial system. In turn, it hampers banks willingness to take exposure to the increased level of liquidity risk in respective member states. On the other hand, banking sector amplifies the predominant uncertainty in the system and re-transmits it back to respective sovereign while transmitting this adverse effect to the real sector as well. Furthermore, these findings help to clearly outline how the fundamental role of commercial banks as liquidity creation institutions act as transmission conduits affecting the non-financial and sovereign sectors during recent crisis episode in the euro zone.

In this respect, our results report a novel finding regarding the role of non-financial corporate sector during sample time period in the context of EMU economies. In particular, even though with higher

dependence of non-financial firms on banks to satisfy their funding needs, the corporate sector does not re-transmit the sovereign spillover risk it receives through banks and attempts to absorb this adverse shock by paying higher premium on the borrowing cost. This outcome certainly suggests that the financial strength of corporate sector in the euro zone is not in distress. In other words, it shows that firms withstand negative shocks from bank and sovereign sectors during recent turbulent times. Moreover, the role of ECB plays a major part in the ability of banking sector to create liquidity in the euro area. The generation of liquidity by banks to real sector during the crisis period at higher cost is a result of stimulus packages provided by ECB to distressed member countries in order to lessen the sovereign crisis effect and simultaneously attempts to restore the ailing economies.

In addition, this chapter contributes to existing literature by taking into consideration simultaneously the risk spillover effect between sovereign, bank and non-financial firm especially during the euro crisis period. In our knowledge, it is a maiden attempt to cater the transmission effect between the said sectors in euro area as an instantaneous structural system that follows the 3SLS estimation process.

Thus the main findings of our results can be outlined as follows:

- The sovereign debt crisis significantly spillovers to non-financial firms in the euro zone through liquidity creation process of banking sector.
- The banking sector attempts to generate liquidity (for short-to medium term) in order to pass the rescue package relief from the ECB to real sector during recent debt crisis to revive the aggregate demand in euro area member states.
- The non-financial corporate sector resists and absorbs the negative shock of recent euro crisis that transmits through banking sector liquidity constraints by paying higher spreads on syndicated-loan and do not re-transmit a similar adversity back towards the corresponding banking and sovereign sectors.

## **Chapter III**

# **Is there a credit risk contagion present among sovereign-bank-firm nexus in the euro zone? A panel VAR analysis of CDS premia**

*“Regulators, governments, and central banks have not focused enough on the interconnectedness between financial sector risk exposures and sovereign risk exposures and their potential interactions and spillovers to other sectors in the economy or internationally.” Gray (2009, pg. 128)*

### **1 Introduction**

The divergence of sovereign yields among the euro zone member states during the recent crisis episode is not simply subjected to volatility in the underlying fundamentals and global risk aversion factors as proposed in the related literature.<sup>136</sup> In this respect, the policy makers and regulators lack to assess extensively the interconnectedness among financial markets regarding sovereign, bank and corporate sectors in order to rationally understand the consequences of the recent crisis episodes (BIS, 2011a).

Since the commencement of the great recession, the interactions between credit risk of public, financial and real sectors increased which play an important role in the emergence of adverse feedback loop that generated persistent distress in the euro area economy (IMF, 2013). Thus, in late 2009 and then in 2011, there is an abrupt rise in system-wide probability of default especially in the euro area’s public and financial sectors. This increase, in turn induces a general fear among the respective debt markets which could potentially be explained as a prime symptom of contagion. Accordingly, there is a significant fall in investor’s confidence regarding the debt repayment ability of sovereigns in the euro area. When this occurs, it generates abrupt increase in the perceived sovereign risk that adversely affects the financial and corporate sectors among euro zone member

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<sup>136</sup> See: Ang and Longstaff (2013), Aizenman et al. (2013), Longstaff et al. (2011), Von Hagen et al. (2012), Cecchetti et al. (2010) and Pan and Singleton (2008) among others.

states. This leads to indicate the presence of potential contagion risk. Therefore, in order to proactively identify and calibrate the unexpected effect of credit risk contagion, the academics and policy makers turn their attention to gauge the impact of increased interdependence between respective debt market's credit risk in the euro zone.

In this respect, with the increasing importance to assess the credit risk dynamics among the corresponding financial markets, the existing empirical literature on the issue is still scarce and in its infancy. In general, mostly related studies focus on the emerging countries due to the presence of increased liquidity in the sovereign debt markets as a consequence of the late 90's financial crisis.<sup>137</sup> However, since the onset of a sovereign debt crisis in 2010 there is a rapid increase in empirical studies dealing with the potential effect of contagion especially in sovereign and financial debt markets in the euro zone.<sup>138</sup> Despite the increased attention, there exists an empirical debate regarding the risk that triggers the recent euro crisis. Some of the studies' argue that the deterioration in public finances and the subsequent increased budget deficits with feeble macroeconomic conditions cause the increase in loss of confidence in sovereigns' ability to repay the respective debt which in turn generated the crisis.<sup>139</sup> While other authors' argue that the distress in the banking sector due to an adverse spillover effect of the sub-prime crisis resulted in the bail-out packages from respective governments, triggers the uncertainty in corresponding debt markets which transformed into a crisis situation in the euro zone.<sup>140</sup> Moreover, there is a lack of consensus regarding the contagion risk transmission from distressed peripheral countries to the rest of euro zone during the public debt crisis period.<sup>141</sup> On the other hand, some authors' believe that the credit risk contagion is over-exaggerated and there are only increased interdependencies present among corresponding debt markets in the euro area member states during recent turbulent periods.<sup>142</sup>

This chapter aims to extend the existing empirical work and attempts to evaluate the presence of contagion in credit risk dynamics by focusing simultaneously on the sovereign-bank-firm CDS markets during recent crisis periods in the context of euro zone. Moreover, the importance of real sector interconnectedness with sovereign and financial markets is totally overlooked while determining the credit risk contagion effect during turbulent times in euro area member states which has attracted increased importance by the academics and policy makers (Gray 2009, BIS 2011a). In addition, we attempt to furnish a solution to the said empirical debates between the order of credit risk contagion among public, financial and real sectors and across countries especially during the

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<sup>137</sup> See: Pan and Singleton (2008) and Remolona et al. (2007) among others.

<sup>138</sup> See: Giordano et al. (2013), Caporin et al. (2013) and Missio and Watzka (2011) among others.

<sup>139</sup> See: Caporin et al. (2013), Kalbaska and Gatkowski (2012) and Missio and Watzka (2011) among others.

<sup>140</sup> See: Acharya et al. (2014), Alter and Beyer (2014) and Alter and Schüller (2012) among others.

<sup>141</sup> See: Koop and Korobilis (2016)

<sup>142</sup> See: Beirne and Fratzscher (2013), Caceres et al. (2010) and Cochrane (2010) among others.

sovereign debt crisis period in the euro zone. On the other hand, in this chapter, following Battistini et al. (2014), we suggest that the increase in risk premia in sovereign-bank-firm<sup>143</sup> nexus during the euro crisis in the EMU is partially due to a credit risk contagion which is in excess to the macro-fundamental and global risk factors.

However, the existing difference regarding the presence of credit risk contagion in the euro zone may be derived from the fact that there is no universally accepted definition of the term present till date. In this context, we follow the definition provided by Constâncio (2012) that the contagion effect among domestic economic sectors' risk of default occurs when the instability in one sector transmits to the other beyond that what could be intended during a normal relationship between the said sectors.<sup>144</sup> Given these definitions, Canova and Ciccarelli (2013) in their survey paper, indicate that the (panel) vector autoregression model is most suitable to evaluate the contagious effect of transmission of idiosyncratic shocks across units and time. Hence, in line with the existing literature, our empirical framework is based on (panel) vector autoregression model of credit risk measures for the sovereign-bank-firm nexus in the euro zone for a period of five years (i.e. from 2007-QIV to 2012-QIV)<sup>145</sup>.

In this vein, following the related literature,<sup>146</sup> we use the credit default swaps (hereafter, CDS) premium as a measure of credit risk for sovereign, bank and corporate sectors in the euro area. In this regard, the steady increase in empirical studies to use the CDS spread as a credit risk indicator for sovereigns' and banks' is due to its higher sensitivity to the underlying market changes.<sup>147</sup><sup>148</sup> In particular, a CDS contract is primarily an over-the-counter (hereafter, OTC) instrument. It basically allows the protection buyer to hedge against a default by the underlying borrower with a fee to the protection seller. Therefore, due to its inherent nature, the CDS spread is an ideal choice to use as a credit risk measure not only for sovereigns but also for banks and corporates in this study for the euro area member states.

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<sup>143</sup> Non-financial firms

<sup>144</sup> In a similar respect, for a contagion across the countries, Forbes (2012) defines contagion as a cascade between cross-countries that occurs when the financial and or macroeconomic shocks generate a spillover risk which is in excess of the underlying economic fundamentals present in the state of normal interdependence among the member states.

<sup>145</sup> Here, "Q" refers to the time period in quarters.

<sup>146</sup> See: Aizenman et al. (2013), Alter and Schüller (2012) and Blanco et al. (2005) among others.

<sup>147</sup> See: Aizenman et al. (2013) and Palladini and Portes (2011) among others. Moreover, by taking the government bond data of a significantly strong country (for instance: in the case of euro zone, it's Germany) as a benchmark and then subtracting its risk premium from individual member states' default risk, results in the reduction of significant data observations.

<sup>148</sup> Besides, during a recent turbulent period the government bond yield's attraction as a measure for the sovereign risk has been reduced markedly due to the presence of other significant discrepancies such as the liquidity premium effect.

Furthermore, following the contagion definition, in the first step we attempt to purge variations from the credit risk of sovereigns, banks and corporates due to the common and specific factors.<sup>149</sup> As far as the common factors are concern, it basically means common to all the member states (for instance: like, the global risk aversion) whereas; the idiosyncratic factors include the macroeconomic, the bank-specific and the firm-specific variables in a particular country in the euro zone. Thus, we use a CDS spread's residual risk after the net-off which reflects a realistic effect of the credit risk contagion for sovereign-bank-firm sectors in the European Monetary Union (EMU) countries. In the words of Battistini et al. (2014), our sovereign credit risk measure refers to the fear of break-up of euro zone. However, we interpret these credit risk measures as an excessive spillover that are contagion by nature due to the market irrationality or herding behavior of investors as a consequence of general increase in the fear of default among respective debt markets in the euro zone during a recent crisis episode.

Our empirical analysis is based on the orthogonal impulse-response (hereafter, IR) functions derived on the (panel) vector autoregression (PVAR) estimations that are significantly different from zero. These impact multipliers are used to distinguish and detect the contagion among sovereign-bank-firm credit risk and also from an individual member state to the rest of the euro area especially during the public debt crisis period. This chapter contributes to the existing empirical discussion in various ways. First, in addition to the sovereign-bank nexus, we include the real sector effect in the credit risk dynamics to extensively evaluate the presence of contagion in the euro area during a recent crisis period.<sup>150</sup> Second, our credit risk parameters treat different contagion effects while providing evidence of excessive spillover between different debt markets simultaneously with in a particular member state and across countries in the EMU. Finally, our third contribution is inherent in the methodology to use the residuals of CDS spread in PVAR after potential variations of common and idiosyncratic effects have been removed that led to realistically gauge the credit risk contagion impact among sovereign-bank-firm nexus in the euro zone.

To give a foretaste of our results, we find that the credit risk contagion affects systemically among the sovereign-bank-firm nexus during the recent crisis episodes in the euro zone which is time-varying inter sector and time-invariant intra sector by nature. In addition, during crisis periods, a contagion feedback loop among sovereign-bank credit risk is present as compared to the nexus with the real sector which simply outlines its weak integration with sovereign and financial CDS markets in the euro zone. Moreover, our results also report the presence of private-to-public transfer of credit risk with the banking sector ensuing a carry-trade behavior especially during the sovereign

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<sup>149</sup> Remolona et al. (2007) termed these determinants as common and risk premium factors.

<sup>150</sup> As proposed in BIS (2011a) and also Alter and Beyer (2014)

debt crisis period in the euro area. However, these outcomes have been partially substantiated when we analyze individually the G-IPSI (Greece, Ireland, Portugal, Spain and Italy) and core countries (Germany and France) in the euro area. Furthermore, contrary to the general perception established in the recent empirical literature, we did not find a direct credit risk contagion from the Greek sovereign to the rest of euro zone public sector. Instead, our results manifest an excessive credit risk spillover from the Greek sovereign to the rest of euro zone's financial sector which is a logical finding and in line with the actual events that occurred during the public debt crisis period. In a relative manner, these results support the findings of Koop and Korobilis (2016) and Caporin et al. (2013). Finally, in the case of core countries,<sup>151</sup> simulation shocks to the German credit risk spills over contagiously to the euro area while simultaneously there is an evidence of "flight-to-quality" phenomenon during the recent public debt crisis period.

The remainder of this chapter proceeds as follows. In Section 2, we review succinctly the related literature and furnish basis to elucidate our definition of a contagion and formulate the hypotheses. Section 3 outlines the analytical framework describing the (P)VAR model with the dataset used in this study. In Section 4, we present and analyze our impulse-response functions obtained from the (P)VAR estimations that are statistically significantly. Finally, in section 5 we draw some tentative conclusions and policy implications in the light of our results.

## **2 Credit risk contagion in the euro zone: Literature review**

The interactions between the credit risk of financial, real and public sectors play an important role in the emergence of adverse feedback loop between these debt markets in distressed economies especially in the context of euro zone. As reported by BIS (2011a), the sustainability of an economic system depends not only on a stable nexus between a bank and a non-financial firm but also on their link with a respective sovereign sector. In particular, to build and sustain a strong economic system, the interconnectedness of these three sectors hold principal importance. Often the related literature mainly focuses on the importance of an efficient financial system to attain long-term sustainable economic output (Reinhart and Rogoff, 2011b). The proponents of a former notion have a valid reason to believe that because an advanced and well-developed financial system is at the core of a sound economy. Specifically, not only it financially intermediates or fulfills the funding needs for itself and for its domestic sovereign but also for its local corporate (and house hold) sectors. Thus, if a domestic banking sector becomes fragile or receives any adverse exogenous

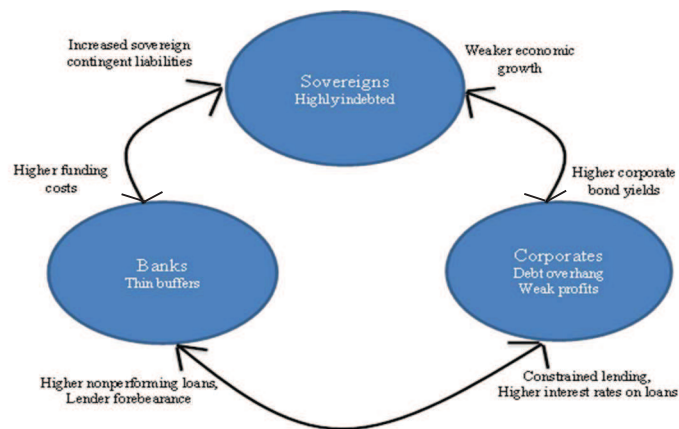
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<sup>151</sup> In the case of France, we find a contagious effect from the rest of euro area sovereigns during the public debt crisis period whereas, the French risk premium only affects the euro zone's financial system in return (The results are available upon request). These results validate the outcome outlined in D'Auria et al. (2014).



shock that perniciously affects its financial situation then not only it propagates this vulnerability towards the real sector but also re-channel it back towards the respective sovereign sector.<sup>152</sup>

Nevertheless, the importance of the sovereign and real sectors' credit risk should not be overlooked while analyzing the effectiveness of a sound economic system. The situation exacerbates if governments were unable to provide the needed solvency cushion to the distressed financial system and in turn becomes a catalyst of credit risk for the banking system as a whole (Castro and Mencia, 2014; BIS, 2013). On the other hand, a fragile real sector makes matter worse due to the increase in the volume of non-performing loans and hence, reduces the economic activity (Abildgren et al., 2013; Holström and Tirole, 1997). Therefore, the probability of default (i.e. credit risk) in these sectors is interconnected and an adverse shock in any one of the sectors advances the vulnerability to another. Moreover, there exists a potential unfavorable causal effect of this uncertainty that travels back to the sector through which it was originated and thus, it gives birth to the incessant cycle of credit risk spillover between the said sectors (Bornhorst and Arranz, 2013). As a consequence, a contagion of default risk emerges between the sovereign-bank-corporate nexus which becomes ominous to the sustenance of a healthy economic system. This vicious cycle can be portrayed with the help of a following figure:



**Figure 1: Sovereign-Bank-Corporate Nexus**  
Source: IMF (2013)

**Figure III.1: Sovereign-Bank-Corporate Nexus (Source: IMF, 2013)**

It can be observed in figure (III.1) that there exists a feedback loop of uncertainty between the said sectors. In particular, in the sovereign-bank link, the vulnerability potentially transfers from a distressed sovereign to its financial system through decrease in the value of public guarantees and government securities that leads to raise the counter party risk and reduce the collateral value which increases the funding cost. Whereas, the causal effect from bank-sovereign nexus is principally due

<sup>152</sup> As mentioned in chapter II of the current thesis.

to bail-out packages and the materialization of contingent liabilities (Noyer, 2010).<sup>153</sup> In addition, the bank-corporate network shows the potential risk transfer from a weak financial system to the non-financial corporate sector by reduction in the volume of available credit and a simultaneous increase in the interest rates of corporate loans. While, the adverse feedback effect from a non-financial corporate to the bank is through an increase in the volume of non-performing loans and consequently, higher firm delinquencies (Abildgren et al., 2013; Cornett et al., 2011; Salas and Saurina, 2002).<sup>154</sup> Finally, the potential transmission of distress among a sovereign-corporate nexus is shown through the increase in corporate bond yields (or an increase in the cost of loans) due to the deterioration in a government's credit rating.<sup>155</sup> Whereas, a reduction in the corporate's profitability due to weaker economic growth and higher unemployment transmits the negative feedback to the respective sovereign mainly through the reduction in tax revenue and in tandem leads to increase the public expenditure (Borensztein et al., 2013).

Since late 2008, the euro zone started to feel the increase in uncertainty (i.e. the probability of default) in its fiscal, financial and real economic sectors due to the great recession period.<sup>156</sup> This influence can be clearly observed with the onset of divergence in the sovereign yield differentials among the euro area member countries (Mody, 2009). With gradual rise in the fiscal and financial distress, the euro area states felt the heat and started to default on servicing their outstanding public debt (especially the peripheral countries for example, Greece in 2010). These events urged the investors' in international capital markets to reassess the risk related to the sovereign's ability to repay its outstanding debt in the context of euro zone. More specifically, the international capital markets started to re-value and reassess the overall solvency of the euro zone's peripheral states which results in the occurrence of recent euro crisis episode.<sup>157</sup> When this occurs, the respective public debt spread and the level of financial distress increased which led the euro area economy progressively into the recessionary state. Thus, it leads to the emergence of an uncertainty spiral between public, financial and real sectors' ability to repay the respective outstanding debt.

A number of recent studies engaged in exploring the issue by only focusing on a two-way relationship between sovereign and banking sectors risk or at the most concentrate on the empirical investigation of euro crisis regarding the contagion trigger among the EMU countries (see: Arghyrou and Kontonikas, 2012; De Santis, 2012; Missio and Watzka, 2011 and Mody and Sandri,

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<sup>153</sup> See: BIS (2011b) for details on the potential transmission channels of vulnerability between sovereign-bank nexus.

<sup>154</sup> See: BIS (2011a) for details on the potential transmission channels of vulnerability between a bank-corporate nexus.

<sup>155</sup> As outlined in chapter I of this thesis

<sup>156</sup> We use the great recession, the Global Financial Crisis (GFC), and the US sub-prime crisis terms interchangeably in this chapter.

<sup>157</sup> In this chapter, we use the sovereign debt crisis, the public debt crisis, the euro crisis, and the European debt crisis terms interchangeably for the recent debt crisis in the euro area.

2011 among others). Although, these studies have made valuable contributions, their findings are limited in nature: firstly they lack to quantify the potential transmission channels;<sup>158</sup> secondly, it is presumed that the risk emanating from the non-financial corporate sector (i.e. in this chapter it represents the real sector) is in fact included in the contagion effect of bank's credit risk on the sovereign sector; thirdly, there is a lack of consensus regarding the order of credit risk contagion between the sovereign-bank and sovereign-sovereign nexus; and finally, the studies have overlooked this vulnerability contagion across the euro area member states especially from the core countries and mainly focused on the peripheral states.

In order to fill this void, the current work suggests that to evaluate the potential spillover effect and the related intensity of credit risk contagion in the economy, especially during the recent euro zone crisis episode, the analysis should take into consideration simultaneously the sovereign-bank-firm nexus. In other words, the inherent interrelatedness of credit risk between these three sectors should be assessed concurrently which varies with the change in respective economic environment (BIS, 2009). Hence, it aids us to better understand the framework of credit risk contagion and its feedback magnitude, especially in the recent crisis period. Furthermore, the implied hypothesis assumed in the related literature that the credit risk contagion from a non-financial firm (due to the increase in its probability of default) to a sovereign is included in the financial risk contagion, basically ignores to treat any direct effect on the sovereign sector from corresponding real sector which may not be through the banking channel (Borensztein et al., 2013). In addition, even this implied hypothesis is not being empirically tested.

Moreover, in this chapter we evaluate the contagion risk from a financially and fiscally distressed peripheral member states to the rest of euro zone countries. In this context, we suggest that in addition to analyze the former effect on the rest of euro area countries, it is equally interesting and important to evaluate the effect from the core countries (especially those states that have high public debt stock and weak growth level: like, Belgium, Finland and France) to the rest of member states in the euro zone. Furthermore, the current work additionally conjectures that the contagion effect from the core countries (that are financially strong with sustainable government debt stock and growth level: like, Germany) to the rest of euro area would be higher due to the fact that if a member country on which the euro system principally rests becomes fragile then the existence of a monetary union would be in peril. In this respect, Koop and Korobilis (2016) report that the division of EMU countries into core and peripheral according to the financial contagion effect is questionable, thus, authors' reject this assumption in the context of recent euro crisis. On the contrary, in the related contagion literature a sovereign-bank nexus is being mainly explored not

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<sup>158</sup> This issue being partially treated in chapters I & II of the current thesis

only in the context of advanced markets but also in the emerging economies (Bolton and Jeanne, 2011). Besides, the current chapter also attempts to isolate the order of credit risk contagion between the sovereign-bank-firm nexus (especially during a recent crisis episode) as the existing studies lack to come up with a consensus regarding the order of such contagion risk (Reinhart and Rogoff, 2011b). So, in this study, we are not only analyzing the credit risk transmission but also attempt to evaluate the presence of any contagion effect among respective CDS markets in the euro zone.

## **2.1 Contagion across sectors?**

With the occurrence of the recent euro crisis, the issue of credit risk spillover comes to the fore front in the related contagion literature.<sup>159</sup> For instance, the recent studies such as Acharya et al. (2014), Thukral (2013), Alter and Schüler (2012), Angeloni and Wolff (2012), Mody and Sandri (2011) and Gerlach et al. (2010) among others, mainly focused on the nexus between the sovereign-bank in evaluating the credit risk spillover effect in the context of euro zone. A common debate can be inferred from these studies regarding the credit risk dynamics between sovereign and banking sectors. For example, Angeloni and Wolff (2012) reports that with the increase in concerns regarding the sovereign solvency, the default risk of bank raises in the euro zone as local banks have invested largely in their respective sovereign debt securities. In a similar vein, BIS (2011b) outlines that the vulnerability of banking sector in the euro area increases due to the reduction in value of public guarantees because of the fiscally distressed sovereigns (i.e. the sovereign risk spillovers to the banking sector).

While, other studies argue that in fact the order of contagion risk of default is from bank to sovereign sector. In particular, due to the spillover effect of the US subprime crisis on the euro area banking sector there is an increase in the financial sector vulnerability which led to the fear of bail-out of these distressed financial institutions. This adversely affects the solvency state of the respective sovereigns which are already struggling with high stock of public debt and stagnant economic growth that in turn raises their debt yield differentials (Acharya et al., 2014; Mody and Sandri, 2011).

In this respect, we observe that as a consequence of the great recession (2007-2009), the fiscal and financial system stability in the euro zone declines and the global risk aversion in international capital markets regarding the sovereign solvency of its member states adversely affected. Keeping this in mind, it can be rationally inferred that during the recent episode of turmoil in the euro zone,

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<sup>159</sup> In this respect, Koop and Korobilis (2016), Arghyrou and Kontonikas (2012) and De Santis (2012) among others focus on the sovereign-sovereign nexus.

credit risk vulnerability transfers from the sovereign to banking sector.<sup>160</sup> In this spirit, Gennaioli et al. (2014) theoretically modeled a change in the sovereign credit risk and show that it adversely affects the related banking sector's balance sheet which leads to the constriction of credit to the real sector, especially during the sovereign debt crisis period. Further, Angeloni and Wolff (2012) empirically outline the same results and find that (since the commencement of the euro crisis in 2010) the increase in sovereign default risk in the euro area member states unfavorably affects the banks' credit risk especially for those financial institutions that bear high exposure to the domestic sovereign bonds in their balance sheets.

On the other hand, Acharya et al. (2014) using the CDS data for the period 2007-11, show that the bail-out risk of a vulnerable financial sector increases the sovereign credit risk. This, in turn leads to deteriorate the creditworthiness of the respective sovereign that reduces the value of public guarantees and the government securities which negatively feedbacks into the distressed financial system. Thukral (2013) also finds similar results while using the CDS data and reports that, irrespective of the crisis period, the principal determinant in the volatility of sovereign credit risk is the vulnerability of banking sector in the euro zone. In other words, according to Thukral, even after the inclusion of fiscal variables, the order of credit risk contagion during the sovereign debt crisis in the euro zone is from the fragile banking system. In a similar manner, Mody and Sandri (2011) remark that the vulnerabilities of a domestic banking sector mirrored in the yield differentials of the local sovereign debt especially for the countries with lower economic growth and high stock of public debt in the context of EMU.

Moreover, Dieckmann and Plank (2012) find similar results and emphasize that the financial sector contagion is higher in countries that are members of the EMU (i.e. the volatility of a domestic financial system affects more to their sovereign sector) due to the lack of control of the money supply (i.e. the euro currency) at an individual state level. In other words, the sovereign issuing the public debt in a currency that it cannot control comes at a cost (Kopf, 2011). Whereas, Gerlach et al. (2010) outline that the increase in volatility of the sovereign risk and its related CDS spread is due to the contagion shock from the banking sector especially in the peripheral euro zone member states. Furthermore, the study reports that the systemic financial risk and the sovereign risk becomes so intertwined with each other after the government intervention (that is, mainly through the issuance of the implicit and explicit guarantees by the sovereign for the contingent liabilities of its fragile banking sector) that it becomes really difficult to understand the credit risk dynamics and its related spillover order between the said sectors.

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<sup>160</sup> See chapter II of the current thesis for related outcome

In this respect, Alter and Schüller (2012) mainly focus on the risk of default contagion between the sovereign-bank nexus in the selected euro zone countries. The study includes the peripheral EMU countries without Greece (i.e. Ireland, Portugal, Spain and Italy-IPSI) and Germany, France, Netherlands as the core states. The authors find that the credit risk spillover disperses from the financial to the sovereign sector in the period preceding the bank bail-outs and during/after these bail-out packages provided by the domestic government. In particular, Alter and Schüller report that the default risk spillover transfers from the banking sector to its sovereign credit risk with higher magnitude in the period during/after the banks bail-out, but this effect fizzles-out quickly. Whereas, during the period preceding these bail-out episodes even though the order of credit risk contagion is the same, its magnitude is lower and there exists a long term correlation especially in the peripheral euro zone countries. These results are limited by nature because the study lacks to control for the macro-economic instabilities which is imperative according to the existing empirical literature while using the CDS data (See: Heinz and Sun, 2014; Beirne and Fratzscher, 2013 and Arghyrou and Kontonikas, 2012, among others).

Furthermore, Alter and Schüller (2012) mainly focus on the credit risk spillover from the financial to the government sector, that is, on the private-to-public risk transmission mechanism and lack to take into account the contagion effect from the corporate sector's risk of default, not only within the country but also across-countries in the context of euro zone. Another shortcoming of the said study is that it additionally outlines results as a cross-country analysis but ignores to measure the risk spillover not only from the individual country to the rest of euro zone but also on the bilateral basis. For example: the authors conducted analysis only by taking the euro zone as a whole.

Besides, Erce (2015) while evaluating a default risk feedback loop between the sovereign-bank nexus in the euro zone finds that the order of contagion risk, in general, is from the sovereign to the banking sector especially in the peripheral member states during the recent turmoil period. The study outlines that in fact the fragility in the public debt markets in the euro area propagates with higher magnitude towards the banking sector, nonetheless the causal effect from the later is also present but with a minimal reaction/intensity.<sup>161</sup>

Hence, in light of the related literature, it is not unfair to conjecture that the existing empirical findings in the previous studies are limited in scope. Specifically, on the one hand, there is a lack of consensus on the order of contagion risk between the sovereign-bank nexus.<sup>162</sup> On the other hand,

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<sup>161</sup> Similar results reported by Gennaioli et al. (2014) and Angeloni and Wolff (2012)

<sup>162</sup> In the respect of emerging market, this debate also exists in the context of credit risk spillover. Some studies follow the notion that the sovereign vulnerability triggers the banking crisis (see: Sturzenegger, 2004 and Borensztein and

the most of these studies assume that the contagion effect regarding the risk of default is interconnected only within the sovereign-bank nexus. Thus, in turn the existing literature neglects the effect of real sector credit risk which is at the forefront for the policy makers and the academics especially during the recent turmoil period in the euro zone (Gray, 2009 and BIS, 2011a). Moreover, this strand of the contagion literature regarding the euro area is still scarce.

Notwithstanding, we find a recent work by Ejsing and Lemke (2011) that indirectly treats the sovereign-bank nexus sensitivity to the non-financial firm's credit risk. In particular, the study evaluates banks rescue package effect on the sovereign and the bank CDS premia using a time period from January 2008 till June 2009 by focusing on the common factor which the authors termed as a "crisis factor". This factor gauges the risk sensitivity of a sovereign and a bank after the bail-out during the crisis period by using the iTraxx index of non-financial CDS premia. Using the weekly CDS data, the authors evaluate how a change in the bank and the sovereign CDS spread moves with the "common crisis factor" and in turn they used it as a risk transfer channel from the private-to-public sector. Ejsing and Lemke apply the Ordinary Least Square (OLS) estimation method to analyze the risk transmission effect in relation to the crisis sensitivity (which is in fact the non-financial firm credit risk) by simulating a change in the sovereign CDS spread (and the bank CDS spread) on an individual basis with the crisis factor. However, the outcome should intrinsically be accepted with caution as we know that the OLS estimation provides biased results because of the inherent endogeneity problem between the dependent and the independent variables that simultaneously affect these parameters (Baltagi, 1998).

In this respect, the current chapter aims to address two specific questions in the context of euro zone: First, to evaluate the dynamics of credit risk contagion between the sovereign, the bank and the non-financial firm and to analyze whether there is any direct or in-direct causal/feedback effect is present in the euro area member states especially during the recent sovereign debt crisis period. Second, this chapter evaluates whether the credit risk innovations from the core member states transmit higher contagion effect to the rest of euro zone than the peripheral ones, if an adverse shock is introduced to the credit risk of the respective sovereign sector.

Albeit, we know that there is no commonly accepted definition of contagion risk at present (ECB, 2009) therefore in this study, we follow the conditions outline by Constâncio (2012). According to Constâncio, the contagion effect among the domestic economic sectors occurs when the instability

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Panizza, 2009), while others find results that in fact the credit risk spillover is from the fragile banking system to its sovereign sector (Noyer, 2010; Arellano and Kocherlakota, 2014).

in one sector transmits to the other beyond that what could be intended during a normal relationship between the said sectors.

So, keeping the related strand of literature in mind, the current chapter attempts to fill this gap by analyzing the default risk contagion in the sovereign-bank-firm nexus which assists to better understand, in particular, the underlying credit risk dynamics to execute effective policy and regulatory measures especially in the crisis period. That is, the excessive spillover depends upon the nature of underlying vulnerability prevalent in the fragile economic sector and the degree of its interconnectedness with other sectors in a specified time period. Hence, we hypothesize that in the context of euro zone, the order of credit risk contagion from bank to sovereign and real sectors should ideally exist during the great recession period. Whereas, the excessive spillover order reverses with the onset of the recent sovereign debt crisis period, that is, the public sector vulnerability transmits towards the banking and real sectors. In other words, the buildup of uncertainty and vulnerability in the sovereign sector that triggers the episode of recent crisis in euro zone member states is partially due to the effect of a fragile financial sector during the period preceding the euro crisis. Moreover, a fractional effect is due to the already weak balance sheet of the fiscal sector with high stock of public debt and a feeble growth level.<sup>163</sup> On the other hand, the rest is due to the investors' herding behavior that can be explained as an increase in the loss of confidence regarding the sovereign's<sup>164</sup> ability to repay the outstanding debt in respective markets during the crisis period. Therefore, we suggest that the abrupt increase in the sovereign CDS premia is a consequence of the fear of default which is contagion by nature that becomes systemic within and across the euro zone countries during the recent crisis episode. Thus, the order of credit risk contagion should ideally be time variant by nature among the sovereign-bank-firm nexus.

Hence, the current study presumes that in fact the order of credit risk spillover between the sovereign-bank nexus depends upon the nature of underlying crisis (which is time-varying) in the euro region. In addition, with the introduction of the non-financial firm's credit risk in this nexus, we attempt to empirically evaluate the implied prevalent assumption in the related literature which considers that the existence of default risk transmission from the real sector to the corresponding sovereign is inherent in the financial risk contagion. However, in evaluating this implied hypothesis, we also examine any direct spillover effect from non-financial firms' credit risk towards the sovereign sector through respective CDS markets in the euro zone. Thus, it is engaging to empirically evaluate this implied condition while treating simultaneously the sovereign-bank-firm credit risk nexus. Moreover, it is equally interesting to evaluate whether the order of credit risk

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<sup>163</sup> As outlined in chapter I of this thesis.

<sup>164</sup> Similarly, in the case of financial and real sectors.



contagion between the sovereign-bank nexus remains time variant with the inclusion of real sector's default risk in the context of euro zone.

## **2.2 Contagion across countries?**

*“In the euro area in particular, the single monetary policy, the common external exchange rate and the related absence of bilateral nominal exchange rates can increase spillover effects across euro area countries” (D’Auria et al., (2014) pg.11)*

Another strand of the contagion literature in the context of recent euro crisis episode mainly focuses on the cross-country spillover between the sovereign debt markets (see: Koop and Korobilis, 2016; Arghyrou and Krontonikas, 2012 and De Santis, 2012 among others). This string of literature attracted great interest from the researchers and the central bankers (BIS 2011b). Because, it not only assists to comprehend the inherent credit risk dynamics between the public sectors across countries but also improves the understanding regarding its economic consequence on the related financial and non-financial sectors, especially in the context of EMU. The excessive spillover effect would potentially be greater in the euro zone not only due to the high financial and economic integration but also due to the non-existence of cross-border currency exchange rate.

Alongside the increased magnitude of sovereign spillover in the EMU, Forbes (2012) defines contagion as a cascade between cross-countries that occurs when the financial or macroeconomic shocks generate a spillover risk which is in excess of the underlying economic fundamentals prevalent in the state of normal interdependence among the member states. In this study, in addition to empirically treat the non-financial sector's credit risk contagion effect with-in the sovereign-bank nexus, we contribute to the former strand of literature by not only treating the effect of credit risk contagion from peripheral countries but additionally measures the excessive spillover effect from core countries as well to the rest of euro zone member states. Specifically, we gauge this effect in corresponding debt markets by inducing a shock to the pertinent sovereign credit risk especially during the recent public debt crisis episode after controlling the underlying economic fundamentals.

On the other hand, the current chapter also contributes to the related strand of literature on evaluating the determinants of pricing the sovereign debt in the euro zone. We suggest that, in fact, the abrupt increase in the sovereign debt differentials during the euro crisis period was fundamentally due to the emergence of contagion risk of default among the respective debt markets. Whereas, the local economic fundamentals or the global risk premium effect is secondary to the contagion risk as a determinant of volatility in the CDS spread of the sovereign debt market during

the euro crisis period in the EMU (see: Hilscher and Nosbusch, 2010; Longstaff et al., 2011 and Ang and Longstaff, 2013 among others).

After briefly probing the sovereign-bank-firm nexus instabilities in the previous section, let us succinctly review the existing spillover literature across the euro area member states of the respective government and financial debt markets. There are a handful of papers that focus on the interactions of a cross-country contagion risk in the context of euro area (see: Missio and Watzka, 2011; Kalbaska and Gatkowski, 2012; Aizenman et al., 2013; Beirne and Fratzcher, 2013 and Caporin et al., 2013 among others).

However, the extant literature regarding the credit risk spillover between the inter-country in the euro zone mainly focused on the public-to-public risk transmission (see: Aizenman et al., 2013 and De Santis, 2012 among others). For instance, the increase in the sovereign risk premium, in general, is after the announcement by the Greek government that in reality its budget deficit is around 13% of GDP (December 2009)<sup>165</sup> which leads to show the presence of potential default risk contagion to the rest of euro zone in related capital markets. As a consequence, the importance of systemic default risk phenomenon comes to the forefront in the context of EMU (Cappiello et al., 2015). In this respect, Aizenman et al. (2013), while analyzing the peripheral countries, report that the systemic sovereign risk which is beyond the explanation of underlying economic fundamentals is contagion by nature. The study describes it as the risk generated by the markets due to the potential volatility in those fundamentals which is quite challenging to account for in the context of euro zone during the crisis period. Moreover, Aizenman et al. outline that the sovereign debt crisis erupting in a euro area due to the Greek fiscal and financial instabilities, affect other member states which leads the investors to segregate between the fiscally vulnerable versus fiscally disciplined countries. The results are limited in scope as far as the excess spillover effect is concerned because Aizenman et al. focus on analyzing the determinants of sovereign yield spread while outlining the unexplained risk (in addition to the country specific macroeconomic fundamentals) as a contagion or a panic risk.

Furthermore, Missio and Watzka (2011) using the Dynamic Conditional Correlation model (DCC) evaluate the time varying correlations of credit risk among the euro zone member countries. The study focuses on analyzing the effects engendered by the sovereign rating announcements and reports the existence of contagion risk of default mainly from Greece to Spain, Portugal, Italy and Belgium within the euro area during the recent sovereign debt crisis period.

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<sup>165</sup> Baimbridge and Whyman (2015), pg. xiv

In a similar respect, Kalbaska and Gatkowski (2012) analyze the sovereign CDS premia to explore the presence of potential contagion across the euro area member states. In particular using the Exponentially Weighted Moving Average correlation analysis (EWMA), the study examines the spillover effect by evaluating the CDS spreads of GIPSI, France, Germany and the UK for the period 2005-2010. The study finds increased correlation and interdependence during the crisis period and report that the sovereign credit risk of Ireland and Spain is the primary source of contagion to the rest of euro zone. However, after utilizing the adjusted correlation analysis the study outlines that the GIPSI countries have lower probability to infect the rest of euro area. In a recent study, Lucas et al. (2014) find significant default risk contagion between the euro zone countries during the period 2008-2013. In particular, the authors analyze the joint and conditional default probabilities of the euro area member states using the CDS premia and show a higher likelihood of sovereign default among the countries that are subject to the increased financial uncertainty as a consequence of a change in the risk dependence which is time-varying by nature.

Moreover, using a Bayesian quantile regression approach, Caporin et al. (2013) examine the sovereign risk contagion across the euro zone. The study outlines that even though the peripheral countries are adversely affected during the crisis period, their respective shock spillover in the European CDS market is unusually stable. In particular, the authors' premise that the interdependencies between the euro area member states were stable and that the credit risk spillover among them was not affected by the magnitude of the shock, leading them to concur that the contagion risk remained subdued during recent crisis period in the euro zone.

Nevertheless, the evidence in favor of credit risk contagion among financial and sovereign debt markets during the recent crisis period across euro zone members is mixed. Specifically, Cochrane (2010) suggests that the phenomenon of default risk contagion across the euro area countries is self-imposed. The author argues that if everyone knew that there would not be any bail-out then the contagion risk would not have raised.<sup>166</sup> In particular, the general increase in the default risk of sovereign debt in the euro zone is due to the expectations of investors regarding the fact whether the rest of GIPSI countries could be bailed out after the default of Greece. Similarly, Beirne and Fratzscher (2013) report that the general increase in CDS premia in sovereign debt markets in the euro zone is not due to the credit risk spillover from different CDS markets, especially during the recent crisis period. In particular, the study finds that country-specific fundamentals and rising

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<sup>166</sup> Article (125) of the Lisbon Treaty (also as Treaty on the Functioning of the European Union- TFEU); (see: <http://www.lisbon-treaty.org/wcm/the-lisbon-treaty/treaty-on-the-functioning-of-the-european-union-and-comments/part-3-union-policies-and-internal-actions/title-viii-economic-and-monetary-policy/chapter-1-economic-policy/393-article-125.html>)

financial market sensitivity to those fundamentals are major factors driving the sovereign CDS premia during the distressed time period in the euro area. Thus, Beirne and Fratzscher find that the reaction (or overreaction) of financial markets due to economic fundamentals are main determinants of credit risk transmission, especially during the period of *borrasca* rather than the period of *bonanza*.

In a similar vein, Alter and Beyer (2014) using the standard vector autoregressive (VAR) technique formulate a contagion index regarding the spillover between: sovereign, bank, from sovereign to bank and vice versa for the euro zone member states. However, the study only finds the evidence of increased interdependence among sovereigns and banks in the euro area during the period 2009-2012. Furthermore, Caceres et al. (2010) analyze the presence of credit risk contagion among the euro area sovereigns over the period 2005-2010. The study finds global risk aversion as a key factor behind the rise in sovereign debt yields in the earlier part (sub-prime) of the crisis whereas, for the later part (public debt) it reports that the country-specific fundamentals are a driving force for the increase in sovereign debt spread in the euro zone.

### **2.3 Hypotheses**

In the light of above discussion, we can summarize the credit risk contagion dynamics notion presented in the associated literature into two general axes that is: public-to-public risk transfer; private-to-public risk transfer and the two specific transmission channels, that is: a fundamental channel and an investor-behavior channel in the context of euro zone. However, the evidence regarding the existence of credit risk contagion is not concrete. Furthermore, there is a lack of consensus on the order of credit risk contagion (and its relative feedback) between the sovereign-bank nexus during recent public debt crisis in the euro area. Moreover, the credit risk interdependence of the non-financial firms in the sovereign-bank nexus is being totally ignored (Gray, 2009; BIS, 2011a). In particular, it is normally implied in the extant empirical literature that the probability of default from the corporate sector is included in the financial credit risk contagion towards the respective sovereign. However, this inherent assumption is not econometrically tested in this context.

In addition, some studies find that the peripheral countries which are in distress such as the GIPSI states tend to trigger very little or no contagion towards the rest of euro zone, whereas, others find that not all but some of the GIPSI countries are a source of increased sovereign yield differentials among the euro zone member states during the recent crisis episode. Nevertheless, these studies even lack to come to accord regarding which of the GIPSI countries are responsible for the credit risk contagion towards the rest of euro area in the recent distressed period. For instance, according

to Caceres et al. (2010), the gravity center of default risk spillover towards the euro zone is from Greece, Portugal and Spain, whereas; Missio and Watzka (2011) find that the principal contagion source is only from Greece. On the other hand, Kalbaska and Gatkowski (2012) report that not Greece but Ireland and Spain are the primary sources of sovereign credit risk contagion to the rest of euro zone. While, certain studies even did not find GIPSI countries as a source of credit risk spillover in the euro zone and report that they have lower capacity to trigger the contagion than the core member states (Koop and Korobilis, 2016).

Hence, in order to fill this gap: firstly, the current work leans towards the previous empirical literature and attempts to evaluate the dynamics of credit risk contagion between the sovereign-bank nexus and its potential feedback in the euro zone during different crisis periods (i.e. the sub-prime and the sovereign debt crisis episodes). Secondly, by dealing with the issue of credit risk interdependence and contagion among sovereign, bank and non-financial firm network which becomes a core policy discussion since the onset of recent financial crisis, we incorporate real sector's CDS spread into the sovereign-bank nexus by treating it as a continuous loop of credit risk transfer. On the one hand, the identification and the source of vulnerability in this vicious circle not only helps to broaden the existing knowledge on the application of monetary and fiscal policies but, on the other hand, it aids the policy makers to outline proactive crisis management strategies to contain its adverse effect on the economic activity.

Finally, while evaluating the public-to-public and the private-to-public contagion risk from the GIPSI and core countries (for example: Germany) to the rest of euro area, this study indicates that it is more engaging to evaluate the latter effect. Moreover, the current chapter, in line with the empirical literature related to the common determinants in the evolution of credit risk, controls for the global risk aversion, and the country-specific fundamentals along with the sector-specific factors in order to gauge and filter out the CDS premia that reflects a realistic contagion effect. Therefore, in accordance with the theory of financial contagion,<sup>167</sup> we define the credit risk contagion as the uncertainty prevalent in excess of the interdependence besides the common fundamental factors across sectors and countries in the context of euro zone. Keeping this in mind, in order to conduct any empirical study, we have to permeate the effects of common and idiosyncratic factors to obtain a residual risk that can be used as a proxy for the credit risk contagion in the respective debt markets that is: sovereign, bank, and non-financial corporate sectors for each euro zone member state. As a consequence, we are also able to contribute to the existing literature regarding the sovereign debt determinants by evaluating whether the abrupt change in sovereign

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<sup>167</sup> See: Obstfeld (1996), Masson (1999), Kaminsky and Reinhart (1999), Dornbusch et al. (2000), Forbes and Rigobon (2002), and more recently Forbes (2012) and Constâncio (2012) among others

CDS premia in the euro area was principally due to the emergence of contagion credit risk among the corresponding debt markets or not, especially during the recent distressed period.

This leads us to outline the analytical framework used in this chapter to measure the above mentioned hypotheses.

### **3 The analytical framework**

As outlined in the previous section, by focusing on the sovereign-bank-corporate nexus especially in the context of euro zone, we attempt to answer the hypotheses mentioned in section 2.3 to evaluate the order of credit risk contagion between the nexus of said sectors and its potential direct or in-direct feedback effect in the recent euro crisis period. Furthermore, we advance this analysis to cater the excessive spillover effect from the individual country's credit risk premium to the aggregate credit risk premia of the rest of euro zone member states and its related causal effect especially for the peripheral (i.e. Greece, Ireland, Portugal, Spain, and Italy: GIPSI) and core countries (i.e. mainly, Germany and France) during the recent crisis period in respective debt markets. Keeping this in mind, our results also provide evidence regarding the fact that whether the sudden increase in sovereign yield spreads in the EMU during the euro crisis period is due to the contagion risk of public debt default or not.

#### **3.1 Methodology**

The recent empirical literature regarding analyzing the excessive spillover effect uses the vector autoregressive (VAR) framework. Following the works of Alter and Beyer (2014) and Koop and Korobilis (2016) on the dynamics of credit risk contagion during the recent euro zone crisis, we use the Panel VAR (PVAR) model to evaluate the order and presence of contagion between the sovereign-bank-corporate default risk variables in the system by incorporating their own lagged effects. As outlined by Canova and Ciccarelli (2009) the PVAR is the most suitable econometric method in order to evaluate the contagion effect of transmission of shocks across the different countries and or the economic sectors because it provides valuable and concrete tool to analyze the dynamics of financial and economic processes. Moreover, the panel VAR, on the one hand, not only increases the efficiency and the power of analysis due to its panel-modeling framework but, on the other hand, efficiently caters the issue of unobserved dynamic heterogeneity (i.e. cross-sectional) by addressing for the fixed effects in the model (Hayashi, 2000). The PVAR model is in line to fulfill the current chapter's objectives of evaluating the importance of contagion in the increase in credit risk volatility among the respective debt markets during the crisis periods in the euro area. Furthermore, it also aids to provide answers regarding the order of credit risk contagion

and its passage across the sovereign, bank, and non-financial corporate sectors in the euro area member states. In this vein, Canova and Ciccarelli (2013) indicate that the panel vector autoregression is ideal to investigate the transmission of idiosyncratic shocks across units and time. It not only caters the static and dynamic interdependencies but also incorporates the time variations in the coefficients and in the variance of innovations.

Let us provide background to introduce the model used in this study to analyze the evidence of credit risk contagion and its order among the sovereign-bank-firm nexus in the euro zone member states especially during the recent crisis period. The model is basically restricted panel vector autoregression (PVAR) in line with the contemporary empirical literature on the default risk spillover (Alter and Beyer, 2014). The main endogenous variables considered in the PVAR are the credit risk of sovereigns, banks and non-financial firms, all in natural logarithmic form as advised by Forte and Pena (2009). In addition, all variations in these variables due to any economy-wide (macroeconomic), bank-specific or non-financial firm specific effects with (common) deterministic time trend was removed prior to the analysis.<sup>168</sup>

In the light of previous section (i.e. section 2), we purge these effects in order to determine the realistic credit risk contagion proxies for the sovereign, bank and non-financial firm sectors that are in excess of the underlying economic fundamentals (and specific risk) present in the state of normal interdependence between the said sectors. In the words of Giordano et al. (2013), our credit risk spillover proxies represent “contagion effect which is not only in excess to changes in fundamental economic factors but also global risk aversion”. Therefore, as mentioned in section 2.2, these are the results of either change in loss of confidence (Calvo, 1988), or the irrational herding behavior (Chari and Kehoe, 2003), or due to other wealth effects for investors’ which are caused by capital losses in respective debt markets in the country that originated the crisis (Kodres and Pritsker, 2002, and Calvo and Mendoza, 2000). So, the current work uses the residuals from the individual OLS regressions of each of the three system variables (i.e. the sovereign-bank-firm credit risk) against the macro-economic, the bank-specific, and the firm-specific control factors with country specific fixed effects.

For instance, the sovereign credit risk after controlling for the macro-economic and global risk aversion factors, as suggested in the related literature,<sup>169</sup> is left with the residual risk that reflects a legitimate variation in the relative sovereign default risk. As put forward by Battistini et al., (2014), this residual in turn may also refer to the fear of break-up of euro zone which is systemic by nature.

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<sup>168</sup> With global risk aversion measured through VIX

<sup>169</sup> See: Longstaff et al. (2011), De Santis (2012), D’Agostino & Ehrmann (2014), and Heinz & Sun (2014) among others.

Along similar pattern, the bank credit risk residual after the control factors<sup>170</sup> presents the variation due to general level of uncertainty prevalent in the corresponding financial system as a consequence to the fear of default in the banking sector. Whereas, the non-financial firm's credit risk residual after controlling for the firm-specific factors is left with the probability of default that is contagion by nature in the underlying real sector.<sup>171</sup>

To empirically measure the credit risk contagion effect simultaneously among the sovereign-bank-firm nexus is quite a taxing task. In this regard, we follow Alter and Schüler (2012) and use the credit default swap (CDS) premia as a default risk indicator.<sup>172</sup> As outlined by Aizenman et al. (2013), the CDS spread is quick to respond to market changes and provides timelier market-based pricing than the bond yields (i.e. the interest rate spread of sovereign debt) as they are subject to time to maturity and embed inflation expectations with demand/supply effect for lending conditions as well as a default risk. Since, the key purpose of designing a CDS contract is to protect the holders from the event of default by the underlying debt borrower, therefore, it mainly caters to the credit risk. So, in this chapter to measure the respective default risk, we utilize the CDS spread.

Thus, the CDS premia after controlling for the above mentioned effects show the excessive spillover/contagion risk due to variation in the probability of default in the corresponding debt markets in the euro area. In this respect, the sovereign CDS premia reflects the loss of confidence in the government's ability to honor its outstanding public debt obligations and ultimately leads to increase the systemic risk of break-up of euro zone (Battistini et al., 2014). While the bank CDS premia indicates the systemic risk of financial system melt down<sup>173</sup> and the non-financial firm's CDS premia shows the increased default probability prevalent in the real sector which leads to portray the differential effect of stagnant economic growth (Heinz and Sun, 2014).

### 3.1.1 VAR framework in panel data

Panel VAR approach enjoys the synthesis of a traditional VAR technique that treats all the variables in a system as endogenous, with the panel data. This technique recently becomes popular among the financial economists who work with the data of many countries.<sup>174</sup> In this context, it is useful to apply P(VAR) technique because we want to jointly model the contagion effect of credit risk dynamics among sovereign-bank-firms for the euro zone during recent crisis episodes. Moreover,

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<sup>170</sup> See: Cornett et al. (2011) and Tucker (2014) among others.

<sup>171</sup> Refer to table (C.4) in Appendix (C), for a list of all the variables used in this chapter.

<sup>172</sup> Berndt and Obreja (2010), Zhang et al. (2011), Ang and Longstaff (2011), Kalbaska and Gatkowski (2012), and Caporin et al. (2013), among others also used the CDS premia as a default risk indicator.

<sup>173</sup> IMF (2009)

<sup>174</sup> See: Alter and Beyer (2014), Neri and Ropele (2015), Arghyrou and Kontonikas (2012) and De Santis (2012) among others



for the individual country a VAR technique is used that also takes into consideration the linkages of default risk in the respective debt markets between the member states in the euro zone. As outlined by Canova and Ciccarelli (2009), the P(VAR) is an ideal technique to treat the shock transmission across the countries, for instance by using it to model the financial contagion which becomes a vital issue in the recent crisis episode especially in the euro area.

Following similar notations in the existing literature, the panel VAR model can be outlined as follows:

$$Z_{it} = \alpha_i + \Theta(L)Z_{it} + \varepsilon_{it} \quad (1)$$

Where  $\Theta(L)$  is the lag operator and  $Z_{it}$  represents our focused three endogenous variables of the sovereign-bank-firm credit risk (i.e.  $Z_{it} = [\text{SV.rsk}_{it}, \text{BK.rsk}_{it}, \text{FM.rsk}_{it}]$ ). Subscripts  $i$  and  $t$  refer to country and time.  $\varepsilon_{it}$  is a vector of residuals. In addition, to determine the appropriate lag-length, we use the consistent moment and model selection criteria (MMSC) proposed by Andrews and Lu (2001), the results are shown in table (C.1) in Appendix (C). It can be observed in table (C.1) that the Akaike Information Criteria (AIC), the Bayesian Information Criteria (BIC), and the Hannan-Quinn Information Criteria (HQIC) show minimum value for one-lag length. Therefore, the optimal lag-length in our system of endogenous variables in the P(VAR) model is one. The P(VAR) of first order is in fact in line with the CDS literature that outlines its economic significance as a data variable which tends to be sensitive in the short-run due to its high responsiveness to changes in the financial and economic conditions prevalent among the respective debt markets (Koop and Korobilis, 2016). So, a first-order PVAR (1) can be specified as:

$$Z_{i,t} = \alpha_0 + \alpha_1 Z_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

In equation (2),  $Z_{i,t}$  is an  $m \times 1$  vector of the three endogenous variables, whereas  $\alpha_1$  is an  $m \times m$  matrix of the slope coefficients, and  $\varepsilon_{i,t}$  is an  $m \times 1$  vector of the error terms which is assumed to be independent and identically distributed (i.i.d).

Furthermore, as mentioned above the main variables used in the current chapter are OLS residuals of the CDS premia from the respective sectors (i.e. sovereign, bank and firm) after accounting for the common and specific control factors that affect the CDS premia of our said sectors including the measure of global investors' risk aversion. Following the definition of contagion by Constâncio (2012), we consider this two-step approach because it filters out and provides the CDS premia which represents the contagion risk that is a net variation in the default risk of sovereign-bank-firm

nexus (Giordano et al., 2013). Thus, the later assists us to pedagogically evaluate and identify the credit risk contagion and its order which is in excess of the underlying economic fundamentals prevalent in the state of normal interdependence with-in and across the member countries in the euro zone during the recent crisis period. In addition, we treat the intertemporal interactions between the focused variables and estimate the impulse responses by calculating the contagion response of one variable from an unexpected shock to another. Moreover, this procedure helps us to maintain the true spirit of a VAR model that presumes all the variables as endogenous in the system of structural equations.<sup>175</sup>

Hence, the PVAR (1) model given by equation (2) estimates the credit risk contagion as a systemic shock between the sovereign-bank-firm nexus during the different crises with-in and across the economies in the euro area. For different crises (that is, the global financial crisis and the euro crisis), and the cross-country analysis,<sup>176</sup> we use the dummy variable as a corresponding case indicator. If the respective coefficient  $\alpha_1$  in equation (2) is positive and statistically different from zero then there is an evidence of contagion: (i) between sectors in a country, (ii) among sectors across countries, in the euro zone during the recent crisis periods. On the other hand, if the coefficient is negative then the co-movement between sector's credit risk reduces and we assume no credit risk contagion even if the results are statistically significant.

However, when using the panel VAR approach, the restrictions should be applied so that the underlying structure is similar for each cross-sectional unit. Since, in practice this restriction seems to get violated, so in the first-step we treat for the individual heterogeneity in the levels of our focused variables by controlling for the fixed effects. Besides, the simple-mean differencing would provide biased estimators due to the presence of lags of the dependent variables because the fixed effects are generally correlated with the regressors (i.e. independent variables). This biasness can be subjugated by the forward-mean differencing which in general known as a Helmert transformation process (Arellano and Bover, 1995). The Helmert procedure in turn filter's out the forward mean which then conserves the diagonality between the transformed and the lagged independent variables. In the current work, we follow Love and Zicchino (2006) algorithm<sup>177</sup> not only for the panel VAR estimation but also to calculate the orthogonality between these variables (i.e. the transformed and the lagged regressors). Thus, we estimate the system parameters by using the panel generalized methods of moments (GMM) estimator. The System-GMM approach introduced by Blundell and Bond (2000) enables to not only cater the simultaneity problem but also accounts for

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<sup>175</sup> See: Brooks, 2014 pg 326

<sup>176</sup> In the respect of Forbes (2012)

<sup>177</sup> Specifically, we use an updated version of this algorithm provided by Abrigo and Love (2015).

the heteroscedasticity that may exist due to the presence of heterogeneous errors with different cross-sectional units in the framework of panel data. It is a better estimation method than the GMM in first difference as normally the lagged levels of the time series result in weak instruments (Bond et al. 2001).<sup>178</sup>

As, we know that due to the a-theoretical nature of VAR approach and the presence of large number of estimated parameters it is difficult to interpret the results in economic sense, for instance: some estimated lagged variables may have coefficients that change sign across the lags with the interconnected equations make it unclear to analyze what effect a given estimated variable would have upon the future values of other endogenous variables in the system.<sup>179</sup> So, in order to overcome this problem we base our analysis on the results of a set of three test statistics which are normally constructed for an estimated VAR model, that is: Impulse–Responses (IR), Block significance test (or commonly known as Granger causality test) and Variance Decompositions (VD).

The IR functions describe the response of one endogenous variable to the shock in another in the system, while holding all other innovations equal to zero. But, then the assumption of keeping the innovation isolated to one of the variables in the system of equations is violated because the actual variance-covariance matrix of residuals is unlikely to be diagonal (i.e. violating the i.i.d assumption in equation 2). Therefore, it is imperative to decompose the errors to assure that they are orthogonal in order to estimate the shocks to one of the variables in the system independently. For this, we use the Cholesky decomposition of variance-covariance matrix of residuals which ensures the orthogonalisation of shocks. This approach requires a specific ordering to be given to variables in the system depending upon their degree of endogeneity that is: the variables that come later in the system are more endogenous than the ones that appear earlier. Since, the results are based on the specified ordering given to the variables according to the objective of underlying research; it is subject to a research bias. To overcome this issue it is advisable to generate the IR functions with reverse-ordering and analyze whether the results have been significantly different from the base case or not. Furthermore, for the IR functions we need to specify the confidence intervals. As, variance-covariance matrix is obtained from the estimated VAR coefficients and their standard errors, following the prevalent norm, we calculate the standard errors of the impulse-response functions and construct the confidence intervals through the Monte Carlo simulations.

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<sup>178</sup> For theoretical details see: Arellano and Bond (1991), Arellano and Bover (1995), and for the application in STATA refer to Roodman (2009).

<sup>179</sup> See: Brooks, 2014, pg. 336

On the other hand, the variance-decompositions (VD's) are also reported to show the change in magnitude of the response variable due to the innovations in the impulse variable. In other words, the VD's present the percentage variation in one variable due to a shock in another variable that is, the proportion of movement in the response variable which is caused by innovation in other variable, accumulated over time. Moreover, the Block-F exogeneity test enables to establish the feedback effect between the focused endogenous variables. In other words, the Granger causality assists in identifying the order of causality among variables in a VAR system.

In this chapter, on the basis of estimated PVAR output we construct these test statistics to analyze and interpret our results.<sup>180</sup> Specifically, the Block-F exogeneity test is used to identify the contagion order and its feedback effect of credit risk between the sovereign-bank-firm nexus in the context of euro area. On this basis, the IR functions and the VD's are constructed to evaluate and analyze the credit risk contagion effect with-in a country (i.e. among the sovereign-bank-firm sectors) and across the member states in the euro zone in respective debt markets. Specifically, the IR's and the VD's are used to determine the proportion of default risk's excessive spillover movements in the sovereign, bank, non-financial firm sectors which are consequence of their own shock and shocks to other sectors within and across the countries in the euro area. Therefore, we mainly focus on generating the IR's and VD's on the credit risk contagion identified in the estimated PVAR output and the granger causality tests that are significantly different from zero which in fact are subject to the underlying time variations. The explicit PVAR model with sovereigns, banks, and firms credit risk variables is presented as equation (5) in Appendix (C).

### 3.1.2 Sample data and time period

In line with the recent strand of literature, we use quarterly data of five years senior CDS premia from 2007 till 2012<sup>181</sup> for sovereigns, banks, and non-financial corporates because these types of CDS are most liquid by nature as they are actively traded in the respective debt markets.<sup>182</sup> Our sample consists of eleven euro zone member states (Austria-AT, Belgium-BE, Finland-FI, France-FR, Germany-DE, Greece-GR, Ireland-IE, Italy-IT, The Netherlands-NL, Portugal-PT, and Spain-ES). The quarterly data of CDS contract for the individual sovereigns, banks and non-financial corporates are gathered from the DataStream and Bloomberg.<sup>183</sup> The credit default swap contract, in general, shows the market default risk relative to the underlying financial asset. Specifically, it is a financial contract in which lenders pass on the risk of default of borrowers to the third party that

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<sup>180</sup> We mainly focus on the results that are significantly different from zero.

<sup>181</sup> Specifically, from 2007-quarter IV till 2012-quarter IV

<sup>182</sup> See: Alter and Schüller (2012), Alter and Beyer (2014), Heinz and Sun (2014) and Erce (2015) among others

<sup>183</sup> For DataStream (DS), we downloaded the CDS data mainly from Thomson Reuters (TR).

provides an insurance against the event if the underlying borrower fails to fulfill its respective debt obligation. In general, the increase in CDS premia indicates growing market expectations of default by the borrower with a peculiar spike in spread at the time of occurrence of the credit event. Furthermore, the CDS spread is normally quoted in basis points (bps).

As far as individual sovereign CDS data is concerned it spans back to late 2005 but for banks and non-financial firms the CDS data coverage is less homogeneous prior to 2007. Therefore, taking into consideration the CDS data coverage and the available information for sovereigns-banks-firms, in the current chapter we use time span from 2007-QIV till 2012-QIV.<sup>184</sup> For analysis, we divide our sample into two main periods. First, we examine the presence of contagion effect of default risk due to the great recession effect on the sovereign-bank-firm nexus in the euro zone, that is: 2007-QIV till 2009-QIV (Jeff Holt, 2009). Second period constitutes from 2010-QI till 2012-QIV as a sovereign crisis episode when the European Union approves the financial assistance plan for Greece against its vulnerable financial and public debt situation (Alter and Schüler, 2012).<sup>185</sup>

Furthermore, Finland is excluded from the analysis due to lack of CDS data availability of its banking sector.<sup>186</sup> In similar vein, differing with most of the existing empirical literature,<sup>187</sup> we did not exclude Ireland from our sample. For estimation purposes, we manage to find the CDS data for the period 2007-2012 regarding the Anglo Irish bank which transformed into the Irish Bank Resolution Corporation (IBRC) in July 2011 and the later functioned till February 2013 when it defunct at last.<sup>188</sup> Since, one of the main objectives of this study is to determine the presence and the order of credit risk contagion between the sovereign-bank-firm nexus in the intra and inter euro area countries: we constructed a system-wide risk index for banks stress and non-financial firms' vulnerability which is specific to an individual country following the methodology outlined by Acharya et al. (2014). The approach is presented as follows:

$$FirmRisk_{i,t} = \sum_{j \in J} w_{j,t} * FirmCDS_{j,t} \quad (3)$$

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<sup>184</sup> In DataStream, the CDS data (from Thomson Reuters) is available from December 2007 and not prior to that whereas, the CDS data from CMA is available prior to December 2007 but not with consistent frequency. In addition, I use the Bloomberg terminal to collect any missing CDS quotes regarding the individual entity (i.e. sovereign, bank or non-financial firm). I am thankful to the Library facilities of INSEAD Business School (Fontainebleau, France), specifically for the access to DataStream, Bankscope, Worldscope databases and their research students who allowed me to use the Bloomberg sessions.

<sup>185</sup> In fact, the Greek government debt started to surge since autumn 2009; as a consequence, Standard & Poor's downgrade their sovereign credit ratings (BIS, 2009). But we consider the onset of sovereign debt crisis since quarter I of 2010 due to the materialization of these vulnerabilities in the sovereign debt sector in the euro zone (see: Popov and Van Horen, 2013).

<sup>186</sup> Detailed list of banks and non-financial firms included in this chapter with respect to the specific country is outlined in tables (C.2) & (C.3) respectively, in Appendix (C). For Finland, we only use its sovereign and non-financial firms CDS data.

<sup>187</sup> See: Alter and Beyer (2014) among others.

<sup>188</sup> IBRC liquidation Bill (2013) (online at: <http://www.oireachtas.ie/documents/bills28/bills/2013/913/b913d.pdf>)

In equation (3), the system-wide firm risk index is represented by  $FirmRisk_{i,t}$  : as the CDS of firm  $j$  from country  $i$  at time  $t$  by  $FirmCDS_{ji,t}$  and the related corresponding weight as  $w_{ji,t}$ . Moreover, to keep the approach simple, the current work uses  $w_{ji,t} = 1/J$ . In addition, the non-financial firm weights could be indexed according to the market capitalization or to the value of their total assets. We follow the later to set the weights for the individual firms in a specific country to construct the credit risk index. Similar technique is applied for banks:

$$BankRisk_{i,t} = \sum_{\forall j \in J} w_{ji,t} * BankCDS_{ji,t} \quad (4)$$

In equation (4),  $BankRisk_{i,t}$  defines the system-wide measure of bank credit risk constructed as the interaction of CDS of bank  $j$  from country  $i$  at time  $t$  ( $BankCDS_{ji,t}$ ) with the corresponding weight as  $w_{ji,t}$ .

Whereas, for the control variables we follow the existing literature that identifies the importance of fundamentals in explaining the variations in CDS spread. A large number of recent studies suggest that the CDS premia is affected by the global risk factors. We use VIX index<sup>189</sup> to control for the global risk aversion following Pan and Singleton (2008) that shows strong link between the sovereign credit risk and the global risk aversion. In addition, Hilscher and Nosbusch (2010) suggest the importance of real economic factors as the important determinant of sovereign CDS spread, we control for these factors by using the GDP growth, inflation, real exchange rate, current account balances, and public debt/GDP. In a similar vein, for the financial sector we control for the bank specific factors, such as: return on assets, bank size (net asset value), provision for loss, interbank ratio.<sup>190</sup> While, for the non-financial firms we include: firm size (total assets), profitability (net margin ratio), leverage (total debt to EBITDA), and growth ratio (price-earnings ratio). The description and sources of all the variables used in this chapter is outlined in table (C.4) in Appendix (C).<sup>191</sup>

On the other hand, since all the variables to be included in the PVAR system are required to be stationary; we tested for the unit root. Traditionally, testing for the unit root is associated with the time series data but the trend to check whether the data variables are stationary or non-stationary

<sup>189</sup> Chicago Board Options Exchange Market Volatility index (VIX)

<sup>190</sup> Longstaff et al. (2011)

<sup>191</sup> However, an important point to note is that the information regarding fundamentals data relevant for the CDS premia determination is difficult to extract due to its low information frequency and the historical nature. As the CDS market operates on high frequency information with investors' making decisions on expected future economic trends. To streamline the effect, we focus on quarterly fundamental data which is mainly interpolated (using cubic spline approach) from semi-annual (and annual) accounting information provided by the non-financial firms (Worldscope) and the banks (Bankscope). Furthermore, following equations (3 and 4), we constructed a system-wide fundamentals index to use in the first step to filter out CDS spreads and gather the residuals as a proxy of variation in the default probability for banks and firms.

now also includes the panel data. Therefore, to test for the stationarity in our panel data, we follow Pesaran (2007) because it runs the t-test for unit roots in the heterogeneous panels with cross-section dependence. Pesaran unit root test is in line with the objectives of the current study because we want to evaluate and identify the credit risk contagion and its related feedback effect in the context of euro zone. Specifically, the euro area constitutes heterogeneous panels with cross-section dependence of the member countries that is, the economic condition of a country is affected by other countries within the euro zone. For instance, a shock in the GDP growth of Germany affects other member states in the euro area, therefore, for the purpose of this chapter it is imperative to take into consideration the heterogeneity and the cross-sectional dependence to test for the unit root.

For brevity, the results of the panel unit root test of focused variables are reported in table (C.5) in Appendix (C). The variables are mostly stationary at first difference i.e.  $I(1)$ , except the banking sector CDS premia which is stationary at  $I(0)$ .<sup>192</sup> This may be due to the fact that we use the natural log form of the CDS spread for all the three sectors following the contemporary empirical literature on CDS data in the context of credit risk dynamics in the euro zone. Furthermore, for the optimal lag-length we follow the model selection criteria outlined by Andrews and Lu (2001). The authors' propose a consistent moment and model selection criteria (MMSC) for GMM models based on the J-statistics of over-identifying restrictions (Hansen, 1982). The results of Andrews and Lu (2001) maximum likelihood-based model selection criteria are reported in table (C.1) in Appendix (C). According to the table, the first order PVAR is the preferred model as it has the minimum BIC, AIC and HQIC. These results are in accordance with the economic significance as the CDS data tends to be highly responsive which is mainly short-term in nature due to the changes in underlying economic conditions (Koop and Korobilis, 2016).

However, in this context since most of the macro, financial, and firm level variables are stationary at  $I(1)$  level and our main variables are also except the bank CDS premia, we check for the cointegration relationship and use Pedroni residual-based test of panel cointegration (Pedroni, 1999).<sup>193</sup> We did not find any cointegration effect between the CDS data of our focused variables mainly outlining a lack of long-term correlation, as also reported by Alter and Schüller (2012). Therefore, we use the panel VAR model to evaluate and identify whether there exists a contagion of credit risk in inter and intra euro zone member states especially during the recent crisis period in the corresponding debt markets (i.e. sovereign-bank-firm).

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<sup>192</sup> The unit root test results for our main interest variables are outlined in table (C.5) in Appendix(C)

<sup>193</sup> Further, we also use Kao panel cointegration test (Kao, 1999), but results remain unchanged.

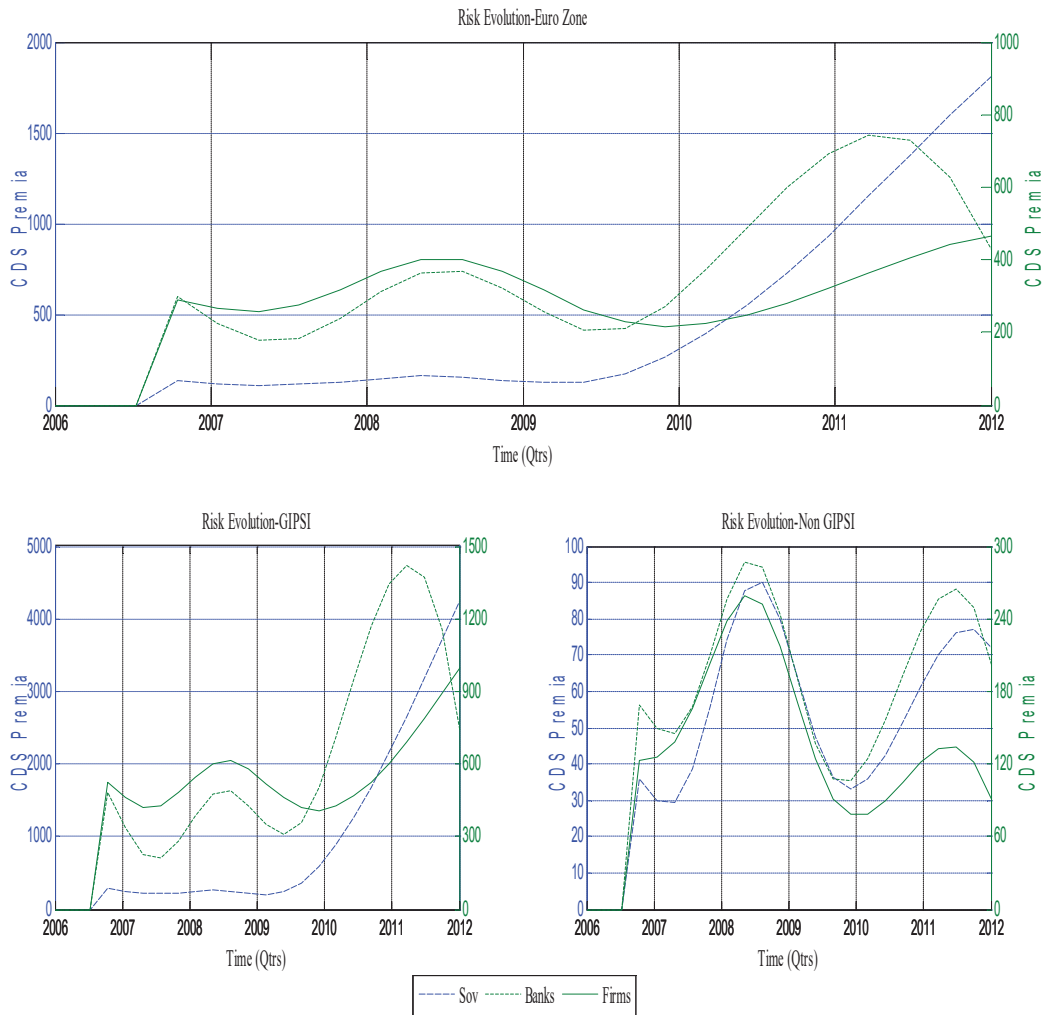
### **3.2 Bird's eye view of credit risk evolution in the euro zone**

In order to observe the general risk evolution in the euro zone, figures (III.2), (III.3) and (III.4) provide some preliminary evidence on the behavior of our focused credit risk variables i.e. sovereign-bank-firm sectors.

Figure III.2 depicts the aggregate volatility in the sovereign, bank and firm credit risk according to the euro zone alongside with the GIPSI and the non-GIPSI member states (i.e. Non-GIPSI: Austria, Belgium, Finland, France, Germany and the Netherlands) for the time period 2007QIV-2012QIV. Moreover, figures (III.3) and (III.4) portray the country-specific default risk evolution in the focused sectors in GIPSI and non-GIPSI countries respectively, in the euro area.

The effect of sovereign debt crisis is quite evident in figure (III.2) since the second quarter of 2010 in the sovereign and the bank CDS premia whereas, in the real sector it started to influence at the end of 2010. Specifically, the credit risk in sovereign, bank, and firm sectors are represented by dashed, dashed-dot, and solid lines, respectively. Moreover, left-side y-axis measures the sovereign credit risk and the right-side y-axis caters the non-financial firm and the bank CDS premia. In general, the change in the probability of default in these sectors evolves together with non-financial firms respond a bit late in the materialization. The effect of the US subprime crisis is obvious in the euro area's banking sector vulnerability with a sublime pass through to the non-financial firms leading to increase its respective default risk probability. In particular, sub graphs of GIPSI and non-GIPSI countries (figure III.2) better clarifies the prevalent economic conditions in peripheral and core member states in the euro zone during the great recession and sovereign crisis episodes.





**Figure III.2: Risk evolution in the EZ, GIPSI & non-GIPSI member states**

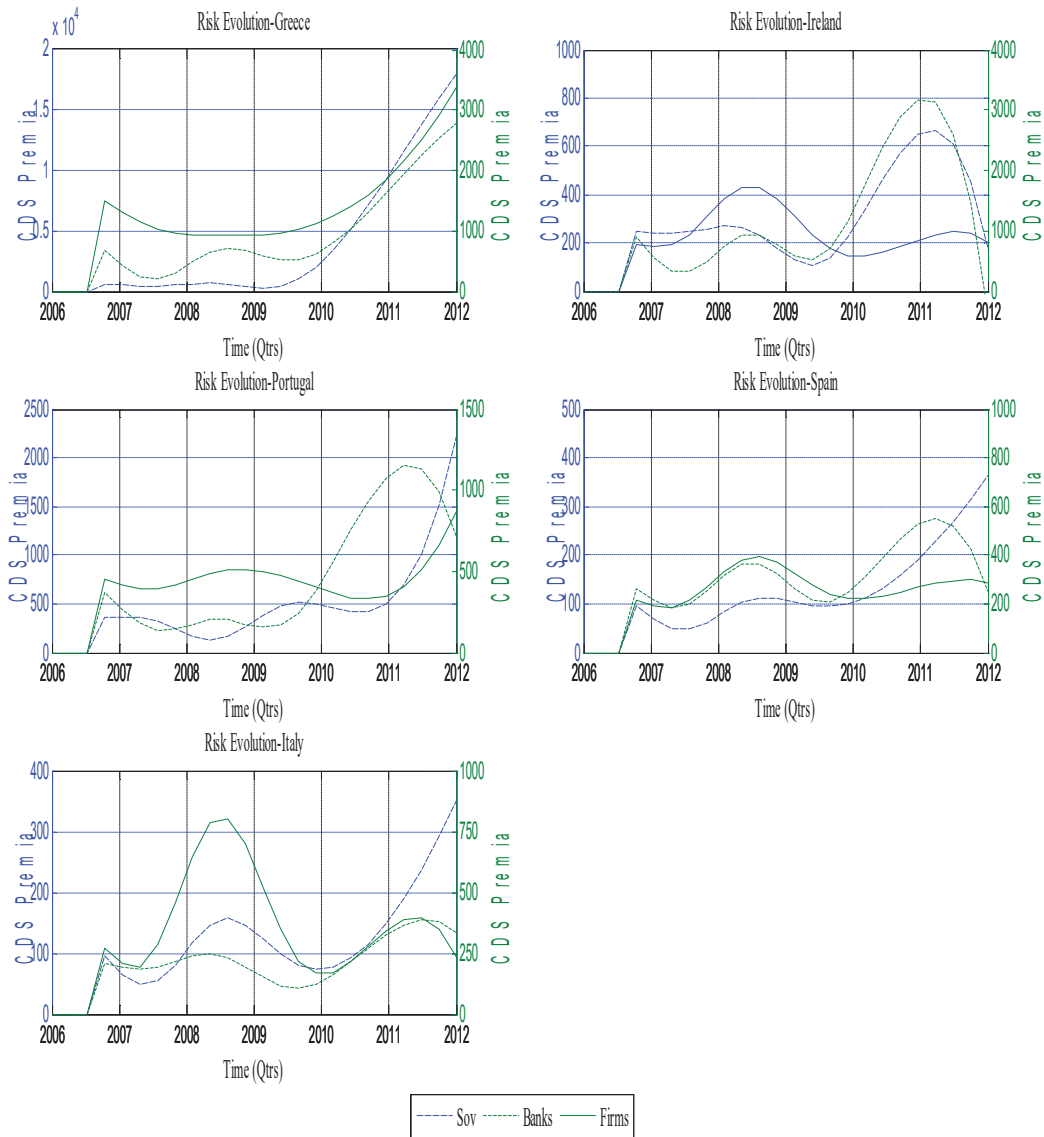
There are apparent differences in the increase in default risk volatility among the GIPSI and the non-GIPSI regions of euro zone. In the peripheral states, since the commencement of the euro crisis the sovereign CDS premia, on average, ranges from 220 bps to almost 4000 bps whereas, in comparison among core member states the change is not of an epic proportion i.e. from 37 bps to almost 77 bps. In a similar vein, banks and firms credit risk follows the isomorphic trend corresponding to the sovereign sector between GIPSI and non-GIPSI regions during the recent crisis period. Moreover, bank credit risk, on average, varies from 348 bps and peaked at 1425 bps while, non-financial firm risk fluctuates from 409 bps to 990 bps in peripheral states. On the other hand, in core countries, the banking sector risk ranges from 117 bps to almost 265 bps whereas; the non-financial corporate sector's CDS premium varies from 77 bps to 134 bps.

Notwithstanding, the variation in firm's credit risk is not as volatile as compared to the financial or the public sector during the sample time period in the euro zone. In this context, it is quite interesting to note that during this time period the firm's credit risk is lower than the banking sector risk of default not only in the core countries but also in peripheral member states mainly indicating the higher level of uncertainty prevalent in the financial system of the euro area.<sup>194</sup> Furthermore, here we can clearly observe the spillover effects of the global financial crisis in GIPSI and non-GIPSI countries. In sub graphs (i.e. figure III.2) of peripheral and core member states, we can easily discern the waves of distress from the sub-prime crisis across the financial markets in the euro zone.

Nonetheless, it is quite interesting to point out that the average credit risk index of banks and sovereigns credit risk converge in the second quarter of 2012, with sovereign risk premia increases and the banking sector spread decreases indicating the shift of financial vulnerability on the public accounts. On the other hand, the convergence with the real sector happened much earlier in the first quarter of 2011. This lagged responsiveness raises the importance of exploring the individual country's credit risk evolution in the respective debt markets in the euro area. In addition, an intriguing indication can be seen in the responsiveness of the real sector's probability of default during the sovereign crisis period between the two euro zone regions. Particularly, the reaction of non-financial corporate sector in the peripheral countries during the crisis period is delayed whereas, firms in the core member states are more sensitive to the adverse financial shocks in corresponding debt markets.

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<sup>194</sup> This trend in the non-financial firms' CDS premia, in fact, validates the outcomes found in chapter-II of this thesis.



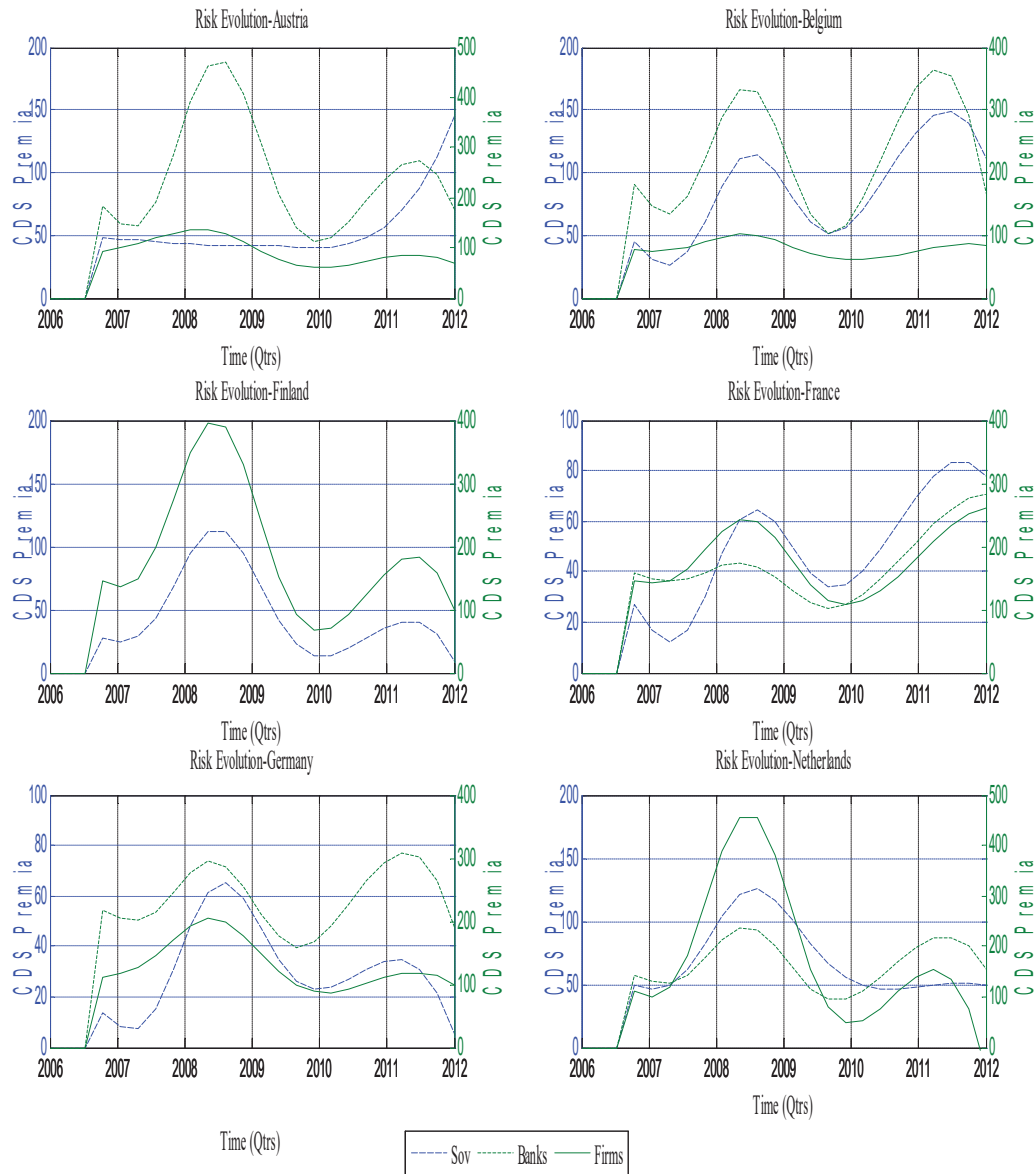
**Figure III.3: Risk evolution in individual GIPSI member states in the EZ**

In this respect, figures (III.3) and (III.4) help to broaden the understanding of credit risk evolution among the focused sectors in individual countries of GIPSI and non-GIPSI regions in the euro zone. Figure (III.3) depicts the credit risk environment among individual peripheral countries. With a brief glimpse, it is evident that the respective debt markets perceive the Greek case as a peculiar one with its public sector CDS premium surges to approximately 18000 bps. This rise in the credit risk volatility of Greek government perceived to unfold for the rest of peripheral member states but it seems to be idiosyncratic in nature. Nevertheless, investors' willing to hedge against the public debt of the rest of GIPSI countries followed a similar trajectory except Ireland. In general, there is a rise

in the CDS premium levels of the sovereign-bank-firm nexus since the commencement of the recent debt crisis in 2010, that is, the credit spreads have increased through-out the euro zone.

However, with the onset of the subprime crisis there is an increase in the volatility in banking sector's risk of default in Greece with its sovereign CDS premium started to show the same variations. As observed, with the collapse of Lehman Brothers in mid-September 2008, the financial stress in Greek banking sector commences to increase which eventually subsides, temporarily, with the European Commission (EC) announcement of approving the bail-out programs for the distressed banks in the euro area (BIS, 2009). On the other hand, the uncertainty in servicing the outstanding public debt in the first quarter of 2010 in Greece instigates an upward surge in its CDS spread which exacerbates the situation with the presence of already high levels of public debt stock. As a consequence, the European governments set up a rescue fund (i.e. the European Financial Stability Facility-EFSF) for aiding euro area member states that were subject to weak or narrow fiscal space.

Moreover, the Ireland and Spain follow the similar risk evolution trajectory as Greece at the start of sovereign debt crisis, whereas, the Italian and Portuguese CDS premia regarding sovereign and real sectors react after an interval of one quarter to the changes in corresponding debt markets. In this regard, we can observe multiple bouts of convergence between sovereign and bank risk of default during the great recession period in Portugal and Italy. Additionally, the general level of credit risk is higher in real and financial sectors than the sovereign sector before the inception of sovereign debt crisis in the euro zone. However, after the onset of recent public debt crisis episode, there is a fall in the default risk premium of non-financial firm demanded by investors in the CDS market in peripheral countries. But, even then the firm's credit risk remains at higher levels as compared to the subprime crisis period especially in Portugal and Greece.



**Figure III.4: Risk evolution in individual non-GIPSI member states in the EZ**

In a similar vein, figure (III.4) shows the credit risk variation in the focused sectors of euro zone's non-GIPSI countries. It is interesting to note that the convergence between sovereign and banking sectors' credit risk is not evident except in the case of France.<sup>195</sup> There is a slight fluctuation in the CDS premia of financial sector in the fourth quarter of 2008, just after the Lehman-Brothers defunct, that leads to the convergence of sovereign spread with the bank spread and it then remains at high levels above the financial sector's risk premium for quite some time in the French economy.

<sup>195</sup> In addition, the convergence materializes much later in Austria and Belgium, that is, in the last quarter of 2012.

This apparently indicates that the French sovereign had taken the financial sector stress on its public accounts swiftly as compared to any other core member state in the euro zone. Whereas, in general, the banking sector credit spread remains at higher level than the sovereign spread in the non-GIPSI countries. Furthermore, in tandem with Italy, Spain and Ireland, the corporate sector in the core member states (except France) in the euro zone validates higher probability of honoring its outstanding debt in the eyes of risk-averse investors after the onset of the sovereign debt crisis. In addition, due to the lack of availability of Finnish banking sector CDS data, we only portray its sovereign and firms credit risk indices.

For comparison between peripheral and core countries credit risk evolution in the euro area, let us analyze Greece and Germany together. It is quite interesting to observe that as Greek sovereign CDS premia started to rise, at the same time the German spread reduces, indicating the phenomenon of investor's "flight-to quality" as outlined by Battistini et al. (2014) in the context of euro zone during the recent debt crisis. While, other peripheral countries (except Ireland) follow similar trend with that of a German sovereign or for that matter to any of the core country (except for Austria) triggering the "flight-to-safety" reaction that eventually reduces the sovereign CDS spread in these member states.<sup>196</sup>

However, the divergence in credit risk premia among the euro area member states' sovereign sector is quite a recent issue. Since, the inception of the monetary union and then the subsequent introduction of the euro in 1999, member states in the euro area enjoyed the period of serenity with availability of cheap funds from respective debt markets and the prospering economic growth. It proved to be an example of a stable and successful integration of the distinct financial markets into a single monetary union, until the onset of the US sub-prime crisis which extends to the global financial markets in the third quarter of 2007 (Sgherri and Zoli, 2009). The divergence in the sovereign debt market for euro area countries started after March 2008 when the US Federal Reserve (hereafter, Fed) bail-out's Bear Sterns that leads to increase the concerns regarding the corresponding government's ability,<sup>197</sup> to service its outstanding obligations in international capital markets (Mody, 2009).

Hence, the policy makers inferred that due to an external shock the divergence in sovereign spreads occurs in the euro zone. But in fact, this yield differentiation was just a matter of time to unfold as it shows the inherent fragility (that has been prevalent since its inception) in the EMU due to the lack

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<sup>196</sup> It is important to note that, while investors' search for quality and safety in sovereign debt markets, there is a general increase in the respective sovereign CDS spread in core countries as well, during the public debt crisis period in the euro area.

<sup>197</sup> With high public debt levels

of fiscal competitiveness and the presence of domestic vulnerabilities in its member states. So, if we assume that the stress in the global financial markets eventually contaminate the value of different classes of assets in debt markets in the euro zone and thus it resulted in the increase in respective credit spreads. Then after controlling for this external effect, the resulting risk premia should go down. However, we have seen that this is not the case as outlined by several empirical studies that analyzes the determinants of credit risk spread in the context of euro zone.<sup>198</sup> Furthermore, by catering the variations in country-specific domestic vulnerabilities, the increased dispersion in the credit risk spread persists in euro zone member states.<sup>199</sup>

In this context, we suggest that the residual risk after controlling for the common and domestic macroeconomic factors in the evolution of risk of default in focused sectors (i.e. in sovereign-bank-firm) is due to the latent contagion effect which is a consequence of the herding behavior of investors in corresponding debt markets in the euro zone.<sup>200</sup> In addition, the spreads remain at high level due to the interaction of uncertainty generated in different debt markets which eventually reinforced the commencement of a feedback loop of default risk. Thus, in the current chapter, we attempt to evaluate the contagion effect of credit risk among the sovereign-bank-firm nexus and strive to identify the excessive spillover order and its feedback effect. On the other hand, we also incorporate the real sector credit risk effect simultaneously with the focused sovereign-bank nexus of the existing empirical literature which is imperative for a sustainable economic system (Gray, 2009; BIS, 2011a). Additionally, this study attempts to econometrically test the inherent assumption of the extant literature that treats the real sector's credit risk as a part of financial risk contagion to the sovereign sector, in the context of euro zone especially during the recent crisis period.

Moreover, in order to better understand the underlying credit risk dynamics in euro area member states, we analyze the inherent vulnerability effect from public and private sectors generated not only in peripheral countries but also in core states of the euro zone. In addition to the contagion literature, for policymakers, the current work not only broadens and extends the knowledge on the economic consequences regarding the respective financial and non-financial sectors due to the recent sovereign debt crisis. But it also enables to deepen the existing understanding on the interconnectedness of credit risk between the focused sectors to build a sustainable economic system.

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<sup>198</sup> See: Pan and Singleton (2008), Longstaff et al. (2011) and Ang and Longstaff (2013) among others.

<sup>199</sup> See: Cecchetti et al. (2010), Von Hagen et al. (2012) and Aizenman et al. (2013) among others.

<sup>200</sup> That is, the irrational panic due to the loss of confidence in the ability of domestic economic agents to service their outstanding debt obligations which emerge as a pure contagion effect among corresponding CDS markets.

## **4 Results**

This section presents our main estimation results on two dimensions. First, we show the intra-country credit risk contagion i.e. the interactions and spillovers between sovereign-bank-firm sectors for peripheral and core member states. Second, we extend the analysis to gauge the credit risk contagion from the peripheral and core countries to the rest of euro zone member states in corresponding debt markets. As mentioned in section (3): the peripheral countries comprise of Greece, Ireland, Portugal, Spain, and Italy (G-IPSI) whereas, the core countries include Germany and France. In this respect, we mainly focus on the detailed analysis of contagion risk from Greece to the rest of euro zone as an example of peripheral country. Whereas, for countries, our analysis mainly concentrates on the excessive risk spillover from German sovereign to the rest of EMU member states. In addition, for the aggregate estimation we focus on the full sample of euro zone countries (i.e. 11 states) which enable us to provide evidence regarding the presence of contagion default risk as a determinant in the abrupt increase of public debt yield differential (CDS spread) especially during the euro crisis period.

In this respect, for brevity, we mainly focused on the impulse-response (IR) functions, variance decompositions (VD) and Granger causality tests for explaining the presence of credit risk contagion and its respective order with feedback effect. Whereas, the result tables regarding the PVAR estimation, the variance decompositions and the full set of IR functions with the Granger causality measures for selected countries are presented in Appendix (C).<sup>201</sup>

Hence, for the ease and coherence of analysis we focus on the impact multipliers (IR functions) derived from the estimation results of the P(VAR) that are statistically different from zero. Before starting reporting and analyzing the intra and inter country default risk contagion in sovereign-bank-firm nexus among the individual and across member states, let us briefly evaluate the dynamics of credit risk contagion in the euro zone, on average, between the said nexus.<sup>202</sup>

### **4.1 Credit risk contagion in the euro zone**

The results of PVAR (1) estimation of credit risk contagion among sovereign, bank and firm in the euro zone is outlined in table (C.6), Appendix (C).<sup>203</sup> In this respect, SV.rsk, BK.rsk, and FM.rsk represent the credit risk contagion variables for sovereign, bank and non-financial firm, respectively. In addition, panels I, II, and III outline results for the whole period, the sub-prime

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<sup>201</sup> In this context, due to brevity, the P(VAR) model stability tests results are available on request.

<sup>202</sup> For the aggregate estimation we focus on the full sample of euro zone countries (i.e. 11 states).

<sup>203</sup> Moreover, tables (C.7) and (C.8) in Appendix (C) report the granger causality and variance decompositions results for the euro zone, respectively.



crisis period and the sovereign debt crisis period. It can be observed that there is a strong presence of credit risk contagion in each sector throughout the three time periods reflecting the evidence of horizontal systemic risk of default in the corresponding debt markets (that is: sovereign, bank, and firm) in the euro zone.<sup>204</sup> Whereas, a dynamic feedback loop of credit risk contagion is present among the sovereign-bank nexus in panel I, with no interaction of the real sector default risk. On the other hand, in panel II, during the sub-prime crisis episode we can see the intricate credit risk contagion dynamics between real, bank and public sectors.

In particular, the results show bi-causal default risk spillover between the sovereign-bank nexus while the feedback effect is stronger in magnitude. Furthermore, the uncertainty in the real sector significantly transmits not only to the financial sector but also to the respective sovereign sector during the Global Financial Crisis (GFC) period. It mainly outlines the differential impact (that is, the direct and indirect) from the non-financial corporates' probability of default towards the public sector. This result validates our hypothesis that the real sector's credit risk is not only a part of the financial sector contagion to the public sector but also there is a direct contagion risk from the real sector to the sovereign sector which is consequent to the reduction in economic activity. This led to raise the unemployment level, deteriorate the economic growth and lower the tax revenue (that is: from corporates and households) for the respective governments in the euro zone.

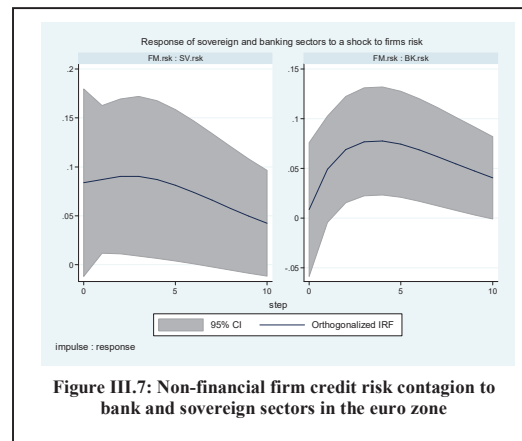
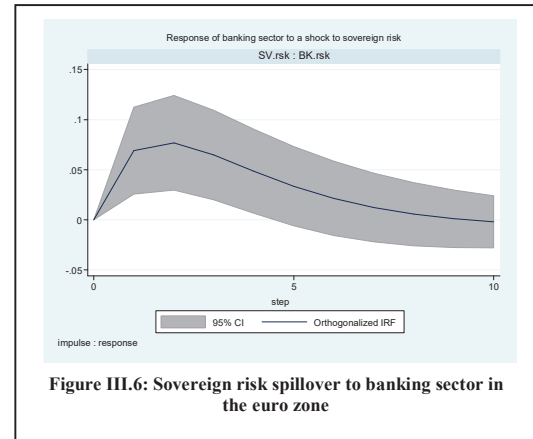
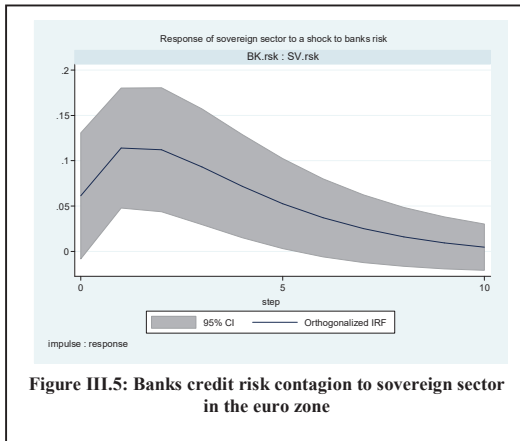
In addition, the results in panel III advocate the impact of sovereign debt crisis in these debt markets. Specifically, we can observe in columns 7, 8 and 9 of table (C.6) Appendix (C), that there is a strong contagion risk from the sovereign CDS to banks and then a pass-through effect towards the real sector in the euro zone.<sup>205</sup> However, the feedback effect from the non-financial sector CDS premia to bank's credit risk show either the evidence of disintegration of financial dependence of the real sector on the banking sector or a policy effect of the Stability and Growth Pact (SGP) in the context of EMU that enables to lessen the risk of financial sector meltdown even with persistent recessionary trend in the euro zone. In order to hone the analysis, we turn our attention towards the impact multipliers generated on the PVAR (1) estimation of credit risk contagion during the crisis episodes.

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<sup>204</sup> Horizontal systemic risk refers to the risk generated through the default of one unit in a system that generates the contagion default for other units in the same system (ECB 2009). For instance, in a financial system, the default of one bank triggers the increase in probability of default for other banks, same is applied for the non-financial corporates and on macro level to the sovereign sector in any economic system. On the contrary, a vertical perspective of systemic risk focuses on the interaction of units in different sectors to generate contagion risk of default. For instance, the emergence of systemic risk due to default of a bank through the increased interconnectedness of the financial sector credit risk with the public and real sectors that generate wave of default in the latter sectors in an economy (ECB, 2009).

<sup>205</sup> In line with the upshots reported in chapter II of this thesis.

In this context, the results from impulse-responses generated through the statistically significant panel VAR estimation of the sovereign-bank-firm credit risk during sub-prime and public debt crisis episodes in the euro area are depicted in figures (III.5, III.6, III.7) and (III.8, III.9, III.10), respectively.<sup>206</sup> In all graphs below, the solid line represents the orthogonal impulse response functions of our focused three variables estimated through panel VAR for the euro zone during different crisis episodes and the 5% error bands are generated by Monte Carlo simulation.



Note: The figures above show IR functions of sovereign-bank-firm nexus during the subprime period in the euro zone. Specifically: figure (III.5) shows the credit risk contagion from banks to sovereign sector, whereas, figure (III.6) depicts the causal credit risk contagion from sovereign to banking sector and, figure (III.7) presents the credit risk spillover from the real sector to sovereign and banking sectors during the sub-prime crisis period in the euro zone. The highlighted areas in all of the figures show two-standard error bands. The forecast horizons are in quarters. In addition, BK.rsk, SV.rsk and FM.rsk represent banks, sovereign and firms credit risk, respectively. The sample time period spans from 2007-QIV till 2009-QIV.

Figure (III.5) reports graph of credit risk contagion from banks to the public sector, while figure (III.6) reports the feedback effect from the sovereign to banking sector in the euro zone, by keeping all other shock effects constant during the great recession period. While, in figure (III.7) we show the excessive spillover effect of the real sector credit risk towards bank and sovereign sectors. In particular, in figures (III.5) and (III.6) we can observe the response of sovereign sector to a one

<sup>206</sup> Graphs related to all IR functions for the euro zone are reported in figures (C.1, C.2 & C.3) in Appendix (C)

standard deviation shock to banks credit risk and the causal effect from the public sector vulnerability towards the financial sector in the euro zone.

It is engaging to observe that both figures follow similar pattern. During sub-prime crisis in the euro zone, banks credit risk innovation impacts temporarily the government CDS premia and its effect fizzles out approximately in the fifth quarter ( $t \leq 5$ ), while in the case of causal sovereign credit risk shock towards the banking sector the impact dies out in the fourth quarter ( $t \leq 4$ ). These results are in the cards as we have observed in the related literature that the US mortgage market instigated the crisis to which the banking sector in the euro zone was heavily exposed to (see: Acharya et al., 2014 and Thukral, 2013 among others). Thus, the great recession effect weakens the financial and liquidity conditions of banks in the euro area which leads to increased pressure on the sovereign sector with the investor's expectation of ultimate bail-outs of these distressed institutions.

Hence, the bank's credit risk contagion spurs up the uncertainty regarding the sustainability and creditworthiness of the corresponding public sector. Furthermore, it is quite interesting to note that the magnitude of systemic effect of bank credit risk shock to the creditworthiness of public sector is higher than its feedback effect which indicates the time varying and sector-specific nature of the financial crisis episode.

On the other hand, with the onset of the great recession period, the corporate sector in the euro zone also shows difficulty in servicing its outstanding debt obligations which not only spills over to the banking sector<sup>207</sup> but also directly transmits to the sovereign sector<sup>208</sup> (Figure (III.7)). In addition, we can observe in figure (III.7) that the innovations from the real sector's probability of default adversely impacts for five and nine quarters significantly on sovereign and bank sectors during the sub-prime period, respectively. This, in turn, depicts the onset of long-term recessionary trend in the economies of euro area member countries. Besides, this long lasting influence basically means that the recessionary effect dissipates slowly from the economic system even in the presence of corrective policy measures towards reinvigorating growth in the euro zone.

As a consequence, in 2008, EU agreed on a € 200bn stimulus package to revitalize the economic growth in the euro zone following the global financial crisis (Baimbridge and Whyman, 2015, pg: xiii). In addition, since the financial aid is also supposed to be borne by respective sovereign sector, this cost in turn is anticipated by the investors' in international capital markets that leads to invoke the issue of fiscal sustainability. Specifically, it poses question on the government's ability to

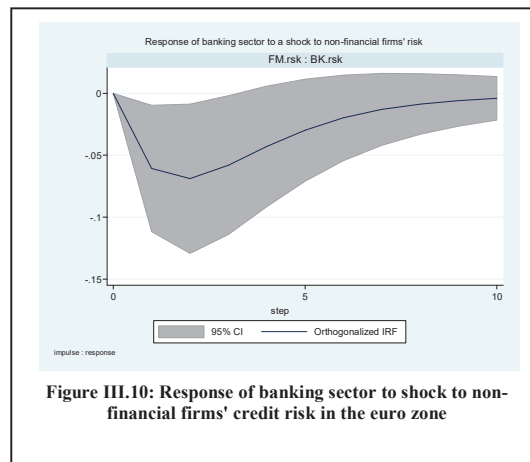
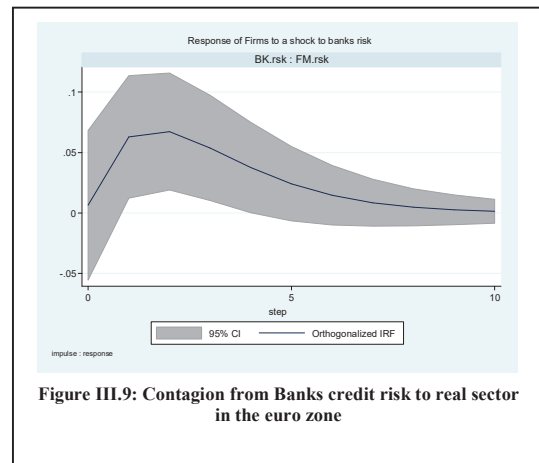
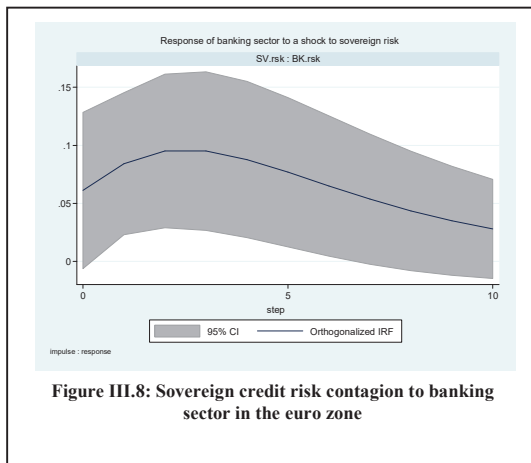
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<sup>207</sup> May be through the increase in non-performing loans

<sup>208</sup> May be by reduction in the overall tax revenue

service its outstanding debt as a consequence to stagnant economic growth and prevalent high public debt level among the EMU countries.

Furthermore, during sovereign debt crisis period in the euro zone, while keeping all the other innovations invariable: figure (III.8) depicts the graph of vulnerability contagion from the public sector to the banking sector, where as figure (III.9) reports the contagion from the bank's credit risk towards the non-financial firm's risk of default and figure (III.10) shows the feedback effect of credit risk contagion from the real sector to the banking sector.



Note: The figures above show the IR functions of sovereign-bank-firm nexus during the sovereign debt crisis period in the euro zone. Specifically: figure (III.8) shows the sovereign credit risk contagion to banking sector, whereas, figure (III.9) depicts the contagion from banks credit risk to real sector and, figure (III.10) presents the feedback effect from shock to the real sector credit risk to the banking sector during the sovereign debt crisis period in the euro zone. The highlighted areas in all of the figures show two-standard error bands. The forecast horizons are in quarters. In addition, BK.rsk, SV.rsk and FM.rsk represent banks, sovereign and firms credit risk, respectively. The sample time period spans from 2010-QI till 2012-QIV.

Keeping in mind the results of sub-prime crisis, we can observe that in the public debt crisis there is an immediate and a higher magnitude of sovereign credit risk contagion towards the banking sector which in turn shows the increased integration of public and financial CDS market as compared to the real sector. In particular, it is a consequence of the loss of confidence in government's ability to

effectively service its short and long-term obligations. This uncertainty is partially due to the cost of sovereign aid to banks in the form of either the recapitalization or the funding of guarantees (i.e. the implicit and explicit) and partially through the simultaneous reduction in the economic activity with wider output gap resulting in lowering of public revenue (due to the reduction in taxation income for the sovereign) (Battistini et al. 2014).

In addition, it is quite interesting to observe in figure (III.8) that the innovations effect of sovereign credit risk impacts the banking CDS premia for medium term (i.e.  $t \leq 7$ ) forecast horizon, indicating a somewhat persistent systemic shock during the public debt crisis period. On the other hand, we have seen previously that during the sub-prime period there is only a temporary contagion effect that fades away quickly (that is,  $t \leq 4$ ).

Notwithstanding, in figure (III.9) we can observe the fear of financial sector melt down which is contagious towards the non-financial firms in the euro zone during the recent sovereign debt crisis period. However, the IR function shows that the shock to the banking sector credit risk affects the real sector in short-term (that is,  $t \leq 3$ ) and the effect fizzles out quickly and becomes insignificant. That is, the spike is short lived and the peak impact occurs in the second quarter after the shock with a multiple of 0.06. Hence, the shock from financial sector credit risk in the average pricing of corporate risk eased out significantly after just three quarters of financial shock in the euro zone.

Furthermore, figure (III.10) reports interesting results. In the figure we can discern a negative response of bank's CDS premia due to innovations in the real sector's credit risk (that is, no contagion is present, even though the result is statistically significant). Specifically, an unexpected shock to the non-financial firm CDS spread generates an inverse reaction from the banking sector during the public debt crisis period, ideally indicating the EMU efforts for the stabilization of its distressed financial sector. For instance, with a general increase in systemic risk of probability of default in the corporate sector<sup>209</sup> the respective banking sector credit risk goes down mainly due to the safety net stimulus packages approved by the euro zone together with the IMF, to ease out the unrest in its financial system during the euro crisis period (Popov and van Horen, 2013).<sup>210</sup>

In addition, it is engaging to realize in figures (C.1, C.2 and C.3), Appendix (C), that the effects of sovereign, bank and firm sectors shock to themselves are significantly different from zero in both the sub-prime and sovereign debt crisis episodes in the euro zone. Thus, it indicates the presence of

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<sup>209</sup> May be either due to the deterioration in the creditworthiness of sovereign sector or reduction in the economic growth

<sup>210</sup> In this context, the European Financial Stability Facility (EFSF) was created in June, 2010 by EU member states to counteract the pernicious financial and fiscal conditions prevalent especially among peripheral countries (<http://www.efsf.europa.eu/about/index.htm>).

horizontal credit risk contagion with-in the respective debt markets and a vertical systemic risk across the corresponding debt markets in the euro area. In particular, this led us to fathom that the credit risk contagion is homogenous with-in sectors and heterogeneous among sectors in the euro zone during the distress periods. Hence, this result shows that our credit risk contagion measures of the sovereign-bank-firm nexus are time independent intra-sector and time dependent inter-sectors which enable us to distinguish the relevant nature of systemic risk in respective debt markets during the recent crisis episodes in the euro zone.

#### 4.1.1 Sum-up

We treat the interconnectedness between sovereign, bank and non-financial firm CDS premia and used the panel VAR estimation to generate the contagion risk, recursively. The explanations are derived from the orthogonal impulse response functions of the statistically significant contagion effects during recent crisis episodes in the euro zone. Our results show evidence that the systemic contributions of each sector is quantified through the credit risk contagion measures which proved to capture the time-varying interdependence among sectors and time-invariant interdependence with-in the sector. In this context, the contagion risk between sovereign credit markets and banks is higher than the respective corporate sector debt market in the euro zone, irrespective of the crisis period.

However, an engaging result is documented by the dynamic structure of the credit risk contagion between the sovereign-bank-firm nexus. For instance, during the sub-prime crisis the contemporaneous contagion risk is found not only from banks to sovereign solvency condition but there is also an evidence of simultaneous excessive spillover of corporate default risk to the public sector credit risk. Whereas, there is a significant immediate innovation effect from the sovereign sector risk of default towards the banking sector in the case of euro crisis. In addition, our results also find a possible carry-trade effect of banks towards the real sector during the sovereign debt crisis period in the euro zone (see: figures (III.9) and (III.10)). Furthermore, these results clearly document the private to public transformation of credit risk in the euro zone during the focused crisis episodes.

Finally, in the words of Allen and Gale (2000) our credit risk contagion measures are a consequence of excessive spillover effects which provide evidence of the presence of financial contagion that

plays an important role in explaining the increased CDS spread in respective debt markets during recent crisis episodes in the euro zone.<sup>211</sup>

## **4.2 Is there intra-country credit risk contagion present in the euro zone?**

In this section, we try to hone in the findings outlined in the previous section by analyzing the credit risk dynamics among sovereign-bank-firm nexus in the selected peripheral and core economies.

### 4.2.1 Peripheral countries (G-IPSI)

In line with the related literature, we mainly report in detail the results for Greece which is fundamentally termed as a main culprit in triggering the recent public debt crisis in the euro zone (see: Missio and Watzka, 2011 and Caceres et al., 2010 among others). Furthermore, the rest of peripheral member states (IPSI) results are also analyzed, succinctly, in the light of different crisis episodes.

#### *4.2.1.1 Greece*

Let us analyze the credit risk dynamics between the sovereign, bank and non-financial corporate sectors in Greece. Table (C.9), Appendix (C) reports the results of VAR estimation regarding the sovereign-bank-firm credit risk measures during the recent crisis episodes in Greece. The panels: I, II and III, outline results for the whole period, the global financial crisis and the euro crisis periods, respectively. In general, we can observe a contagious presence of the horizontal systemic risk within the said sectors in Greece regarding their probability of default in all panels.

It is quiet intriguing to observe in panel II, table (C.9)<sup>212</sup> that Greek banking system in fact withstands the sub-prime crisis effect and was not subject to the credit risk contagion towards its public sector. This finding is in contrast to our results in section (4.1) where, on average, the euro zone analysis showed the build-up of the financial sector's credit risk towards the sovereign sector that proved to be the partial cause of the recent crisis episode. However, we can see the contagious effect from the Greek banking sector to its real sector that leads to constrict the volume of credit towards the domestic non-financial corporates. It may be due to the consequence of the deepening of GFC episode that result in a credit crunch situation. Therefore, this upshot mainly outlines the fact that Greek financial system was fundamentally comprised of the bank-base credit towards the domestic corporates and households (that is, it principally followed the traditional banking practices and was retail-oriented) (IMF, 2009).

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<sup>211</sup> In addition to weak macro-economic, systemic and fiscal fundamentals effect

<sup>212</sup> Appendix (C)

On the other hand, table (C.9) panel III, shows the results during the sovereign debt crisis period in Greece. It is evident in columns (8) and (9) that there is a presence of credit risk contagion from the Greek public sector towards its bank and real sectors. Notwithstanding, there is a strong contagious effect from the sovereign to banking sector in Greece, whereas only a moderate contagion effect is present towards the non-financial corporates. Keeping in mind the results found in the sub-prime crisis period, it is quite clear that the Greek banking sector was not responsible for the distress in its public sector. On the contrary, already high level of public debt stock and the reduced economic growth with Greek sovereign unable to capitalize and build-up reserves during the times of bonanza (that is, during 2000-2007) led to the eruption of the crisis situation in the country (IMF, 2010). The evidence regarding contagious effect of credit risk in the Greek economy can be clearly discern by analyzing the graphs of the impact multipliers.

In this respect, figure (III.11) depicts the impulse response function during the great recession period, whereas, figures (III.12) and (III.13) show the contagion effects from the public sector to bank and real sectors in Greece during the euro crisis period.<sup>213</sup>

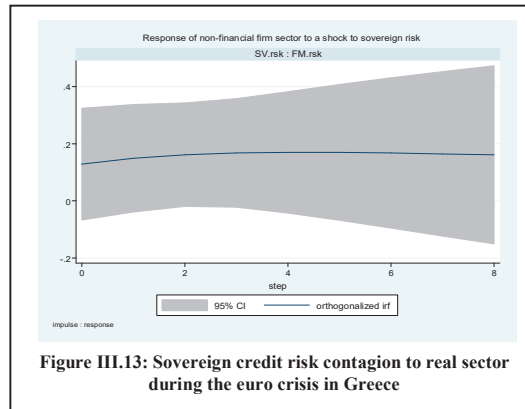
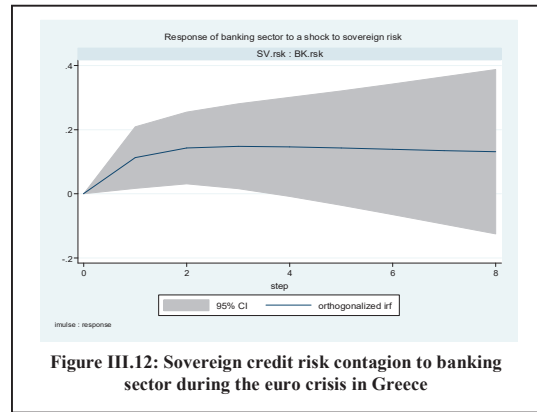
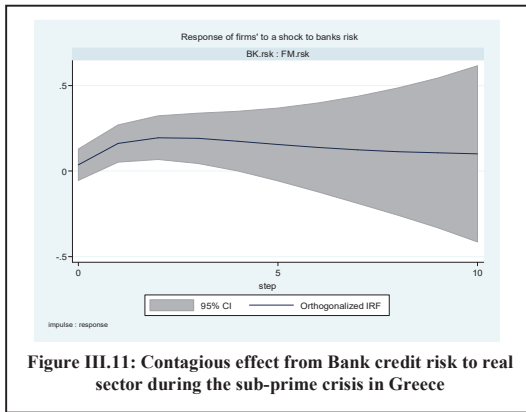
In sub-prime crisis period in figure (III.11), an unexpected shock to the CDS spread of Greek banking system is moderately contagious towards its real sector and the effect impacted only in short-run ( $t \leq 4$ ). Whereas, during the euro crisis period, the sovereign solvency risk quickly becomes contagious to the Greek banking sector in the first quarter and peaked in the second quarter, which principally evinced the respective public sector's problem of debt overhang and the underlying difficulty in easing out the distress in banks. In particular, the response of bank's CDS spread to the innovations in sovereign sector shows the higher integration of these debt markets due to the reduction in value of government securities and guarantees as a consequence of deterioration in the Greek sovereign ratings.

On the other hand, the real sector probability of default is affected due to the shock from the sovereign credit risk which indicates a prolonged session of recessionary trend in the Greek economy but the estimated impulse responses are mostly insignificant (figure III.13). Furthermore, there is an immediate effect from sovereign credit risk to firms indicating a highly responsive real sector against the event of default by the Greek sovereign in May 2010 and its subsequent application for financial aid to the troika (ECB/IMF/EU).

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<sup>213</sup> The respective Granger causality and variance decomposition results are reported in tables (C.10) and (C.11) in Appendix (C). In addition, Appendix (C) also contains graphs of all the IR functions, that is, figures (C.4 & C.5).





Note: The solid lines in figures above show the IR functions of statistically significant VAR estimation results among the sovereign-bank-firm nexus during both the crisis episodes in Greece. Figure (III.11) shows the banking sector's contagion effect to the real sector during the great recession period. Whereas, figure (III.12) depicts a severe contagion from the sovereign credit risk to banks and, figure (III.13) presents a moderate credit risk spillover to the real sector from the public sector during the euro crisis period. The highlighted areas in all of the figures show two-standard error bands. The forecast horizons are in quarters. In addition, BK.rsk, SV.rsk and FM.rsk represent banks, sovereign and firms credit risk, respectively. The sample time period for the sub-prime crisis spans from 2007QIV-2009QIV and for the euro crisis from 2009QIV-2012QIV.

It is quite interesting to note that the occurrence of government default event impacted more harshly to the real sector than the banks in Greece mainly showing that the corresponding debt markets penalizes Greeks for their irrational behavior of utilizing erratic level of consumption (that is, economic activity) from the future to the present. On the contrary, this result is somewhat biased due to the fact that firms' CDS data that was available through DataStream is subject to direct influence from the Greek sovereign.<sup>214</sup> In addition, the excessive spillover effect from the public sector to financial sector remained significant till the fourth quarter and then becomes insignificant (figure III.12). These results, in turn, provide evidence of high integration and co-movement of sovereign debt market with that of banking sector in Greece especially during the euro crisis period.

Nevertheless, we did not find the presence of private to public transformation of credit risk across the said crisis periods in Greece as mentioned in section (2.1) and reported in section (4.1) of this

<sup>214</sup> See, table (C.3) in Appendix (C). In addition, we are thankful to Mr. Adrian Pop for his valuable comments on non-financial firm's data.

chapter. Moreover, the results lack to establish the existence of a feedback loop between the default risk contagion measures among the sovereign, bank and real sectors. In turn, these indications confirm the case that the Greek economy fundamentally is plagued with pernicious levels of huge public debt which becomes detrimental when the euro zone receives an external shock in the form of the sub-prime crisis. Hence, the credit risk contagion is from the sovereign to banks as far as Greece is concerned during the said turbulent period.

#### *4.2.1.2 IPSI countries*

While analyzing the rest of the euro area peripheral member states, the results for Spain most clearly show that the sovereign sector takes the tail risk of its banking sector on the public balance sheet. The fear of materialization of the financial system melt down emerged as a fundamental factor for the transformation of the credit risk from private to public sector in recent crisis period. In addition, our results also support the generation of incessant cycle of the risk of default mainly between the sovereign and banking sector with only a unidirectional contagion from the real sector to banks as proposed in the study by IMF (2013). In this context, we report the impulse response functions of the sovereign-bank-firm credit risk for *Spain*.

Figures (III.14), (III.15), (III.16) and (III.17) depict the impulse-response functions generated on the estimated results through VAR (1) for Spain during the great recession and the euro crisis periods, respectively. Here, we mainly focus on the results that are statistically different from zero and provide evidence of the credit risk contagion among the sovereign-bank-firm nexus in Spain. In figure (III.14), we can observe the indication of default risk contagion from the financial sector towards the sovereign sector during the GFC period mainly reporting the fact that the Spanish sovereign takes its banking sector tail-risk on the public balance sheet.<sup>215</sup> The results are in fact in line with the events. For instance, the case of formation and then bail-out of Bankia is a prime example, when the Spanish government constitutes a banking conglomerate comprising of seven domestic banks due to their distressed financial conditions. However, the impact of sovereign action went in vain when Bankia becomes insolvent and requested for a bail-out from the government during the last quarter of 2012 (Minder, 2012).<sup>216</sup>

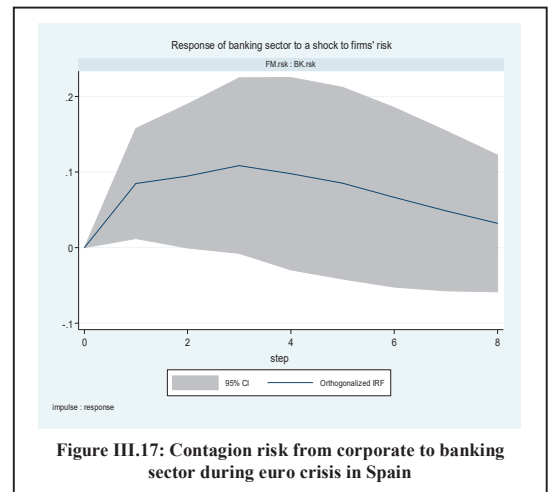
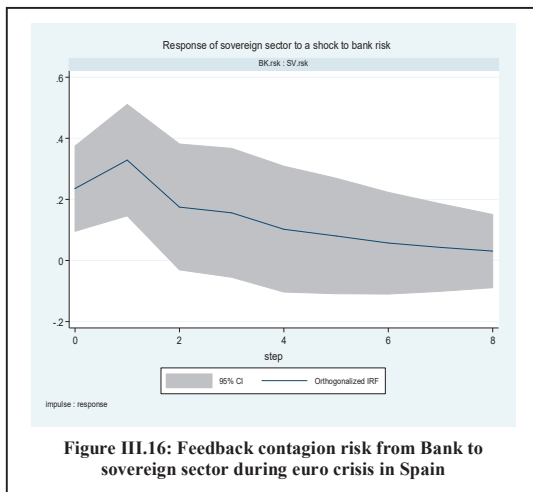
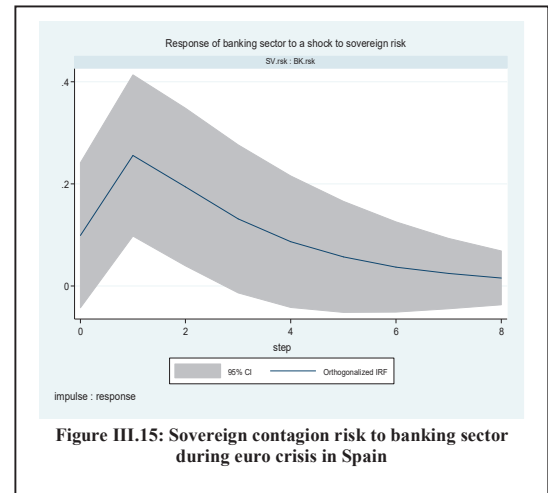
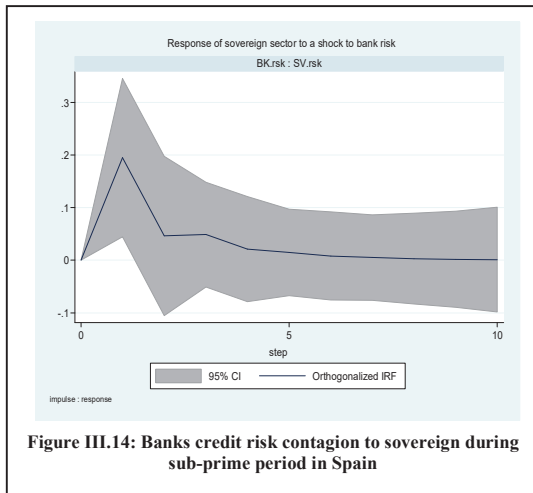
Nevertheless, the effect dissipates speedily ( $t \leq 2$ ) and work its way out of the system. In addition, as a consequence during the euro crisis episode, the build-up of financial uncertainty in the Spanish public sector contagiously transmits the increased sovereign credit risk to the respective banking

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<sup>215</sup> The respective granger causality and variance decomposition results are reported in tables (C.13 & C.14), Appendix (C).

<sup>216</sup> Minder, 2012 (Online at: [http://www.nytimes.com/2012/05/26/business/global/spanish-lender-seeks-state-aid-ratings-cut-on-5-banks.html?\\_r=0](http://www.nytimes.com/2012/05/26/business/global/spanish-lender-seeks-state-aid-ratings-cut-on-5-banks.html?_r=0))

sector which in turn provides evidence regarding the materialization of private-to-public risk transformation (figures III.15 and III.16).



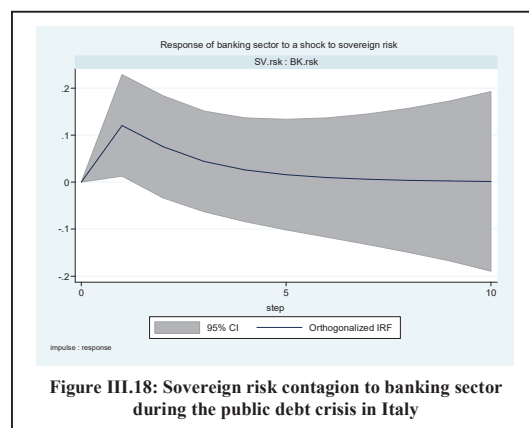
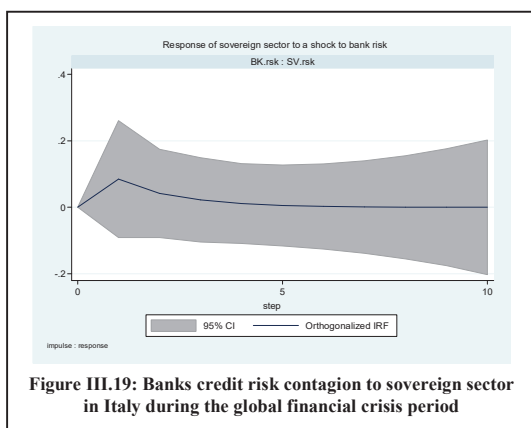
Note: The solid lines in figures above show the IR functions of the sovereign-bank-firm nexus during both the crisis episodes in Spain. Figure (III.14) shows the banking sector contagion effect to the sovereign during the great recession period. Whereas, figure (III.15) depicts a severe contagion from the sovereign credit risk to banks and, figure (III.16) presents a causal contagious effect to the public sector from banks during the sovereign debt crisis period. In addition, figure (III.17) depicts a moderate credit risk effect from the real sector to banks in the euro crisis episode. The highlighted areas in all of the figures show two-standard error bands. The forecast horizons are in quarters. In addition, BK.rsk, SV.rsk and FM.rsk represent banks, sovereign and firms credit risk, respectively. The sample time period for the sub-prime crisis spans from 2007QIV-2009QIV and for the euro crisis from 2010-QI till 2012-QIV.

Furthermore, in figure (III.16), there is an immediate causal credit risk contagion from banks to the Spanish sovereign sector. Notwithstanding, the responsiveness of the public sector solvency risk to an unexpected shock to the banking sector credit risk is contemporaneous in nature but it becomes insignificant quite rapidly. Hence, these results report the presence of default risk loop which is contagious by nature among the sovereign-bank sectors in Spain (for two quarters) especially during the euro crisis period.

On the contrary, there is also a testament of the real sector's credit risk spillover to banks but it fades away very quickly and becomes insignificant (figure III.17). That is the spike was very short

lived ( $t \leq 1$ ) and the shock effect from the real sector's solvency risk in the pricing of banks risk, on average, eased out significantly in the first quarter in Spain during the euro crisis period. In addition, the corresponding vector autoregression estimation results are reported in table (C.12), Appendix (C).<sup>217</sup> Thus, Spain is one of the prime examples of the private to public transformation of credit risk contagion from banks to the sovereign sector during the recent crisis episodes.<sup>218</sup> In turn, the findings in this section substantiate the results reported in section (4.2) of this chapter which indicates that actually the default risk contagion among the sovereign-bank-firm nexus is time varying in nature and is subject to the excess spillover order which is dependent upon the type of sector from where the crisis emerged. Furthermore, the results in table (C.12), Appendix (C), validate the presence of horizontal systemic risk with-in sector and the vertical systemic contagion risk of default among sectors in the context of Spain during the great recession and the public debt crisis periods.

Keeping the above findings in mind, *Italy* also reports more or less similar results. During the great recession period the banking sector's credit risk increases its sovereign sector risk of default, but is not significant (figure III.18). On the contrary, figure (III.19) depicts the unexpected shock to the creditworthiness of the Italian sovereign that is contagion towards its banking sector during the public debt crisis period. It can be observed in figure (III.19) that the respective contagion affects only in short-run ( $t \leq 2$ ) and work its way out of the system very rapidly and becomes insignificant. Moreover, these results are in line with the related literature which outlines that banks in Italy had suffered little due to the US sub-prime crisis (Di Quirico, 2010).



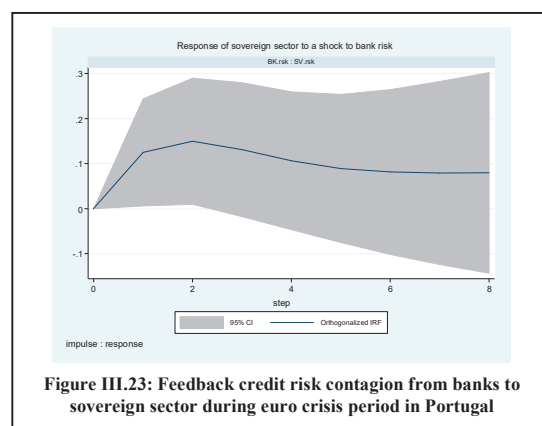
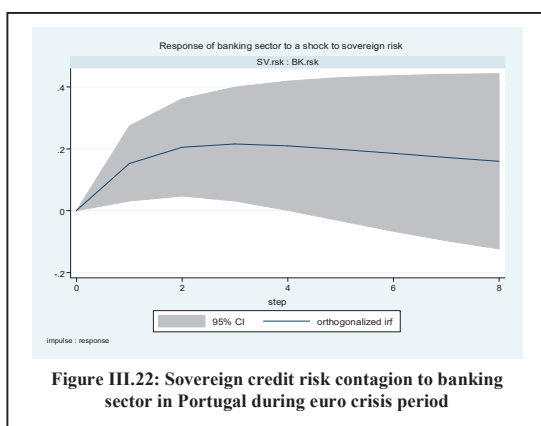
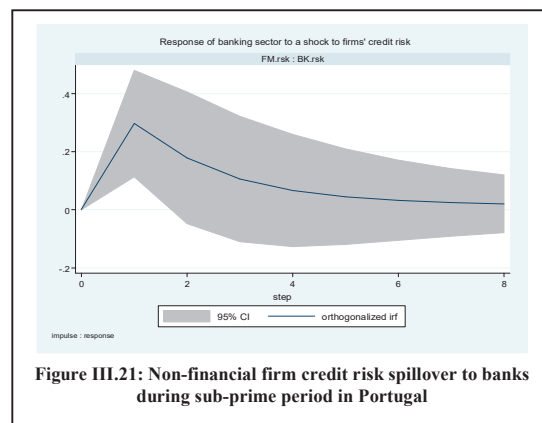
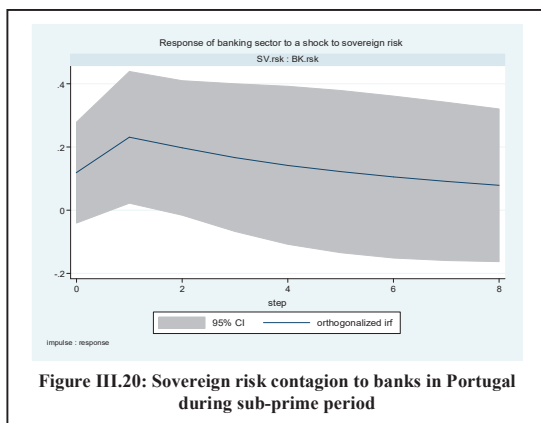
Note: The solid lines in figures above show statistically significant IR functions of the sovereign-bank nexus in Italy. Figure (III.18) depicts the contagion risk from banks credit risk to the sovereign sector during the great recession period. Whereas, figure (III.19) shows the sovereign solvency contagion risk towards the banking sector during the euro crisis period. The highlighted areas in above figures represent two-standard error bands and forecast horizons are in quarters. Moreover, BK.rsk and SV.rsk show bank and sovereign credit risk, respectively. The sample time period for the sub-prime crisis spans from 2007QIV-2009QIV and for the euro crisis from 2010-QI till 2012-QIV.

<sup>217</sup> For the reason of brevity, from now onwards we only report the IR graphs of statistically significant results and corresponding (panel) vector autoregression estimation tables.

<sup>218</sup> The result becomes clear after observing the granger causality outcome reported in table (C.13), Appendix (C).

However, the collapse of Lehman brothers in September 2008 leads to the abrupt increase in the counter-party risk in the Italian interbank loan market that spurs-up its cost. As a consequence, the higher illiquidity and uncertainty in the domestic financial market urges the Italian government to provide support in order to ease out the turbulent situation but this effect was not contagiously transferred to its sovereign sector.

On the other hand, the impulse-response functions estimated on the VAR results for *Portugal* report mix trends. In contrast to Greece, Spain and Italy, during the great recession period the credit risk contagion in Portugal is from the sovereign to banks (figure III.20). In addition, there is also a presence of the default risk spillover from the real sector to banks during the GFC period (figure III.21). These results mainly support the findings of Claeys and Vasicek (2014). More specifically, our results validate that the contagion in Portugal during the turbulent periods is due to the high level of public debt and budget deficits with diminishing economic growth which in turn becomes basis for the request of financial assistance from the Portuguese sovereign to troika in May, 2011 (figures, III.22 and III.23).



Note: In above graphs the solid lines represent the IR functions that are significantly different from zero for the sovereign-bank-firm credit risk in Portugal. Figures (III.20) and (III.21) show the default risk contagion from the sovereign and real sectors to banks during the sub-prime period, whereas figures (III.22) and (III.23) depict the presence of credit risk contagion loop between the sovereign and its banking sector during the euro crisis period. The highlighted areas in above figures represent two-standard error bands and the forecast horizons are in quarters. Moreover, BK.rsk, SV.rsk and FM.rsk show bank, sovereign and firms credit risk, respectively. The sample time period for the sub-prime crisis spans from 2007QIV-2009QIV and for the euro crisis from 2010-Q1 till 2012-QIV.

Besides, in the figure (III.21), we can discern that the default contagion risk from the real sector to respective banks dies away quickly ( $t \leq 2$ ) and the effect becomes insignificant during the sub-prime period. Whereas, the contagion risk from the sovereign sector is persistent towards banks during the euro crisis period (figure III.22). In addition, the deterioration in government's credit rating and the increased uncertainty among investors' in capital markets regarding the Portuguese sovereign's ability to service its public debt leads to the reduction in value of its sovereign debt securities. In this respect, the domestic banking sector that held these securities on their asset side adversely impacted which in turn deteriorated its liquidity position and hence led to reduce the overall balance sheet strength (Battistini et al., 2014).

Nevertheless, like Greece, in Portugal the main factor of recent distress in economic condition is due to the aggregate fiscal imbalance problem. Particularly, the public debt stock builds up over time to such pernicious levels that when investors' in international capital markets started to distinguish the sovereign competitiveness among the euro area member states due to the shock from the GFC, the Portuguese government's (and financial sector) ability to obtain funds from the capital market deteriorates. As a consequence, with the disappearance of fiscal space and the distressed banking sector, the Portuguese sovereign applied for a bail-out program.

Moreover, taking into consideration the figures (III.20 to III.23), our results partially validate the hypotheses outlined in section (2.1) regarding the presence of the probability of default spillover from the real sector to the sovereign through the financial contagion. In this context, these findings also substantiate that the abrupt increase in the CDS premia among the sovereign-bank-firm nexus is principally due to the presence of contagion risk from the loss of investors' confidence in Portuguese government ability to cope up with its public debt problem.<sup>219</sup>

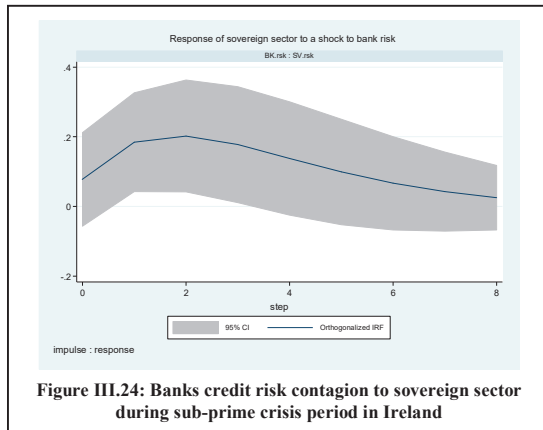
On the other hand, in the case of *Ireland* our results only provide the evidence of contagion risk from banks to the respective sovereign, irrespective of the different crisis periods. The corresponding impact multipliers in figures (III.24 and III.25) enable us to assess the systemic effect of an unexpected shock to the CDS premia of banking sector on the Irish sovereign during sub-prime and public debt crisis episodes. In both figures, we can observe that the innovations from banking sector's credit risk immediately impacts the sovereign CDS premium in Ireland. Albeit, the deviations are of contemporaneous nature in the government sector's solvency risk due to the shock in the banking spread but this effect is clearly stronger in the euro crisis period.

This result is quite peculiar to observe because we do not find the private to public transformation of contagion risk from the Irish banking sector towards its sovereign even after it rescued the

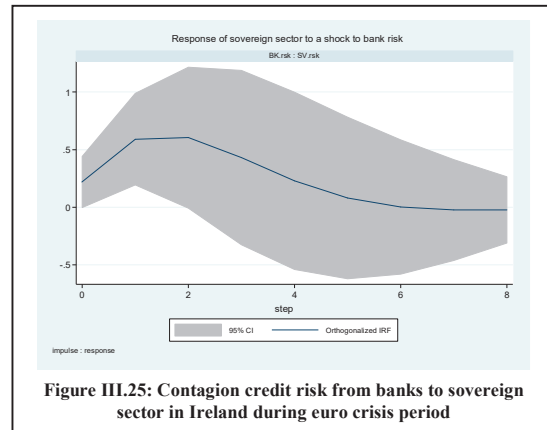
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<sup>219</sup> In the context of euro area, Giordano et al. (2013) also report similar findings.

distressed domestic banks (Alter and Schüler, 2012). In other words, the cost of bank's bail-out on the public balance sheet affected adversely which increases the Irish budget deficit to 32% of GDP in September 2010 (Baimbridge and Whyman, 2015). However, our credit risk contagion measures did not find statistically significant effect from the public sector to other sectors during the euro crisis period in Ireland.



**Figure III.24: Banks credit risk contagion to sovereign sector during sub-prime crisis period in Ireland**



**Figure III.25: Contagion credit risk from banks to sovereign sector in Ireland during euro crisis period**

Note: Presence of default risk contagion from the Irish banking sector to its sovereign sector during the global financial crisis and the euro crisis periods. In above graphs, the solid lines represent the IR functions that are significantly different from zero for the sovereign-bank credit risk in Ireland. For more details, please refer to previous figures.

Nevertheless, the deviation in the response of public sector becomes higher due to a shock in banks credit risk during the euro crisis episode which may outlines the indication of increased distress in the Irish sovereign sector (i.e. the reduction in its fiscal space) that leads to its request of the rescue package in the month of November 2010.<sup>220</sup>

#### 4.2.2 Core countries

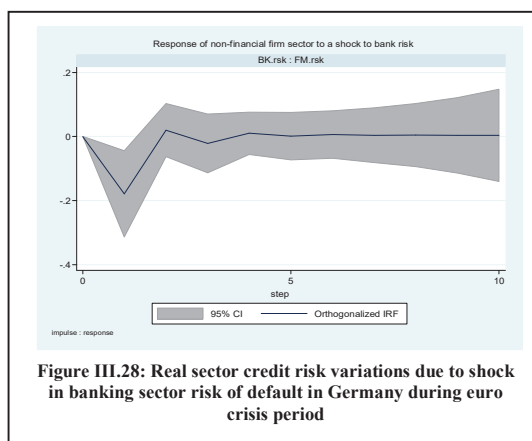
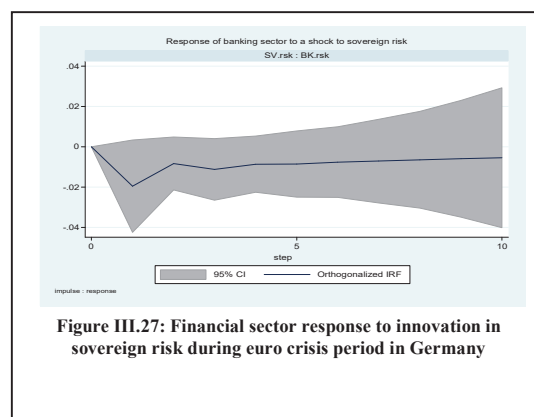
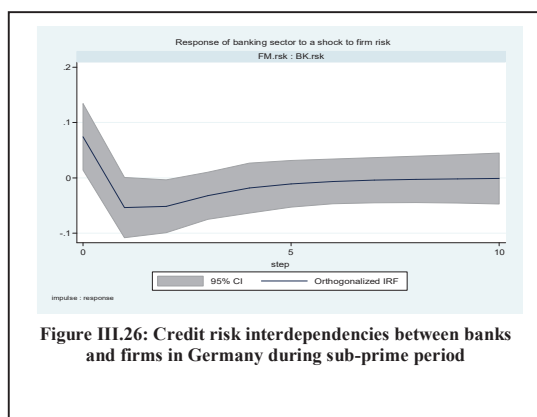
In this section, we analyze the credit risk contagion dynamics among the sovereign-bank-firm nexus during the recent crisis episodes in the core euro area member states. As mentioned in section (3), we mainly focus on Germany and France as selected core countries.

Taking the case of *Germany*, the impulse-response functions generated on VAR estimates of the focused sector's default risk that are statistically different from zero are reported in figures (III.26), (III.27) and (III.28) for the GFC and the euro crisis periods. The results of contagion risk of default between sovereign, bank and non-financial firm sectors in German economy are quite intriguing. In fact, we did not find the presence of credit risk contagion among the focused sectors in Germany, mainly indicating the absence of fear regarding its financial, public and real sectors meltdown in the

<sup>220</sup> See: Baimbridge and Whyman (2015), pg. xiv

respective debt markets. However, we interpret these results as the disintegration of credit risk among the domestic economic sectors that are subject to time-variations in Germany.

In particular, from figures (III.26, III.27 and III.28) we can clearly discern the presence of disintermediation and diversification between the sovereign, bank and non-financial firms credit risk dynamics in the context of Germany, irrespective of the different crisis periods. Specifically, in figures (III.26) and (III.28) there is a lucid effect of disintegration among German banks and corporates during the great recession and euro crisis periods. In turn, these results enable us to interpret that the firms in Germany to fulfill their financing needs are not dependent only on the respective banking sector but also play an active role in the capital markets (may be through the issuance of bonds) even in the turbulent times.



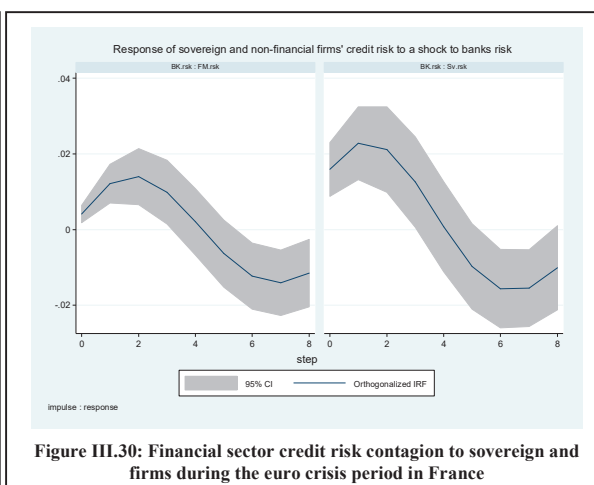
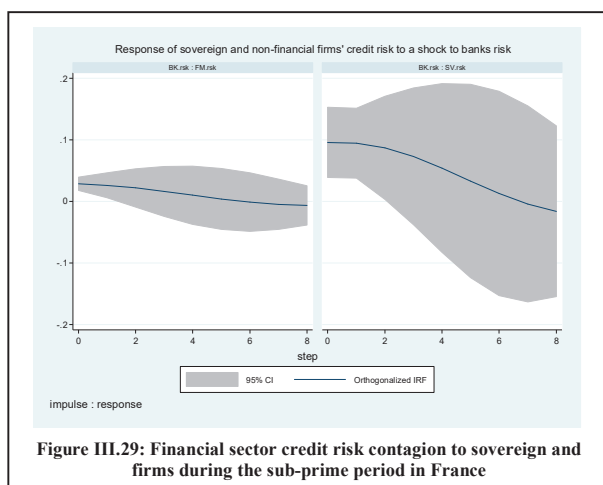
Note: The above figures depict presence of credit risk interdependencies among the sovereign, banks and firms in Germany during the recent crises. The solid lines in all figures represent the orthogonal response due to one standard deviation shock in the impulse variable. The highlighted areas in above figures represent two-standard error bands and the forecast horizons are in quarters. Moreover, BK.rsk, SV.rsk and FM.rsk show bank, sovereign and non-financial firms credit risk, respectively. The sample time period for the sub-prime crisis spans from 2007QIV-2009QIV and for the euro crisis from 2010-QI till 2012-QIV.

As a consequence, the increase in funding costs or the reduction in the volume of loans by banks (due to turbulent financial periods) does not perniciously intimidate non-financial firms and simultaneously the potential higher rate of corporate default does not threaten banks liquidity



conditions in the context of German economy (Artus, 2013).<sup>221</sup> Furthermore, in figure (III.27), even though the impulse response function is not significant we interpret this result as the banking sector in Germany concentrates on holding the governments bond portfolio as diversified as possible which results in the disintegration of bank risk and the German sovereign risk (D’Auria et al., 2014). In contrast, the credit risk dynamics among the sovereign-bank-firm nexus in France portrays quite a unique picture more or less related to the results found in the context of GIPSI countries.

In this context, we mainly report the impact multipliers generated on the VAR estimation results that are significantly different from zero during the recent crisis periods in *France*. Figures (III.29 and III.30) outline the contagion effect from the French financial sector towards its sovereign and real sectors during sub-prime and euro crisis periods, respectively. It is interesting to observe that irrespective of the crisis period, the contagious effect is from the financial sector. Specifically, there is an immediate shock effect from banks credit risk towards sovereign and real sectors, while the public sector receiving higher magnitude, in particular. Whereas, this excessive spillover effect in the French economy fades out quickly, that is, in the second quarter after the shock from its bank’s credit risk.



Note: The response of sovereign and real sectors to a shock to banks credit risk in France during recent crisis periods. The solid lines represent the IR functions estimated from the focused three-variable vector autoregression (VAR) with identification through the Cholesky decomposition of one standard deviation. The highlighted area in figures show two-standard error bands. The forecast horizons are in quarters. Whereas: SV.Rsk, BK.rsk and FM.rsk show sovereign, bank and firms credit risk, respectively. The sample time period spans from 2007-QIV to 2009Qiv and 2010-QI to 2012-QIV, for the sub-prime and public debt crises, respectively.

On the other hand, in the euro crisis period, the effect lasts a bit longer, that is, till the third quarter but its magnitude is quite on the lower side as compared to the sub-prime crisis period. In fact, these

<sup>221</sup> Online at <http://cib.natixis.com/research/economic/publications.aspx?lang=fr>

results substantiate that the French financial sector acted as an intermediary between euro area debtors (especially the peripheral ones) and creditors outside the euro zone. Therefore, during the sub-prime crisis, capital flows into the French economy were diverted towards the peripheral countries in order to receive higher returns. As a consequence, French financial sector's exposure to these EMU member states (especially; Spain, Greece and Italy) increases that led the investors' in the capital markets to reduce their investment exposure in the French government securities.

Consequently, during the euro crisis period, French financial sector reduces its exposure to peripheral states that result in immediate reduction in the magnitude of contagious transfer of credit risk towards its sovereign sector. As, it reduces the higher probability of bail-out of French financial sector from its respective sovereign (Hobza and Zeugner, 2014). Even though, our results clearly outline the contagious effect from the financial to sovereign sector in France, the investors' in international capital markets did not treat French sovereign credit risk at par with the G-IPSI countries, may be due to its sustainable fiscal balances and the increased investment from German investors during recent crisis periods. In turn, the core euro area results clearly show divide among countries (in our case between the German and the French economies) according to the corresponding debt markets that systemically assess the level of fiscal and current account balances in relation to financial distress, especially during the euro crisis period. Hence, this result indicates that for the euro area, the financial markets are able to discern between the diverse set of public borrowers (Caporale and Girardi, 2013).

#### 4.2.3 Sum-up

In sections (4.2.1 and 4.2.2) we try to substantiate the results outlined in section (4.1) by evaluating the credit risk dynamics among the sovereign-bank-firm nexus on the selected individual peripheral and core member states in the euro zone during recent crisis episodes. The findings in these sections partially validate the results established in the context of aggregate euro zone. For instance, not every member state especially in the peripheral area reports that the credit risk contagion is time-varying among sectors and time-invariant with-in sector (except, Spain) during the sample period in the euro zone. In addition, the presence of contagion risk (directly and indirectly) from the real sector to respective sovereign during the focused crisis episodes in the euro area is only found to be indirectly present through the financial contagion especially in the cases of Spain and Portugal.

Furthermore, the effect of credit risk contagion from the private to public sector and the evidence of default risk feedback loop are also present but only in few economies.<sup>222</sup> On the contrary, we are

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<sup>222</sup> Mainly in Spain and Portugal

not able to support the findings of the carry-trade behavior from banks during the recent crisis period in the euro zone as outlined in section (4.1). In a similar vein, the selected individual euro area member states lack to validate the direct credit risk contagion effect from the real sector to the respective sovereign, irrespective of the crisis episode. On a different note, the core euro area countries report mixed results. Interestingly, we did not find the evidence of contagion risk of default between focused sectors in the core area countries during the sample period (especially in the case of Germany). Albeit, in the case of France, we do report the presence of financial sector credit risk contagious effect to sovereign and corporates, irrespective of the crisis period.

These findings enable us to infer that it is not necessary that the nature of crisis remains time-variant during the turbulent periods (for instance: the banking crisis transforming into the public debt crisis in subsequent periods). Nevertheless, it is also not reasonable to assume that the nature of crisis remains sector invariant during a specified time period as a number of recent empirical studies (see: Popov and van Horen, 2013 and Harjes, 2011 among others) outline that since 2010 in the euro zone, the nature of turbulence is only related to the fiscal imbalances. For instance, it basically means that during a specified time period there may be emergence of different types of crisis like banking or fiscal or even currency crises.<sup>223</sup> On the other hand, there may be a crisis trigger from another integrated sector and not from the perceived distressed sector, as shown in the cases of Ireland and France. Therefore, the heterogeneity among the structural and economic system of individual member states in the euro zone should ideally be kept in mind while formulating a policy mix on the aggregate EMU basis. Moreover, this finding proactively provides support in taking the corrective measures against alleviating the distress in the respective debt markets.

### **4.3 Is there an evidence of inter-country default risk contagion in the euro zone?**

In this section, we mainly evaluate whether a shock to country's credit risk premium contagiously affects sovereign-bank-firm nexus in the rest of euro zone, especially during the euro crisis period. To represent the peripheral and core regions, we mainly focus on analyzing the presence of credit risk contagion from Greece and Germany to the rest of euro zone during the sovereign debt crisis period in respective debt markets.<sup>224</sup>

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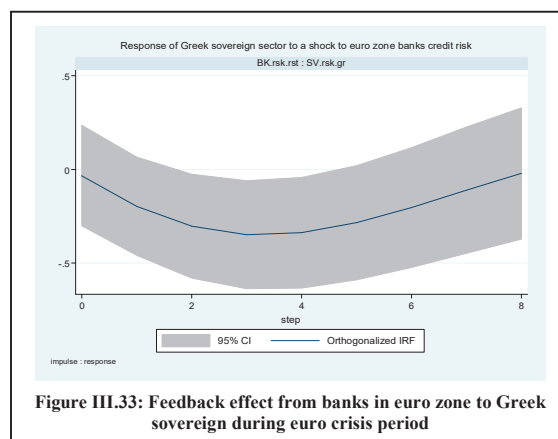
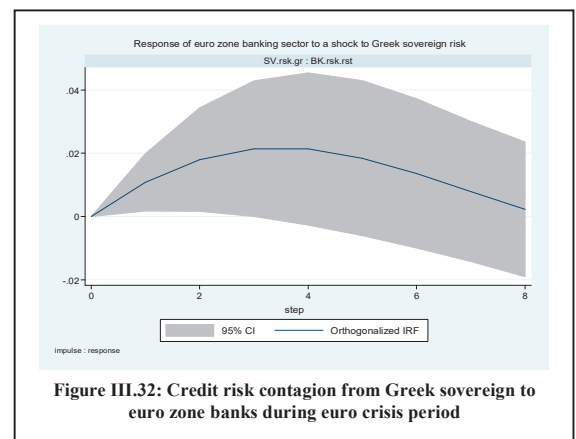
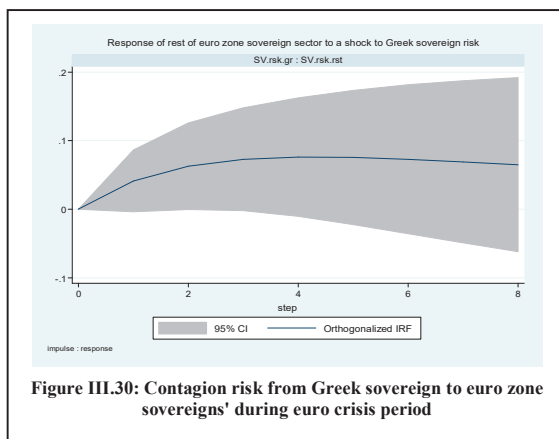
<sup>223</sup> In this respect, the currency crisis is not relevant in the case of euro region. However, it may become relevant only in the case of break-up of the euro zone.

<sup>224</sup> We briefly mention the results related to the IPSI and France while evaluating Greece and Germany in detail.

#### 4.3.1 Default risk contagion from the Greek sovereign to euro zone's sovereign-bank-firm nexus

In this respect, table (C.15) Appendix (C), reports the estimation results regarding the credit risk contagion from the Greek sovereign towards the rest of euro zone's sovereign-bank-firm nexus in the recent crisis periods. However, for analysis we mainly focus on the impulse-response functions generated on the vector autoregression estimation results during the sovereign debt crisis period.

In particular, figures (III.31), (III.32) and (III.33) outline the responses of the rest of euro zone sovereign-bank-firm credit risk against a one standard deviation shock to Greek's sovereign CDS spread especially in the public debt crisis period. As a consequence, the reported impulse-response functions gauge the effect of a change in Greek sovereign risk premium on other euro area states enabling us to examine the presence of credit risk contagion from a selected peripheral country to the remaining EMU members during the euro crisis period.



Note: The solid lines in above graphs show the IR functions of Greek sovereign towards the rest of euro zone's sovereign and banks during the public debt crisis period. The highlighted area in figures shows two-standard error bands. The forecast horizons are in quarters. In addition, figure (III.31) shows default risk contagion from the Greek public sector towards the remaining euro zone member states which is not significant. Figure (III.32) depicts the presence of increase in uncertainty in the euro zone's banks due to the innovations to sovereign risk in Greece, whereas; figure (III.33) portrays the response of Greek sovereign to the innovations in the euro zone banking sector. Whereas: *SV.rsk.gr*, *SV.rsk.rst* and *BK.rsk.rst* represent Greek sovereign risk, the rest of euro zone's sovereign and bank risk, respectively. The sample time period spans from 2010-Q1 to 2012-QIV.

The graphs below show the IR functions of statistically significant results reported in table (C.15), Appendix (C). In particular, figure (III.31) depicts that risk from the Greek sovereign's inability to service its outstanding public debt increases the respective uncertainty among the remaining public sectors in the euro area. Moreover, this effect of impulse response function is not significant.

On the other hand, in figure (III.32), we can observe the contagious effect from the Greek sovereign to the rest of euro zone banking sector during the public debt crisis period. In particular, the response of banking sector's CDS spread in the EMU to a one standard deviation shock to the sovereign sector default risk in Greece shows an abrupt impact with almost resolute influence. The IR function in figure (III.32) indicates the intricate credit risk dynamics present in respective debt markets in the euro area. Furthermore, it shows the serious contagious effect to the euro area financial system from the Greek sovereign due to the reduction in value of its government bonds as a consequence to a downgrade in respective credit ratings.

In turn, banks in the euro zone were hard-hit by this sovereign default event which affected their total balance sheet value. Subsequently, the ECB conducted the stress tests on 91 EU financial institutions which revealed that seven banks failed to preserve the adequate capital amount required by the regulators (ECB, 2010).<sup>225</sup> Therefore as a corrective measure, the euro zone finance ministers set-up a bail-out program with € 500bn as the European Stability Mechanism (ESM).<sup>226</sup> Hence, it can be perceived that the contagion risk from the government debt markets to the bank becomes quite significant in the euro zone during the sovereign debt crisis period.

Nevertheless, quite an engaging outcome is reported in figure (III.33). Particularly, figure (III.33) shows that as there is an increase in the risk of default in the financial system of euro zone, the sovereign CDS premium of Greece goes down during the euro crisis period. Although, the result is statistically significant after the second quarter till the fifth, it is not considered as a contagion effect as mentioned in section (3.1.1). Despite that fact, we interpret it as an indication that with a bail-out package the Greek sovereign was able to turn-over its outstanding public debt through the financial assistance framework of the euro zone banking system operated mainly by the ECB and the bail-in effect of the private investors.<sup>227</sup> On the one hand, in general, it increases the concerns regarding the financial system solvency in the euro area and on the other hand, it starts to ease the fiscal imbalance situation in Greece with its government simultaneously implementing the austerity measures (Featherstone, 2011). Hence, there is a presence of public-to-private transmission of credit

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<sup>225</sup> Financial Stability Review (December, 2010), available at <http://www.ecb.europa.eu/pub/fsr/shared/pdf/ivafinancialstabilityreview201012en.pdf?d80416324a10f3cb4149e717e226311e>

<sup>226</sup> <http://www.esm.europa.eu/>

<sup>227</sup> Along with financial assistance from IMF

risk contagion from the innovations in Greek sovereign towards the rest of euro zone. Furthermore, there is no effect towards the real sectors of EMU countries leading to indicate the close integration of public and financial debt markets especially during the euro crisis period (table (C.15), Appendix C).<sup>228</sup>

Therefore, our results portray more clear and quantified channel of transmission of Greek sovereign credit risk towards the rest of euro zone. In contrast to the existing studies (see: Missio and Watzka, 2011 and Aizenman et al. 2013, among others) that mainly evaluate only sovereign-sovereign nexus report that with the increase in the default risk of Greek sovereign the credit risk increases among the rest of euro zone member states. However, these studies lack to identify the spillover channel. In this respect, our results help to better understand the excessive spillover effect because we manifest that in fact the contagion effect from Greece towards the euro area is through its financial sector that heavily invested in Greek sovereign bonds to satisfy their risk appetite. Consequently, with the Greek default event and subsequent reduction in its sovereign credit rating leads to the lowering of these asset value for the euro zone financial sector. As a result, the distress in euro area's financial sector increases that generate higher probability of bail-outs from respective sovereigns. This effect, in turn, transfers the increased distress in financial sector to respective sovereigns in the rest of euro zone.

Moreover, Portugal and Spain exhibits similar results, whereas, in the case of Italy we do not find the credit risk contagion from its sovereign sector to the rest of euro zone but instead the reverse contagious effect is reported. On the other hand, the Irish financial system reveals a severe contagious effect not only to the euro zone's sovereign but also to the banking sector substantiating our hypothesis that the order of credit risk contagion is not necessarily time-varying in nature. In addition, our results also validate that the credit risk contagion plays an important role in the overall volatility of sovereign yield differentials (i.e. the CDS spread) in the euro zone member states especially during the recent crisis period.

#### 4.3.2 Shock to Germany's risk premium and relative response of euro area's sovereign-bank-firm nexus

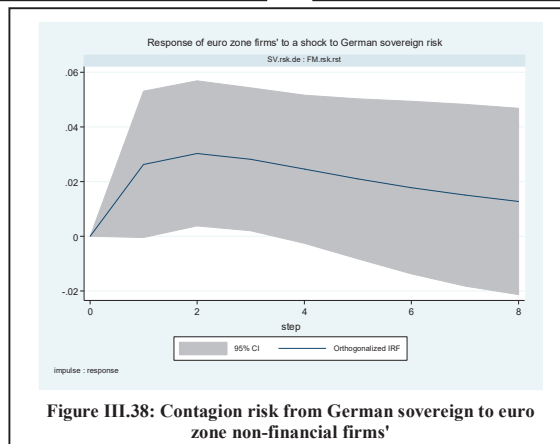
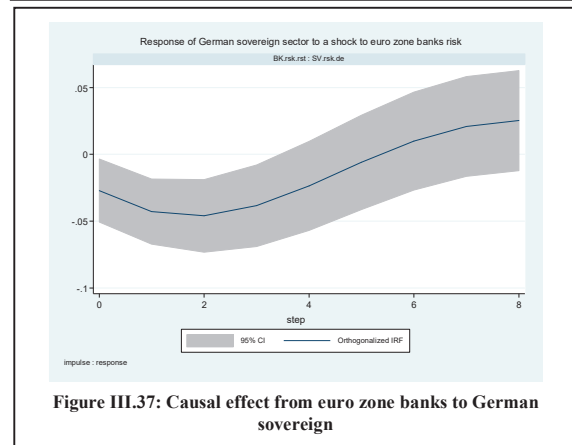
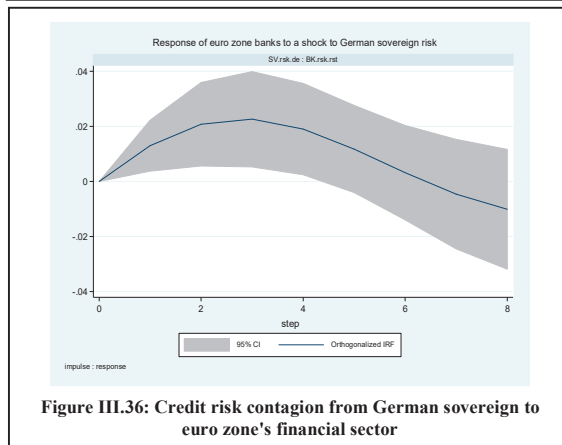
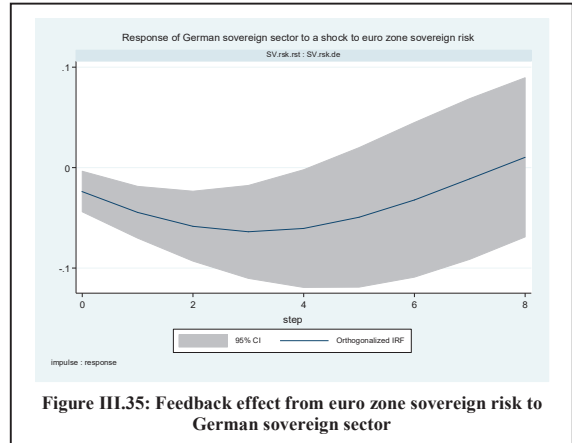
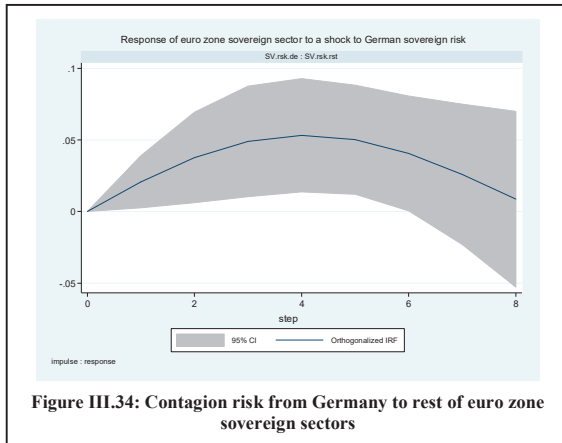
In this section, we attempt to evaluate our hypothesis outlined in sections (2.2 & 2.3) regarding to investigate how the monetary union will react if we induce a positive shock to the sovereign risk of default to its strongest and financially secure member state (that is: Germany).<sup>229</sup> In this respect, table (C.16) Appendix (C), reports the estimation results of credit risk contagion from the German

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<sup>228</sup> De Santis (2012) also reports the similar results.

<sup>229</sup> Although, we did not find the presence of credit risk contagion among sovereign-bank-firm nexus with-in Germany during the recent crisis period

sovereign to the remaining euro area sovereign-bank-firm nexus during the euro crisis period. The presence of contagion risk is evident among the sectors indicating the horizontal systemic risk of default in the respective debt markets in all panels in table (C.16). On the other hand, in all panels, it is quite interesting to observe the presence of contagion credit risk from the German sovereign to the euro zone's sovereigns, banks and firms. These engaging scenarios are portrayed in the IR functions generated from a shock (i.e. one standard deviation) originated by the safest EMU economy that is Germany, to the rest of euro zone.



Note: The solid lines in above graphs show the IR functions of a shock in the German sovereign towards the remaining euro zone's sovereign-bank-firm nexus during the recent crisis period. The highlighted area in figures shows two-standard error bands. The forecast horizons are in quarters. Figures (III.33) and (III.34) depict the credit risk dynamics between the sovereign sectors of Germany and the rest of euro zone, whereas, figures (III.35) and (III.36) portray the default risk contagion among the German sovereign and the euro zone's financial sector. In addition, figure (III.37) shows the contagion risk from German sovereign solvency to the euro zone's non-financial corporate sector. Moreover: *SV.rsk.de*, *SV.rsk.rst*, *BK.rsk.rst* and *FM.rsk.rst* represent German sovereign risk, the rest of euro zone's sovereign, bank and firms credit risk, respectively. The sample time period spans from 2010-Q1 to 2012-QIV

The above graphs depict IR functions of the results reported in table (C.16), Appendix (C) that are significantly different from zero. In this respect, figure (III.34) outlines that a shock to the German sovereign CDS spread contagiously affects the risk premia of the rest of EMU countries and increase a general fear of public default in the euro area debt markets. Specifically, it indicates that in capital markets as investors lose their fascination with German sovereign securities as a safe haven instrument than in turn, it adversely hits the probability of default of other sovereigns in the euro zone. However, in figure (III.34) we can observe that this response effect is persistent in nature and remains significant till the sixth quarter after the shock among respective debt markets in the euro zone. In addition, the consequent result after the shock peaks in the fourth quarter and take a while to dissipate from the CDS market of euro area countries.

On the contrary, figure (III.35) shows the feedback effect from a shock of other euro area sovereign's credit risk to the government sector in Germany. Interestingly, the trend here is entirely antithetical in nature indicating the phenomenon of "flight-to-quality" or "flight-to-safety" in corresponding debt markets in the EMU. In particular, with a rise in the general risk premium of the remaining sovereigns in the euro area, investors immediately seek refuge in the German sovereign securities mainly searching for safe returns on their investments. However, the shock to Germany's risk premium generates a larger and slightly more resolute effect on other member countries sovereign risk of default in the euro region.

Furthermore, the credit risk dynamics among the sovereign credit risk of Germany and the euro zone's financial system reports the isomorphic trend with that of sovereign solvency risk. In particular, figure (III.36) shows the evidence of contagion risk from a decrease in the value of German bunds towards the default risk of banks in the EMU. This result suggests that the financial system in the rest of euro area prefers exposure to the German sovereign debt and is going to be adversely affected (approximately after one year) if Germany loses some of its appeal as a safe haven for investment. On the other hand, figure (III.37) outlines that as the euro area banking sectors' CDS premia increases there is resulting decrease in the sovereign CDS spread of Germany. Basically, this indicates a potential trend of disintegration among banks of the rest of euro zone with the German sovereign solvency risk (Artus, 2013).<sup>230</sup> In other words, the investors in the sovereign CDS market do not consider the general increase in the risk premium of the financial system in the euro zone (other than Germany) as a threat as compared to the ability of German's sovereign to service its outstanding public debt. In turn, it increases the liquidity towards German government bonds in the respective debt markets. However, both these simulation effects (figures (III.36) and

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<sup>230</sup> Online at <http://cib.natixis.com/research/economic/publications.aspx?lang=fr>



(III.37)) take less time to fade away than the potential contagion among sovereign sectors of Germany and the rest of euro zone.

Moreover, it is quite engaging to discern that in figure (III.38) we have the evidence of contagion risk from German sovereign sector to the rest of EMU corporates. This finding provides a significant testament of the presence of contagion risk that may be through the trade effect. In particular, a shock to the sovereign risk premium of Germany adversely affects the non-financial firm's bottom line and increases their risk of default in the remaining euro zone during recent crisis period. In other words, it indicates the lower demand for goods and services from German consumers that negatively transmits to the corporates in the rest of euro zone which significantly depend on their exports to Germany. Thus, it shows the higher intensity of trade linkage between Germany and other euro area member states (Elekdag and Muir, 2014).

Hence, largely these simulations validate our hypothesis mentioned in section (2.3) that the contagious effect to other euro area countries would be higher if there is an abrupt increase in the sovereign risk premium of a financially strong country on which a monetary union principally rests. In turn, it leads to engender rise in the general risk perception of break-up of the EMU during the distressed time period that raises the CDS spread in all the corresponding debt markets (i.e. sovereign-bank-firms).

#### 4.3.3 Sum-up

Taking into consideration the results in section (4.3.1) and (4.3.2), we show that there is a presence of credit risk contagion from peripheral countries (in our case from Greece) towards the remaining euro area member states during the sovereign debt crisis period. However, the credit risk transmission channel is not directly from sovereign-sovereign as suggested in the contemporary literature. But, rather we find that the proper path is from Greek sovereign towards euro zone's financial sector and then the increase in the probability of default of respective sovereign in the CDS markets. Therefore, in the light of these results we report that during the recent debt crisis period there is not only the evidence of a fiscal crisis but also of a banking crisis, that is, the different types of financial crises were present according to the economic and financial structure of the individual economies within the euro area member states. Hence, the order of systemic contagion risk depends upon the underlying fragility in the distressed sector that excessively spillovers to others which is not necessarily time-varying in nature (for example, during the euro crisis period: contagion is present from the Greek sovereign credit risk to the rest of euro area

countries financial sector that generates ripple contagious effect towards its respective sovereign among rest of euro area member states).

On the other hand, similar results are reported in the context of core countries (for instance: in the case of Germany). Furthermore, the findings also account for the increased liquidity towards the euro area core members (i.e. Germany) which are financially and fiscally stable as compared to others leading to the materialization of a market sentiment that investors' search for quality in turbulent times among the respective CDS markets.

## **5 Conclusion**

The commencement of the recent economic crisis provides a renewed impetus to the forgotten phenomenon of contagion among the financial markets. In this respect, the increased interaction of the credit risk in respective debt markets that generated an adverse feedback loop of default among the sovereign-bank nexus in the context of euro zone comes to the forefront for the regulators and policy makers especially during the recent euro crisis period. In turn, it draws attention of the academics and the researchers that resulted in an abundance of empirical studies on the issue. However, it is not unreasonable to say that the related literature lacks to cater comprehensively the credit risk dynamics and fundamentally focus only on the sovereign-bank nexus in the context of EMU. Taking into consideration the policy recommendations outlined in Alter and Beyer (2014), the current chapter extends the empirical knowledge by focusing on the cross market credit risk dynamics of sovereign-bank-firm nexus in the euro zone. The study not only contributes to better understand the consequences of the euro crisis to the real sector but also provides the economic application of how the contagion risk plays an important role in the volatility of CDS spread among the corresponding debt markets.

Therefore, in this chapter we use the panel vector autoregressive framework to distinguish the importance of credit risk contagion among the sovereign-bank-firm debt markets in the euro zone especially during the public debt crisis. Moreover, we attempt to furnish the harmony to the prevalent empirical debate regarding the order of contagion risk from the peripheral countries to the rest of euro area during recent crisis period. In doing so, our findings provide quite engaging results.

In the context of euro zone as a whole, we report that the contagion is systemic by nature regarding the sovereign-bank-firm credit risk which is time-invariant with-in sector and time-varying among sectors. Consequently, the private-to-public risk transfer is quite evident among the recent crisis periods. Moreover, irrespective of the crisis periods there is a higher integration between the sovereign credit market and banks against the respective non-financial firms in the euro zone, on

average. On the other hand, the contagion credit risk from the real sector to the sovereign and banks was found with the euro zone's financial system ensuing carry-trade behavior in the turbulent times. In this respect, as we make more acute analysis by taking into consideration the individual G-IPSI and the core countries in the euro area, our findings only partially validate these results.

Thus, these results enable us to infer that it is not necessary that the nature of crisis remains time invariant during the turbulent periods in a country or economic region (for instance, it is not imperative that the banking crisis transforms into any other kind of crisis in subsequent periods as assumed in the related literature). On the other hand, it is also not reasonable to assume that the nature of crisis remains sector invariant during a particular time period. As handful of studies reported that since 2010 in the euro area, the distress is mainly related to the fiscal imbalances (see: Popov and van Horen, 2013 and Harjes, 2011 among others). For instance, it basically outlines the fact that during a specific time period there may be emergence and presence of different types of crisis (like financial and or fiscal) at the same time in different member states of the monetary union. Moreover, there is evidence of the real sector credit risk contagion to the sovereign only through the respective financial contagion and no direct influence was found in the individual member states as reported in the context of euro area as whole. Furthermore, no carry-trade behavior by the financial system was validated regarding the individual G-IPSI and core countries. However, only a unidirectional sovereign risk contagion to the real sector is reported directly and through the corresponding financial contagion channel. In addition, a lucid finding of the private - to-public risk transfer is reported only in the context of Spain.

In this respect, while evaluating the presence of contagion risk from the sovereign risk premia of G-IPSI and core countries to the rest of euro area, we find quite interesting results. Specifically, during the euro crisis period, there is an evidence of contagion from the Greek sovereign risk premia to the rest of euro area bank's risk of default that eventually transforms into the sovereign crisis in the rest of euro zone. Therefore, the order of systemic contagion risk depends upon the underlying fragility in the distressed sector in a euro area country that excessively spills over to others which is not necessarily time-varying in nature. For instance, our results report the presence of fiscal and financial crises during the euro crisis period. Consequently, the contagion order depends upon the inherent weakness in the economic structure of the corresponding member states in the euro zone.

In a similar vein, simulating a shock to the German risk premium provides isomorphic results but with an indication of "flight-to-quality" phenomenon. It basically indicates the increased liquidity towards the core countries during turbulent times from the rest of euro area member states. Alternatively, this result outlines that the core country's credit risk severely affected other countries

risk premia in the euro zone without being significantly receiving the same feedback effect in return.

Thus, in the light of above results the tentative policy recommendations can be summarized as follows:

- While formulating a policy-mix for the EMU, it is prudent to take into consideration the heterogeneity that prevails among the credit risk interconnectedness of the sovereign-bank-firm nexus regarding the structural and economic system of the individual member states.
- In taking corrective measures to lessen and contain the contagion risk in the euro area, the credit risk dynamics between the significant economic sectors should be considered and attention should not be limited only to the sovereign-bank nexus.
- Finally, increased efforts should ideally be pursued by the regulators and the EU institutions towards the disintegration and disintermediation of the sovereign-bank-firm nexus to reduce the probability of credit risk contagion during turbulent times in the euro zone. This may be accomplished by encouraging corporates to diversify their funding needs towards the capital markets (as our simulation results report in the case of Germany). On the other hand, among sovereign-bank network, the disintegration may be achieved by adequately pricing the domestic and the euro zone's sovereign debt securities with the corresponding regulations on the overall exposure of local banks.



## **General Conclusion**

This thesis examines in detail and from different angles the spillover effect of the recent euro crisis between the sovereign, bank and real sectors. Particularly the current study evaluates how the recent debt crisis especially affects the real sector along with banks and the sovereign sector in the euro zone. To understand the principal upshots of the euro crisis effect on non-financial and financial firms is important not only for regulators and portfolio managers but also for policy makers to devise efficient corrective measures in order to trigger and revive economic growth in EMU.

However, in the context of the euro zone during the recent crisis period, extant empirical literature (i) deals with the sovereign risk spillover to the financial sector only, (ii) treats the identification of determinants in sovereign risk premia, (iii) is not convincing on the issue of the presence of contagion among credit risk dynamics in the euro zone, (iv) debates about the order of the risk spillover especially in the sovereign-bank nexus, (v) lacks consensus regarding the issue that the contagion risk originated from peripheral countries towards the rest of euro area member states. Therefore, the study of the realistic impact of recent sovereign crisis on the real and financial sectors has become an important issue for researchers and market practitioners alike in the context of the euro zone.

In this respect, the current dissertation offers an empirical work that not only evaluates the effects of the recent sovereign crisis on the real sector but also treats the respective financial and contagion transmission channels in the euro area member states. In particular, it strives to determine the evidence of a euro crisis spillover on the borrowing cost of non-financial private firms from foreign investors' viewpoints, and examines the efficiency of austerity measures. The thesis then identifies and gauges the potential transmission channels of sovereign distress towards the real sector especially during the recent crisis in EMU countries. In particular, we deal with the distortions in domestic loan markets as a consequence of recent turbulent times. Secondly, we extend the ongoing analysis of the spillover effect of sovereign distress to the real sector in order to evaluate the contagion channel effect in respective CDS markets due to an increase in the general fear of default among risk averse investors.

## **Issues investigated**

The research issues explored in this thesis are the following: First, we looked at the impact of the external public debt risk on the borrowing cost of private non-financial firms during the recent crisis period in the euro zone. The importance of external vs domestic and total public debt in the evolution of the sovereign risk premia during the recent crisis period is also investigated along with the prevalent creditor rights protection effect in the euro zone. Furthermore, with a significant sovereign risk spillover to the real sector, we then evaluate the efficiency of the EU austerity measures on syndicated-loan spreads of private firms to revive economic growth in the region. To test these hypotheses, we use the multivariate ordinary least square estimation method in 14 euro zone member states for the period 2005-2011.

Subsequently, we probe the potential transmission channel of this sovereign vulnerability towards non-financial firms during the euro crisis period. In addition, we provide a solution to the existing debate on crisis spillover effects in the sovereign-bank nexus. Particularly, this part of the study attempts to fill the gap by treating the government, bank and corporate nexus as a continuous structural system which is empirically impossible to truncate in order to effectively analyze the rational effects of the euro crisis episode. By doing so, we explain in detail how sovereign risk transmits to the real sector through the banks liquidity risk and the evidence regarding its respective causality. The sample includes panel data of twelve euro zone countries for the period 2005-2012. The analytical method used is the simultaneous equations model, which is estimated through the 3SLS estimation approach, because it provides robust results by not only treating the inherent endogeneity problem but by addressing the cross-equation correlation of error terms.

Finally, the main purpose in this part of the study is to extend the ongoing analysis by identifying and further furnishing evidence of contagion that acts as an additional factor of the credit risk spillover from sovereign to the real sector during the euro crisis period. In this respect, we examine the evidence of contagion among the credit risk dynamics of the sovereign-bank-firm nexus in the EMU countries. With the jump increase in CDS spreads of respective debt markets in the euro zone after the collapse of Lehman Brothers in late 2008, a symptom of credit risk contagion has come to the forefront in the academic and policy makers circle. We, therefore, focus on the contagion definition as the “excess spillover” after controlling for idiosyncratic and common fundamental factors among financial markets to evaluate its importance in the evolution of risk premia during the recent crisis episodes in the euro area. We include in the analysis the real sector effect with the sovereign-bank nexus which was overlooked by previous studies and determine realistic credit risk contagion measures while evaluating the excessive spillover effect among the said sectors and

across countries in the euro zone. The empirical analysis is based on the impulse-response functions derived from panel vector autoregression that are estimated through system-GMM method for ten countries of the euro zone for the period 2007-2012.

## Main findings

We found, first, a significant impact of external public debt on the borrowing cost of private firms in the euro zone during the sovereign debt crisis. In turn, this result suggests the significance of external public debt in the overall evolution of sovereign risk premia during recent turbulent times in the euro zone and its upshot on the real sector. Particularly, these findings shed light on the significance of total and external public debt levels against domestic debt in the increase in sovereign risk premia on the aggregate economic activity in the euro zone during the recent crisis episode. Hence, it shows the transfer of national resources mainly from distressed to healthy economies in the EMU during the sovereign debt crisis period. To that effect, the moderating influence of creditor rights protection plays an important role in the relationship between the sovereign risk spillover and non-financial loan spread. Thus, the weak creditor rights protection prevalent in member states exacerbates this effect.

However, this creditor rights protection does not carry a heavy weight and after a certain threshold its additional effect on the nexus between external public debt and the syndicated-loan spread of non-financial firms dissipates. Specifically, this result suggests that, if, as in emerging markets<sup>231</sup>, the creditor rights protection effect did exacerbate the sovereign risk spillover on non-financial firms, its significance was limited in nature during the turbulent times in the euro zone. Hence, this finding clearly differentiates between emerging markets and euro zone economies (i.e. advanced markets) with respect to the moderating effect of creditor rights protection on the sovereign-firm nexus.

Second, our findings manifest a lucid impact of the recent euro crisis on private sector loan spread by analyzing the austerity measures effect in the EMU countries. In this regard, we found the presence of a significant credibility channel i.e. international capital markets realized the fiscal consolidation efforts of the EU and started to reduce the risk premium in loan markets of non-financial private firms. Besides, there also exists an indication of aggregate demand channel during the period preceding the euro crisis but its effect was minimal in nature.

While analyzing the potential transmission channel of sovereign vulnerability towards the real sector, we found firstly, that the traditional function of commercial banks regarding the creation of

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<sup>231</sup> See: Bae and Goyal (2009)



liquidity for the corporate sector acts as a significant conduit. Particularly, the sovereign risk significantly transmits to the liquidity creation process of euro area banks and then to the real sector but in an unorthodox manner especially during the recent crisis episode. In addition, this channel of bank liquidity risk exposure conveys an adverse feedback effect to the sovereign sector, in turn generating an incessant circle of risk spillover. In this respect, the banking sector liquidity risk acts as a conduit that not only propagates sovereign uncertainty towards the non-financial corporate sector but also re-channels it back to the government sector in the euro zone. Besides, a unique impact of policy intervention of the ECB's rescue stimulus was observed when banks passed along the sovereign risk towards the corporate sector by generating liquidity but at higher interest costs during the recent turbulent times. Secondly, it is quite peculiar to observe that the non-financial sector with a higher dependence on banks in the euro zone did not re-transmit this adverse effect. This upshot suggests lower financial distress among non-financial firms in EMU countries. Finally in the analysis of the periods preceding and during the euro crisis, our findings suggest that liquidity management strategies of banks in the EMU are sensitive to the type of crisis. Indeed, before the beginning of the euro crisis, that is during the US sub-prime crisis effect on the EU's financial institutions, with the increase in sovereign risk premia, banks reduced their exposure to the liquidity risk. However, during the euro crisis period itself, banks did not reduce the exposure and tried to generate liquidity for the real sector but at very high cost indicating the impact of the stimulus package.<sup>232</sup>

With respect to determining the cross market credit risk dynamics among the sovereign-bank-firm nexus to identify the presence of a contagion risk especially during the euro crisis period, we found that: firstly, on the aggregate euro zone level, contagion is present systemically among the sovereign-bank-firm credit risk which is subject to time-invariant intra sector and time-variant inter sectors. Moreover, the behavior of the sovereign sector taking the tail risk of distressed banks is quite evident with the transformation of private debt into public debt during recent crisis periods. In addition, a unidirectional excessive spillover of sovereign vulnerability exists on the real sector risk of default but only through the channel of financial contagion during the euro crisis episode. In this regard, a possible carry-trade behavior by banks towards firms is also observed. Secondly, on the individual euro area member level, we did not strictly observe evidence of contagion among credit risk of sovereign-bank-firms to be time invariant intra sector or time-varying inter sectors in each EMU country (we focused on peripheral countries-GIPSI and core countries-Germany and France). However, this result is in contrast to findings reported by existing empirical studies, which observe

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<sup>232</sup> From ECB, EU and IMF

that since 2010 the distress in the euro area has been related to fiscal imbalances only.<sup>233</sup> For instance, this result outlines the fact that during a particular turbulent time there is a possibility of different types of financial crises present among different member states in the euro area depending upon the inherent structure of the respective economic systems. In addition, a unidirectional contagion from sovereign credit risk towards the real sector is observed not only through the financial sector but also directly from the respective government that validates the consequent distortions in corporate debt markets during the euro crisis period. Moreover, a direct contagion effect from non-financial firms' credit risk towards sovereign risk premia is also outlined in this crisis period explaining the cross-market disruptions in respective CDS spreads. In contrast, private-to-public risk transfer is only observed in the case of Italy and Spain.

Finally, with respect to cross-country credit risk contagion among euro area member states, we found a severe contagion risk from Greek, Portuguese and Spanish sovereigns towards the rest of the euro zone during the recent crisis episode. Moreover, irrespective of the sub-prime or euro crisis periods, the Irish financial sector is a source of credit risk contagion to the remaining states in the euro area. These results suggest that the order of systemic contagion risk depends upon the underlying fragility in a specific sector and the inherent weakness in the economic structure of the countries in the EMU. For instance, these observations provide evidence of both the fiscal and banking crises during the recent sample period in the euro zone. Subsequently, this result supports the findings of Acharya et al. (2011) regarding public-to-public risk transfer that indicates a “two-way” feedback effect between healthy and bailed-out countries.<sup>234</sup> Furthermore, in the case of core countries, simulating a shock to Germany's sovereign risk premium furnishes similar results with that of peripheral states but with an indication of a “flight-to-quality” phenomenon. Particularly, it shows that investors search for safety in CDS premia during turbulent times in respective debt markets in the euro zone.

Hence, this thesis provides a comprehensive analysis of the euro crisis spillover effect especially on the real sector along with the financial and public sectors of the EMU. It is shown that increase in sovereign risk premia adversely affects the borrowing cost and in turn the default risk of non-financial firms especially during the public debt crisis period in the euro zone. In doing so, the thesis validates and confirms the presence of the bank liquidity risk and credit risk contagion channels as transmission conduits of sovereign distress towards the non-financial corporate sector in the euro area. Thus, the sovereign debt crisis triggers distortions not only in respective debt

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<sup>233</sup> See: Harjes (2011) and Popov and van Horen (2013) among others

<sup>234</sup> That is in Greece, Portugal and Ireland

markets but also in credit markets that adversely spillover to real and financial sectors in EMU countries.

## **Implications**

Rational and reasonable policy implications can be derived from the above-discussed results that are upshots of the specific examinations carried out in this thesis dissertation.

As far as the importance of the external public debt spillover on the real sector in overall sovereign risk premia is concerned: our results imply that a higher external public debt could increase the sovereign probability of default that leads to a future increase in corporate taxation, and a potential crowd-out effect i.e. reduction in the access to external capital markets by non-financial firms. Moreover, the EU's austerity measures are likely to be long-term in their nature, and that may have a negative impact in the short term as foreign lenders increase the cost in loan markets as partially outlined by our results. Furthermore, this adverse effect would ideally be higher on small and medium-sized enterprises (hereafter, SME) that are constrained by having limited options of available financing avenues. This is due to the fact that our sample in chapter I included syndicated-loan markets and on average it is well known in finance literature that SMEs lack access to these markets.

Therefore, policy makers should take this issue into account when formulating fiscal consolidation measures during turbulent times. In this respect, the ultimate policy objective in a crisis episode is to revive economic growth and output as in the case of the euro crisis period in the EMU. If the external and international markets do not make credible enough efforts which improve the economic outlook, then it will exacerbate the prevalent distress in the economy and hence a differential increase in sovereign default risk premia will be generated. So, ideally, fiscal packages should include a supporting protection package for the most vulnerable non-financial industry in the real sector which helps revive economic growth in distressed periods.

With regard to our results that point to the banking sector liquidity risk as a conduit of sovereign distress towards non-financial firms, regulatory authorities should place more importance on controls and checks on banks' exposure to the liquidity creation process. However, recently Basel-III started to give importance to the liquidity exposure for banks with the introduction of the Liquidity coverage ratio (hereafter, LCR) and the Net stable funding ratio (hereafter, NSFR). Besides, to date, regulators confer a higher importance to bank's solvency rather than to its exposure to the liquidity risk.

We suggest that liquidity exposure due to a maturity mismatch in the transformation of liquid liabilities to illiquid assets is the principal factor that morphs the higher liquidity risk into the banks' solvency risk which causes financial crises and acts as a conduit of transmitting the sovereign distress towards the real sector. Therefore, this suggests an implication for regulators to reassess banks' liquidity risk controls and to formulize such measures that encourage banks to engage in lending to private and SME's sectors.<sup>235</sup> Moreover, as proposed in our chapter-II's results, market makers and regulators should rationally put adequate risk-weightage to sovereign securities and abandon their habit to implement "one-size-fits-all" strategy because in the current uncertain financial environment, we have observed its consequences, so it is not cogent to treat each sovereign security as riskless because these debt securities do contain potential risk of default.

With respect to our empirical results regarding chapter-III, there are quite interesting policy implications. In particular, the presence of a contagion effect due to a high interdependence in credit risk dynamics across countries and different asset classes (i.e. securities of different sectors in our case) plays an important role in the emergence of the systemic meltdown of the whole financial system during the euro crisis period. In this regard, policy makers ideally should attempt to formulate maneuvers that reduce the higher interconnectedness among respective debt markets in the euro zone. Specifically, policies that encourage disintermediation in the bank-firm nexus that reduce firms' dependence on bank lending should be drafted and implemented in the euro zone, i.e. by providing other funding avenues to firms such as encouraging them to avail themselves of services from other financial markets (i.e. capital markets) to fulfill their credit requirements.<sup>236</sup> Moreover, for the sovereign-bank nexus, first, regulations should be formulated and implemented regarding giving due risk weightage to sovereign securities and these financial instruments should not be treated as riskless (i.e. 100% safe) to be used by banks as collateral in the inter-bank market and with the ECB. Second, policy makers should work towards the implementation of banks' mutualisation in turbulent times by focusing on supranational resolutions rather than indulging national sovereigns to partake as it would lead to higher respective budget deficits and risk of default in distressed EMU countries.

On a different note, at investors' portfolio management level, this contagion risk due to the higher interconnectedness of credit risk during the crisis period across asset markets and across countries render diversification strategies useless as all credit instruments in euro member states are subject to similar risks. Hence, investors will be unable to implement diversification strategies to efficiently manage their portfolios in such circumstances. Therefore, in this regard, diversifications to

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<sup>235</sup> That is rather investing highly in the government sector as suggested through the implementation of LCR

<sup>236</sup> In this regard, our results in the context of core-countries credit risk contagion suggested these policy implications

international markets and especially to emerging countries' capital markets may help limit the effect of the contagion spillover from respective debt markets of the euro zone. Last but not the least, market and policy makers, and EU institutions should focus on reducing the uncertainty in the economic and political system in the euro zone to curtail the effect of the contagion risk in debt markets.

### **Limitations and directions for possible extensions**

As we know that limitations of research work arise when there is a gap between what a researcher wanted to do and what he/she did under specific circumstances; in this regard this current thesis is not an exception. Although the empirical research conducted in this thesis furnishes useful and novel findings, there are some inevitable limitations. First, in chapter I we wanted to work on the bilateral loan data for non-financial small and medium-sized enterprises but due to lack of access to the required databases (such as: Dealogic and Dealscan) we directed our attention towards syndicated-loan for non-financial private firms. Furthermore, the objective of the first chapter is to determine the spillover effect of the euro crisis on the real sector borrowing costs by focusing on public debt, demonstrating the causation to firms' cost of borrowing is quite a taxing task. This is simply due to the fact that there are unobserved factors which affect both public debt and solvency of firms simultaneously. Therefore, we use a large set of control factors to provide rational results. Besides, it is challenging to substantiate causation in this respect, so our results in chapter I should ideally be construed as conditional correlations that can be used by empirical researchers for future work.

Second, in chapter-II we proposed to treat the sovereign-bank-firm nexus simultaneously as an instantaneous structural system that generates a feedback loop of default and estimated this simultaneous equations model through the 3SLS method. In this respect, even though the 3SLS estimation method is ideal as a system estimator as compared to OLS and 2SLS which fail to treat the endogeneity problem and correlation between cross-equations error terms, it does not strictly provide robust results because 3SLS relies on the assumption that all equations in a system are exactly specified. As outlined by Agunbiage (2011), 3SLS is the best system estimator for an exactly identified model (SEM) as compared to OLS and 2SLS even in the presence of multicollinearity in exogenous variables. However, an alternative estimation method is present that relaxes this assumption i.e. the Full Information Maximum Likelihood (hereafter, FIML). Besides, Johnson et al. (2010) report that 3SLS is the best system estimator for over-identified and exactly identified model if sample size is large with no severe multicollinearity in exogenous variables.

Therefore, in this regard it is better to use both estimation methods and compare the results for robustness purposes.

Third, chapter-III on the presence of contagion in the credit risk dynamics of the sovereign-bank-firm nexus follows Constâncio's definition of contagion (2012) as the "excessive spillover" in addition to macroeconomic and idiosyncratic factors. In this respect, it is suggested by Bollerslev et al. (2013) that irregular spillovers can be more adequately described by the Generalized Extreme Value (hereafter, GEV) distribution rather than the normal distribution. Taking into consideration the assumptions of extreme value theory, Claeys and Vasicek (2014) outline evidence of the contagion effect as an event that is exorbitantly negative in nature. Therefore, it is prudent to incorporate this into our work by focusing on GEV distributions to be fitted to extreme values (as contagion event) that can be estimated through the method of Maximum Likelihood.

In addition, since our thesis dissertation is focused on the euro zone especially during the sovereign debt crisis period, it fails to include other advanced markets such as the US and the UK. In this field, for more robust conclusions and an in-depth assessment, the possible extension of the current study is to include the analysis of systemic risk (contagion effect of the credit risk) in the US and the UK and compare these findings with respect to the euro zone.

On the other hand, as one of the principal issues in empirical analyses is the required data availability, to conduct our empirical analysis we made considerable efforts in data collection. However, we acknowledge that an intensive assessment using bilateral loan data for small and medium-sized enterprises will provide a more lucid picture of the recent euro crisis spillover effect on the real sector in the euro zone. Furthermore, comparing our results of the bank liquidity risk index<sup>237</sup> with NSFR, will furnish evidence regarding the efficiency of the said measure regarding ease of computation and implementation to diverse financial sectors in euro area countries. Moreover, it extends the robustness of the current analysis regarding transmission channels of sovereign distress towards the real sector in the context of the euro zone.

Finally, building on the existing results of chapter-III regarding the presence of a contagion risk among respective debt markets in the euro zone during the sovereign crisis period, it would be appealing to extend the analysis to hone our understanding regarding differentiation among "wake-up-call" contagion and "pure" contagion.<sup>238</sup>

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<sup>237</sup> We follow methodology of Berger and Bouwman (2009)

<sup>238</sup> As reported by Giordano et al. (2013)

## **Concluding remarks**

This thesis takes an opportunity to provide bases to better understand the spillover effects of the recent euro crisis on the sovereign-bank-firm nexus in EMU countries. Historically, we observed the convergence in sovereign spreads and the availability of cheap funds that spurred the aggregate demand level in euro area countries and then the respective divergence that resulted in the euro crisis episode. Additionally, we witnessed the reaction from the ECB and the EU in order to lessen and mitigate the adverse effects of the sovereign crisis by principally focusing on the financial and public sectors through providing implied guarantees and stimulus packages. However, to date the desired results of these corrective measures have not been fulfilled.

In this regard, we suggest that the potential solution to this problem lies in focusing on the real sector. Since the key objective is to revive economic growth, decrease unemployment rates and increase consumption, policy makers in the EMU should consider providing supplementary rescue packages directed towards the most fragile industries in the real sector (rather than directed only to the financial sector) which in fact is critical in generating aggregate demand in the euro area economy. In this respect, the current thesis attempts to provide rational upshots on the real sector along with the financial and public sectors in the euro zone that enable us to enhance and deepen empirical knowledge for effective and efficient formulation of corrective policy measures during turbulent times. In addition, the desired results could also be achieved through the increased public-private partnership for public works in distressed economies with required investment fundamentally provided by supranational institutions.

## Appendices

### Appendix A. Chapter I

Industrial countries (billions of US dollars)

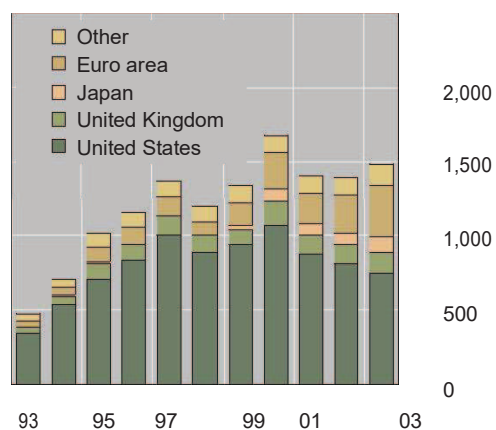


Figure A.1: Syndicated Lending by Nationality of Borrower

Source: Gadanez (2004)

Table A.1: Integration of the syndicated-loan market (Euro area countries)				
Borrower nationality	% of deals <sup>1</sup> where the arranger is of the same nationality <sup>2</sup> as the borrower (based on number of deals)		% of funds <sup>1</sup> provided by banks of the same nationality <sup>2</sup> as the borrower (based on USD amounts)	
	1993–98	1999–2004 <sup>3</sup>	1993–98	1999–2004 <sup>3</sup>
Austria	5	42	33	42
Belgium	17	22	31	16
Finland	26	13	16	9
France	48	50	45	46
Germany	43	46	57	44
Greece	7	29	8	24
Ireland	20	18	16	14
Italy	34	53	39	48
Luxembourg	10	8	30	7
Netherlands	24	29	28	25
Portugal	31	27	30	23
Spain	64	51	64	49
Euro area <sup>4</sup>	59	72	71	67
Euro area <sup>5</sup>	39	42	43	38

(1) Calculated also including purely domestic deals. (2) From the same region, where regions are shown. (3) For 2004, first quarter only. (4) Borrower from any euro area country, arranger/provider from any euro area country (i.e. total). (5) Borrower from same euro area country as arranger/provider, euro area average. Source: Gadanez (2004)



**Table A.2: Data definition and source**

Variables	Description	Source
<u>Loan-level</u>		
Loan spread (bps)	Total number of basis points (bps) at time of issuance above or below related benchmark rate specified in the loan term, one bps is a 1/100th of a percentage point.	SDC Platinum
Loan size (U.S.\$ millions)	Total loan issuance amount.	SDC Platinum
Maturity (yrs)	Total number of years from issue until final maturity.	SDC Platinum
<u>Firm-level</u>		
Leverage ratio	Ratio of total debt to total asset	World Scope / Data Stream
Profitability ratio	Ratio of net income to total asset	World Scope / Data Stream
Size of assets	Natural logarithm of the total value of assets	World Scope / Data Stream
<u>Macro-level</u>		
Total public debt to GDP	Total gross central government debt to GDP	Reinhart & Rogoff (2011)
Total public debt to GDP	Total gross central government debt to GDP	ECB data warehouse
External public debt to GDP	Total gross external debt to GDP	Reinhart & Rogoff (2011)
External public debt to GDP	Total gross external debt to GDP	ECB data warehouse
Domestic public debt to GDP	Total gross domestic debt to GDP	ECB data warehouse
ICRG political index	Political risk rating from International Country Risk Guide (ICRG)	Political risk services
Creditor rights index	Credit depth of information index (0=low to 6=high)	World Bank
Creditor rights index	Strength of legal rights index (0=weak to 10=strong)	World Bank
Real GDP growth (percent)	Real GDP growth rate (percentage change)	EuroStat
Real GDP volatility	Standard deviation of real GDP growth (current year)	EuroStat
Current account to GDP	Current account balances as a share of GDP	World Bank
Terms of trade index (2000=100)	Net barter terms of trade index (2000 = 100)	World Bank
Growth of exports (percent)	Percentage change in exports	IFS, IMF
Private credit to GDP	Domestic credit to private sector (% of GDP)	IFS, IMF
Budget Deficit	Government surplus/deficit to GDP	World Economic Outlook
Real stock price index growth	Real stock price index growth	IFS, IMF
Real exchange rate	Annual USD/Euro real exchange rate	Fed. Reserve Bank of St. Louis
Change in real exchange rate	Percentage change in real exchange rate	Fed. Reserve Bank of St. Louis
<u>Global</u>		
VIX	S&P 500 volatility index	Fed. Reserve Bank of St. Louis

Table A.3: Descriptive Statistics

Variables	Overall Sample				Sample divided by public external debt							
	Panel I				Panel II							
					Above median public external debt				Below median public external debt			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
<u>Syndicated-loanlevel</u>												
Loan spread (bps)	191.28	115.98	3.00	1100.00	192.84	118.30	10.00	1100.00	189.62	113.58	3.00	675.00
Loan size (U.S.\$ millions)	428.03	823.18	3.10	10937.73	452.37	902.34	4.19	10937.73	402.14	729.76	3.10	7473.70
Maturity (yrs)	9.79	6.66	1.00	35.00	9.42	6.50	1.00	35.00	10.20	6.81	1.00	32.00
<u>Firm-level</u>												
Leverage ratio	0.69	0.28	0.00	1.10	0.72	0.27	0.00	1.10	0.66	0.29	0.00	1.09
Profitability ratio	0.07	0.16	-0.57	1.51	0.06	0.12	-0.57	0.96	0.08	0.18	-0.25	1.51
Size (Log of assets)	4.94	1.81	0.00	13.31	4.99	1.89	0.00	9.92	4.88	1.72	0.00	13.31
<u>Macro-level</u>												
External public debt to GDP 1/	182.88	109.19	0.35	1019.13	230.61	133.99	153.75	1019.13	132.55	25.36	0.35	153.19
External public debt to GDP 2/	41.80	103.06	0.00	1071.01	54.99	142.06	3.98	1071.01	27.81	10.91	0.00	75.24
Total public debt to GDP 2/	62.83	20.28	6.10	110.00	58.78	13.19	24.70	107.80	67.13	25.07	6.10	110.00
Domestic public debt to GDP 2/	34.67	14.05	1.17	70.27	30.29	10.28	1.17	66.96	39.32	15.91	5.97	70.27
ICRG political index	79.88	4.59	71.00	93.83	80.45	4.08	72.00	89.67	79.28	5.02	71.00	93.83
Creditor rights index 3/	4.86	0.77	0.00	6.00	4.66	0.59	2.00	6.00	5.08	0.88	0.00	6.00
Creditor rights index 4/	5.80	1.53	3.00	9.00	6.11	1.34	3.00	9.00	5.48	1.64	3.00	8.00
Real GDP growth (percent)	1.47	2.21	-5.50	6.60	1.36	2.35	-5.50	5.90	1.59	2.05	-5.50	6.60
Real GDP volatility	1.50	1.14	0.15	6.68	1.45	1.16	0.15	6.68	1.55	1.12	0.25	5.47
Current account to GDP	-2.56	6.08	-15.02	11.71	-2.27	6.21	-12.66	10.12	-2.86	5.92	-15.02	11.71
Terms of trade index (2000=100)	100.33	4.76	74.75	111.69	100.32	5.75	74.75	111.69	100.33	3.41	82.89	106.15
Growth of exports (percent)	9.88	11.12	-27.31	33.22	8.39	12.73	-22.97	33.22	11.46	8.84	-27.31	21.19
Private credit to GDP	162.42	445.83	73.76	13501.48	151.98	45.55	73.76	294.79	173.50	638.56	75.05	13501.48
Government budget balance to GDP	-3.26	3.83	-15.60	5.34	-3.22	4.06	-15.60	2.90	-3.30	3.58	-9.90	5.34
Real stock price index growth	0.10	0.36	-0.47	1.00	0.06	0.28	-0.47	1.00	0.14	0.42	-0.35	1.00
Real exchange rate	1.35	0.08	1.24	1.47	1.36	0.07	1.24	1.47	1.35	0.09	1.24	1.47

Table (A.3) continued...

Change in real exchange rate	0.03	0.05	-0.05	0.09	0.03	0.06	-0.05	0.09	0.03	0.04	-0.05	0.09
<u>Global</u>												
VIX	21.42	7.92	12.81	32.69	21.86	7.40	12.81	32.69	20.95	8.41	12.81	32.69

Note: The table reports descriptive statistics of all data variables used in chapter-I of this thesis. Panel I shows the overall sample results. Panel II gives results of sample data segmented on the basis of median value of external public debt to GDP which is 153.7.

1/ Data from Reinhart & Rogoff (2011)

2/ Data from European Central Bank (ECB)

3/ Creditor rights index proxies by Credit depth of information index (ECB)

4/ Creditor rights index proxies by Strength of legal rights index (ECB)

**Table A.4: Number of observations by country**

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Austria	2
Belgium	24
Cyprus	3
Finland	6
France	168
Germany	112
Greece	13
Ireland	16
Italy	105
Luxembourg	9
Malta	1
Netherlands	72
Portugal	52
Spain	323
Total	906

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## Appendix B. Chapter II

Table B.1: Data definition and source

Variables	Description	Source
<u>Macro-level</u>		
Govt. bond Spread	Spread between ten years government bonds rate of the considered countries and ten years government benchmark rate (Germany)	OECD
Inflation (CPI)	Inflation ratio indexed by consumer price (CPI) (annual %)	World Development Indicators
Inflation (PPI)	Inflation ratio indexed by producer price (PPI)	Eurostat
$\Delta$ Inflation ( $\Delta$ PPI)	Change in inflation rate (using PPI)	Author's calculation
GDP growth	Growth of GDP (annual %)	World Development Indicators
$\Delta$ GDP	Change in GDP level	Eurostat
Ln_GDP	Natural logarithm of GDP level	Author's calculation
Real exchange rate (euro/usd)	Real exchange rate	Fed. Reserve Bank of St. Louis (USA)
Ln_real exchange rate	Natural logarithm of real exchange rate	Author's calculation
<u>Bank-level</u>		
Liquidity creation index	Refer to Appendix (B) text	Author's calculations using balance sheet data of banks from Bankscope
Ln_Lci	Natural logarithm of liquidity creation indicator (Net income/ Total Asset Average)% (ROA)	Author's calculation
Return on assets		Bankscope
Z-score	Sum of the return on assets and capital ratio divided by income volatility	Author's Calculation
Provision for loss	Provision for loan losses divided by total loans	Bankscope
Interbank ratio	Due from bank over due to bank	Bankscope
Ln_total assets	Natural logarithm of total asset	Bankscope
<u>Syndicated loan-level</u>		
Loan spread (bps)	Corporate loan spread: syndicate banks interest rate on non-financial corporates loan over Euribor rate	SDC Platinum
Ln_loan spread	Natural logarithm of corporate loan spread	Author's Calculation
$\Delta$ Loan spread	Change in corporate loan spread	Author's Calculation

...Table B.1 continued...

Loan amount (\$m)	Loan amount of transaction	SDC Platinum
Ln_loan amount	Natural logarithm of loan amount	Author's Calculation
Maturity (yrs)	Maturity of loan transactions (i.e. issue date minus final due date)	SDC Platinum
<u>Firm-Level</u>		
Net asset value (NAV) (\$m)	Mean Net Asset Value (book value)	Datastream
Ln_NAV	Natural logarithm of Net Asset Value	Datastream
Historical Share Volatility	Average of annual share price movement to a high and low from a mean price for each year	Datastream
Earning growth	(Change in earnings per share / Earnings per share of the last year) * 100	Datastream
Stock Turnover	Arithmetic average of the last five years of Inventory turnover	Datastream
Leverage ratio 1	(Total debt/EBITDA)	Datastream
Leverage ratio 2	(Net debt/EBITDA)	Datastream
Leverage ratio market	(Debt to Equity market value)	Datastream
Profitability ratio	(Change in Net Margin/last year Net Margin)*100	Datastream
Growth multiple	(Price Earning ratio)	Datastream
Profitability ratio (Earnings per share-5year percentage growth)	(Change in net margin over six year) / Net Margin six years ago) * 100	Datastream
Liquidity ratio	(Current ratio-1 year percentage change)	Datastream
Liquidation ratio	(Total shareholders' equity/Total assets)	Datastream

<b>Table B.2: Descriptive Statistics</b>				
<b>Variables</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
<u>System-Level</u>				
Govt. bond Spread	1.219	2.935	-0.939	21.002
Bank liquidity creation index	0.529	0.630	-2.531	2.807
Corporate loan spread (bps)	253.162	88.013	33	515
<u>Macro-Level</u>				
Inflation (CPI)	2.168	1.347	-4.479	4.879
Inflation (PPI)	99.293	5.841	89.555	108.649
Δ Inflation (ΔPPI)	3.028	3.237	-4.792	5.98
GDP growth	0.795	3.173	-8.538	6.588
Δ GDP	0.024	0.026	-0.035	0.054
Ln_GDP	16.013	0.048	15.914	16.067
Real exchange rate (euro/usd)	1.342	0.073	1.244	1.472
Ln_real exchange rate	0.293	0.054	0.219	0.387
<u>Bank-Level</u>				
Ln_lci	-0.574	0.709	-3.639	1.032
Return On Assets	0.599	1.499	-7.305	8
Z-score	1.203	1.718	-7	6.397
Provision for loss	2.748	3.524	-1	33.052
Interbank ratio	139.46	61.424	23.312	317
Ln_total asset	7.3176	1.043	5.055	9.9
<u>Syndicated Loan-Level</u>				
Ln_loan spread	5.46	0.426	3.496	6.244
Δ Loan spread	0.229	1.207	-0.837	8.939
Loan amount (\$m)	1176.55	1184.164	107.527	10612
Ln_loan amount	6.825	0.679	4.677	9.269
Maturity (yrs)	6.459	2.256	1	14.32
<u>Firm-Level</u>				
Net Asset Value (NAV) (\$m)	2513745.124	2326548.641	169057	8688000
Ln_NAV	14.277	0.999	12.037	15.977
Historical stock volatility	0.329	0.107	0.172	0.947
Earning growth	99.223	394.379	-39	3819
Stock turnover	5.903	3.994	3	33.28
Leverage ratio 1 (Total debt/EBITDA)	3.106	4.264	-15	21
Leverage ratio 2 (Net debt/EBITDA)	2.379	4.001	-15.062	19
Leverage ratio_mkt (debt to equity market value)	1.914	2.043	0.348	11
Profitability ratio (Net Margin-1 year percentage change)	-137.298	1755.032	-15725	6614
Growth multiple (Price earnings ratio)	32.885	67.140	8	583
Profitability ratio (Earnings per share-5year percentage growth)	3.833	9.129	-8	25
Liquidity ratio (Current ratio-1 year percentage change)	12.314	50.780	-17.38	478
Liquidation ratio (Total shareholders' equity/Total assets)	-10.41	169.630	-1608	41

<b>Table B.3: Ordinary Least Square (OLS) estimation of our structural system of risk spillover with-in government, bank and non-financial firm sectors in the EZ</b>			
	<b>Govt. bond Spread</b>	<b>Bank liquidity creation index</b>	<b>Corporate Loan spread</b>
Bank liquidity creation index	0.630* (0.379)		-0.847 (1.448)
Govt. bond Spread		0.082** (0.033)	
Corporate loanspread		-0.003 (0.008)	
<u>Macro-level controls</u>			
Ln_real exchange rate	-0.151*** (0.489)	-0.967 (1.434)	-0.308 (0.187)
Inflation (PPI)	0.199*** (0.046)	-0.010 (0.015)	0.622*** (0.182)
GDP growth	-0.433*** (0.081)	0.033 (0.026)	-0.815** (0.329)
<u>Bank-level controls</u>			
Return On Assets (ROA)		0.039 (0.053)	
Provision for loss		0.016 (0.019)	
Interbank ratio		0.002** (0.001)	
Ln_total asset		-0.016 (0.065)	
<u>Loan-level controls</u>			
Ln_loan spread			0.184 (0.133)
Maturity (yrs)			-0.885* (0.494)
<u>Purpose</u>			
General			1.647* (0.947)
Leverage Buy Out (LBO)			2.214** (0.956)
Project Finance (PF)			1.989** (0.977)
Recapitalization			3.041*** (1.128)



Refinancing			1.970** (0.937)
Restructuring			2.211* (1.203)
<u>Firm-level controls</u>			
Ln_Net asset value (NAV)			0.306 (1.021)
Historical stock volatility			1.477 (0.957)
Stock turnover			0.017 (3.038)
Leverage ratio			-0.930 (2.268)
Liquidation ratio			-0.031 (0.165)
Growth multiple			-0.092 (0.143)
Profitability ratio			0.001 (0.005)
Liquidity ratio			0.061 (0.570)
Constant	-1.405*** (0.4340)	1.451 (1.306)	-6.227*** (2.283)
R-squared	0.405	0.135	0.403

Note: The dependent variables of the Simultaneous Equations Model (SEM) are: government bond spread (Euro area sovereign 10 year bond yield minus Germany's government bond 10 years yield); Bank liquidity creation index of the euro area banking system defined in table (B.1) and syndicated loan spread (bps) of firms located in the euro area with lead banker situated with-in euro area countries. The three columns indicate simultaneous equations model of our structural system framework which is estimated through the 3SLS method, respectively. Further, the system includes a total of 96 observations that are gathered through the weighted average procedure in order to form a balanced panel data for the euro area countries. We use data sample of 12 countries due to the availability of all the required data fields in our structural system. The list of countries included is outlined in table (B.6). The definition of all the variables included in the OLS estimation can be observed in table (B.1). In short, Leverage ratio here is (Total debt/EBITDA); Liquidation ratio (Total shareholders' equity/Total assets); Growth multiple (Price earnings ratio); Profitability ratio (Net Margin-1 year percentage change); Liquidity ratio (Current ratio-1 year percentage change); Return on Assets (Net Income/Total assets). Robust standard errors are reported in parentheses whereas, \*\*\*, \*\* and \* represent significance at 1%; 5% and 10% level, respectively

**Table B.4: Comparison of our results estimated through 3SLS estimation of our structural system of risk spillover with-in the three sectors of the economy i.e. government, banks and non-financial firms in the Euro zone**

	Panel I: With-out sovereign crisis			Panel II: With sovereign crisis		
	Govt. bond spread	Bank liquidity creation index	Corporate loan spread	Govt. bond spread	Bank liquidity creation index	Corporate loan spread
Bank liquidity creation index	0.071 (0.067)		-0.483** (0.216)	-1.981*** (0.678)		1.660* (0.874)
Govt. bond spread		0.261*** (0.081)			-0.155** (0.065)	
Corporate loan spread		-0.005** (0.002)			0.002 (0.001)	

Note: The dependent variables of the Simultaneous Equations Model (SEM) are: government bond spread (Euro area sovereign 10 year bond yield minus Germany's government bond 10 years yield); Bank liquidity creation index of the euro area banking system defined in table (B.1) and syndicated loan spread (bps) of firms located in the euro area with lead banker situated with-in euro area countries. The two panels i.e. Panel I and II indicate results obtained through the 3SLS estimation method for the period preceding the sovereign debt crisis and the period during sovereign crisis in the euro zone, respectively. For brevity and comparison purposes, we reproduce the interested variables results already reported in tables (II.2) and (II.3) in chapter II to analyze the change in banking sector's liquidity management strategy in the euro zone. We use data sample of 12 countries due to the availability of all the required data fields in our structural system. The list of countries included is outlined in table (B.6). Definition of all the variables included in the 3SLS estimation can be observed in table (B.1). Robust standard errors are reported in parentheses whereas, \*\*\*, \*\* and \* represent significance at 1%, 5% and 10% level, respectively.

**Table B.5: Loan Purpose**

<b>Category</b>	<b>Definition</b>
Leverage Buy Out (LBO)	To acquire another company/assets and using the potential cash flow to repay the borrowed loan
Project Finance (PF)	To finance a potential profitable project and repaying the borrowed amount through the cash flow received during operations of the project
Recapitalization	Funds needed to recapitalize the current business
Refinancing	To swap the existing loan with a new one with other syndicate banks and also with extended due date
Restructuring	Extending the tenure of maturity date with the same loan contract and syndicate banks
General	If the loan purpose is not specified it is categorized as general

**Table B.6: List of Euro-area countries considered in our study**

Austria
Belgium
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain

Why banking sector liquidity risk?

*“.....But perhaps most importantly, the financial crisis demonstrated that liquidity is the most vital component of a properly functioning financial system – it is the essential lifeblood of banks and other financial institutions, and, by direct extension, the essential lifeblood of all other parts of the corporate and governmental world.”* (Erik Bank, 2013)

Banking sector liquidity risk is considered to be at the heart of modern financial intermediation theory. It is the foremost function that banks follow in smooth functioning of financial markets and the economy. However, it is also one of the main avenues that cause vulnerability in their balance-sheet value. Indeed, one of the principal functions of banks is to create liquidity and to provide smooth flow of credit in the economy. The importance of liquidity creation process was first evaluated by Bryant (1980) and then by Diamond and Dybvig (1983). The studies mainly put forward the idea that how banking sector creates liquidity for the rest of economy by financing illiquid assets (for instance: business loans, retail loans etc) through liquid liabilities (for example: certificate of deposits, short-term bonds, demand deposits etc). In turn, banks hold illiquid assets and provide liquidity to the economic agents and in this process expose themselves to liquidity risk. In other words, the exposure to liquidity risk arises when banks are not being able to fulfill the demand for funds by its depositors because they are used to finance illiquid assets (i.e. loan to debtors). Therefore, in an extreme case a bank will be forced to sell its assets incurring losses to honor its obligations that become due.

In this context, Diamond and Rajan (2001) study the relationship between bank's ability to create liquidity and its exposure to the related risk by focusing on inherent fragility of the financial sector. The study manifests that bank's function of liquidity creation or any function for that matter in fact renders its capital base weak. In reality any financial transaction executed by a commercial bank to conduct business, directly generates exposure to its liquidity risk and eventually affects its capital adequacy level (i.e. irrespective on the asset or liability side of its balance sheet). In a similar vein, banks also generate liquidity through off-balance sheet activities which render them exposed to even higher liquidity risk by contracting loan commitments in current period to provide required funds in the future (Holström and Tirole, 1997).

Therefore, banks not only create liquidity by delving into both sides of its balance sheet but also contracting guarantees that are off-balance sheet. So, the banks taking exposure to liquidity is vital for the availability of credit to the rest of economy. In this context, Diamond and Rajan (2005) evaluate the importance of liquidity risk as a potential cause of bank's failure that generates a contagion leading to the

meltdown of financial system as a whole. In other words, the study outlines that the liquidity risk can ruin banks and leads to increased fragility in the financial system that poses threat to the meltdown of real sector and further the whole economic system.<sup>239</sup> In addition, Basel Committee on Banking Supervision (BIS, 2009) also realizes the importance of liquidity in addition to the solvency risk in financial industry after the emergence of the recent US financial crisis. Despite that, the proponents of Basel-III confer more importance to bank's solvency rather than its liquidity while implementing regulatory controls on the financial industry in order to prevent any turmoil in the future. In this respect, we suggest that in the context of recent crisis environment it is the banking sector's exposure to liquidity risk that plays a vital role in generating uncertainty in the whole economic system.

### **Banks liquidity vs. solvency**

In their seminal study, Diamond and Dybvig (1983) emphasized that the main function of a commercial bank is to provide liquidity to the economic agents. However, with the emergence of bank run situations the policy focus shifts towards the solvency problem. In fact, bank runs render the financial firm weak, leaving it unable to honor its liquid liabilities on demand. Taking into consideration this effect of mismatch of funding illiquid assets with short-term or on demand liabilities leaves the banking system fragile and illiquid which eventually invokes the issue of its solvency under related macro-economic environment. As put forward by Allen and Gale (1998), business cycle plays a fundamental role in the emergence of bank run situations that accentuate the importance of bank fundamentals leading to treat its solvency as a major trigger as compared to respective liquidity risk.

In this context, the regulatory authorities mainly give primary importance to the controls and checks of bank's solvency issues rather than to its liquidity exposures. As can be observed through the apparition of BIS reports, since the onset of Basel regulations (i.e. Basel I, II and now III), the financial industry regulators focused mainly on the solvency issue but with the onset of recent global financial crisis, only then they started to realize the importance of liquidity exposure of banking sector as a major cause of these financial turmoil in advanced economies.<sup>240</sup> In this respect, however it is quite difficult to quantitatively separate the two interconnected bank risks i.e. the solvency risk and the liquidity risk (Rochet and Vives, 2004).

In the light of above mentioned parlance, even though bank solvency and liquidity risks are interconnected phenomena and are difficult to separate,<sup>241</sup> we suggest that in fact bank's exposure to

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<sup>239</sup> Recent examples include: Northern Rock (UK) and Lehman Brothers (US) banks failure in 2008

<sup>240</sup> BIS (2008), (2009) and (2010)

<sup>241</sup> Quignon (2011)

liquidity risk is the first step towards the build-up of a potential solvency problem. In other words, pedagogically, financial institutions do not become insolvent overnight and the distress process is gradual in nature.<sup>242</sup> That is, banks ideally feel the pressure from higher liquidity exposure leading to the state of illiquidity and when they are unable to succeed in solving the illiquidity problem then it'll turn into the conundrum of insolvency. Indeed, with the illiquidity problem, financial institutions have option to resolve the situation because of their existing positive net worth. Particularly, banks are exposed to liquidity risk, for example—not enough liquid assets to fulfill the demands of the depositors which can be solved through other avenues such as, by availing bridge loans or cash-flow from external sources. The condition is feasible in the sense that banks can avail loans to ease the liquidity pressures because lenders take into consideration the positive net-worth of borrower banks (i.e. banks assets are more than its total liabilities). Besides, banks have other option of a fire sale of its semi-liquid and illiquid assets at a lower price bearing the loss in repaying its outstanding liabilities that are due.

The option of selling assets at a loss in turn generates the solvency problem in banks. Therefore, we surmise that “bank’s exposure to liquidity risk should be given primary importance while drawing regulatory controls for financial intermediaries<sup>243</sup> in order to enable the smooth functioning of credit market and the economic system as whole.” In this regard, BIS (2009) recognizes the importance of banking sector exposure to liquidity risk and includes Liquidity coverage ratio (LCR-for short term liquidity exposure) and Net Stable Funding Ratio (NSFR-for long term controls) in the context of Basel-III.

Furthermore, ample existing literature outlines the importance of banking sector liquidity risk as a monetary policy conduit to real sector. In this regard, Kishan and Opiela (2000) show the significance of bank lending within the context of monetary policy transmission channel. The study emphasizes the importance of banks liquidity creation function as a primary role in the transmission of monetary policy effect to the real sector. For instance, contractionary policy affecting the reserve requirements influences the certificate of deposits, short-term bonds and demand deposits which are primary sources to generate loans to non-financial corporates leading to transmit an adverse effect to the real economic sector. In a similar vein, Kashyap and Stein (1997) find similar results and show that banks that hold high level of illiquid assets are more responsive to policy effects in advancing uncertainty to other sectors of the economy. Moreover, BIS (2009) specifically shed light on the foremost importance of banking sector liquidity in the context of crisis situation.

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<sup>242</sup> However there are exceptions to this assumption for instance in case of heavy trading in derivatives market

<sup>243</sup> Especially the commercial banks

Hence, in chapter-II of this thesis we focus on banking sector exposure to liquidity risk because the objective here is to evaluate the spillover effect of recent sovereign crisis on real sector in euro zone. In this context, there is ample literature that put forward the quantitative measurement techniques regarding bank's exposure to liquidity risk. Deep and Schaefer (2004) measure banks liquidity risk through "liquidity transformation gap" (hereafter, LT gap) by taking into consideration only liquid liabilities and assets normalized by total assets. Whereas, other studies focus either on bank's asset side or liability side ratios to calculate its exposure to liquidity risk. For instance, to measure liquidity risk exposure inherent in bank's balance sheet, Chen et al. (2012) use current asset ratio and funding ratio separately as a measure of banks liquidity. This in fact is limited by nature because it only takes into account the information regarding either asset side or liability side of bank's balance sheet.

However, these indicators are also limited in the sense that they do not comprehensively include banking sector exposure to liquidity risk which is inherent in its liquidity creation process that takes into consideration both the asset and liability side information of its balance sheet, simultaneously. The seminal paper of Berger and Bowman (2009) developed a comprehensive technique to measure the liquidity risk of banking sector by including the information not only from the asset and liability side of bank's balance sheet but also takes into account the off-balance sheet activities that renders bank to higher exposure to liquidity risk. Therefore, in chapter-II, we follow the Berger and Bowman's methodology in measuring banking sector exposure to liquidity risk. The calculation steps of liquidity creation index follows:

- Firstly, we classify bank assets, liabilities and equity as liquid, semi-liquid and illiquid.<sup>244</sup> The said classification is based on the ease, cost and time it takes for the customers to withdraw liquid funds from banks; and the ease, cost and time it takes for a bank to get rid of its portfolio investments to meet the liquidity needs. Similar procedure is followed for off-balance sheet items.
- In a second step, the on and off-balance sheet items of banks as categorized in the previous step are given weight according to the liquidity or illiquidity they generates. The weights given are -0.5, 0, +0.5 to illiquid, semi-liquid and liquid items of banks' balance sheet. The signs of the weights are consistent with the theory of liquidity creation, indicating that liquidity is created when banks transform (finance) illiquid assets with liquid liabilities. In addition, liquidity is destroyed when liquid assets are converted to illiquid liabilities such as equity capital. In turn, the illiquid assets and liquid liabilities are assigned a weight of +0.5 and liquid assets and illiquid liabilities are given -0.5 weights, while semi-liquid assets and liabilities are assigned 0 as weight.

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<sup>244</sup> Refer to table (B.7), Appendix (B)

- In the final step, we combine the weights assigned in previous steps to obtain the indicator of liquidity creation that measures bank exposure to liquidity risk. risk.

$$\text{Liquidity Creation Index} = \frac{0.5 (\text{illiquid assets}) + 0 (\text{semi-liquid assets}) - 0.5 (\text{liquid assets}) + 0.5 (\text{liquid liabilities}) + 0 (\text{semi-liquid liabilities}) - 0.5 (\text{illiquid liabilities}) + 0.5 (\text{illiquid guarantees}) + 0 (\text{semi-liquid guarantess}) - 0.5 (\text{liquid guarantees})}{\text{Total assets}}$$

In addition, BIS (2009) proposes two ratios as the implementation of regulatory framework in relation to bank's liquidity exposure as a consequence to address the issues emerged after the US sub-prime financial crisis. The first is Liquidity coverage ratio which is calculated as (stock of high quality liquid assets / total net cash outflows over the next 30 calendar days), and mainly focused towards evaluating the short-term capacity of banks against exposure to liquidity risk. Whereas, the second ratio, the NSFR, addresses the overall long term resilience of banking sector against its liquidity risk exposure. The Net stable funding ratio in fact takes into account the information from both sides of the balance sheet (i.e. asset and liability) and also includes off-balance sheet activities.

In this context, NSFR is in a way similar to the indicator created by Berger and Bowman (2009). NSFR also assigns specific weights to different type of assets and liabilities but require in-depth information while providing relevant weights. In particular, NSFR is measured as a ratio between the Available sources of Stable Funding (ASF) and Required sources of Stable Funding (RSF). The amount of available stable funding, in fact, takes into consideration the liabilities that are treated as stable, whereas, the amount regarding required stable funding generates from the assets side that are considered to be illiquid by nature. Therefore, banks are exposed to lower liquidity risk when the NSFR ratio is higher than the acceptable limits demanded by Basel-III.

Despite the fact that the NSFR ratio is comprehensive in nature and takes into consideration the information not only from both sides of the bank's balance sheet as well as the off-balance sheet activities, in our opinion is not infallible on the grounds of empirical implementation and the modern financial intermediation theory. In particular, to compute ASF and RSF, the classification and assignment of weights to different kinds of bank liabilities and assets are not lucid which on the one hand, require



very detailed data information and, on the other hand is not feasible to generalize with banking sector of different countries experiencing diverse economic conditions. Whereas, liquidity creation index of Berger and Bowman (2009) can be easily linked not only with the existing theory of financial intermediation but also is simple in nature to compute and compare with banks in different economic regions. However, we intend to use NSFR as a development of chapter-II's work and to analyze and compare the results in the context of euro crisis period.

**Table B.7: Classification and weightage of Banks balance sheet and off-balance sheet items to calculate liquidity risk index (source: Berger & Bowman, 2009)**

<b>Assets</b>	<b>Liquidity level</b>	<b>Weights</b>
<b>Cash and cash equivalents</b>	Liquid	-0.5
<b>Total securities<sup>245</sup></b>	Liquid	-0.5
<b>Corporate and commercial loans</b>	Illiquid	0.5
<b>Consumers loans</b>	Semi-liquid	0
<b>Other loans</b>	Semi-liquid	0
<b>Fixed assets</b>	Illiquid	0.5
<b>Other asset</b>	Illiquid	0.5
<b>Off-balance sheet</b>	Illiquid	0.5
<b>Liabilities</b>		
<b>Demand deposits</b>	Liquid	0.5
<b>Savings</b>	Liquid	0.5
<b>Term deposits</b>	Semi-liquid	0
<b>Interbank deposits</b>	Liquid	0.5
<b>Short term funding</b>	Liquid	0.5
<b>Total long term funding</b>	Semi-liquid	0
<b>Other liabilities</b>	Illiquid	-0.5
<b>Subordinated debt</b>	Illiquid	-0.5
<b>Equity</b>	Illiquid	-0.5

<sup>245</sup> According to Berger and Bouwman (2009), the total securities are affected by a weighting -0.5 (regardless of maturity).

**Appendix C. Chapter III**

$$\begin{bmatrix} Z_{AT\_sv,t} \\ M \\ Z_{ES\_sv,t} \\ Z_{AT\_bk,t} \\ M \\ Z_{ES\_bk,t} \\ Z_{AT\_fm,t} \\ M \\ Z_{ES\_fm,t} \end{bmatrix} = \begin{bmatrix} \alpha_{1,0} \\ M \\ \alpha_{n,0} \end{bmatrix} + \sum_{i=1}^p \begin{pmatrix} a_{1,i} & K & a_{1n,i} \\ M & O & M \\ a_{n1,i} & L & a_{nm,i} \end{pmatrix} \begin{bmatrix} Z_{AT\_sv,t-i} \\ M \\ Z_{ES\_sv,t-i} \\ Z_{AT\_bk,t-i} \\ M \\ Z_{ES\_bk,t-i} \\ Z_{AT\_fm,t-i} \\ M \\ Z_{ES\_fm,t-i} \end{bmatrix} + \begin{bmatrix} \mathcal{E}_{AT\_sv,t} \\ M \\ \mathcal{E}_{ES\_sv,t} \\ \mathcal{E}_{AT\_bk,t} \\ M \\ \mathcal{E}_{ES\_bk,t} \\ \mathcal{E}_{AT\_fm,t} \\ M \\ \mathcal{E}_{ES\_fm,t} \end{bmatrix} \quad (5)$$

where  $\mathcal{E}_{j,t} : wn(0, \Sigma_{\mathcal{E}})$

**Table C.1: Model selection criteria**

lag	CD	J	Jpvalue	MBIC	MAIC	MQIC
1	0.67364	56.7202	0.11296	-199.95	-33.28	-99.981
2	0.67261	46.527	0.11241	-158.81	-25.473	-78.834
3	0.69807	35.4829	0.12705	-118.52	-18.517	-58.538
4	0.75219	25.7701	0.10513	-76.898	-10.23	-36.911

Note: According to Andrews and Lu (2001), panel VAR with lag one shows minimum MBIC, AIC and Hannan QIC, therefore we use PVAR(1) in our GMM System estimation

**Table C.2: List of banks with respect to the euro zone countries**

Country	Banks	Count
Austria	Erste Group, Bank für Arbeit und Wirtschaft und Österreichische Postsparkasse AG (BAWAG P.S.K), Raiffeisen Zentralbank Österreich	3
Belgium	KBC Group	1
France	Crédit Mutuel, BNP Paribas, Credit Agricole, Credit Lyonnais, Natixis, Calyon Bank	6
Germany	Bayerische Landesbank, Commerzbank, Deutsche Bank, HSH Nordbank, IKB Deutsche Industriebank AG, Landesbank Berlin, Landesbank Baden-Württemberg, Landesbank Hessen-Thüringen, Norddeutsche Landesbank Girozentrale (NORD/LB), WestLB AG	10
Greece	Alpha Bank, EFG Eurobank Ergas, National Bank of Greece	3
Ireland	Allied Irish Bank, Irish Bank Resolution Corporation (IBRC/Anglo Irish Bank)	2
Italy	Banca Montepaschi Di Siena, Banco Popolare Italiana, Unicredito, Intesa Sanpaolo, Banca Italease, UBI Banca Group	6
Netherland	Rabo Bank, ING Banks, SNS Bank	3
Portugal	Banco Comercial Portugues, Banco BPI, Banco Espirito Santo	3
Spain	Banco Sabadell, Banco Popular Español, Banco Pastor, Banco Santander, Bankinter SA, La Caixa, Banco Bilbao Vizcaya Argentaria (BBVA)	7

Note: The table reports the list of banks for which the five years CDS spread data is available through the DataStream and Bloomberg for the period 2007-QIV till 2012-QIV. Further, for bank specific control variables, we use BankScope to collect the data regarding bank fundamentals by manually cross-matching with the CDS data, the bank name and a series of other identification information such as (BIC-Business Identifier Code and SIC-Standard Industrial Classification indicators')

**Table C.3: List of firms with respect to the euro zone countries**

Country	Non-financial corporates	Count
Austria	Telekom Austria, OMV	2
Belgium	Applied Mats Inc, Belgacom, Solvay	3
Finland	Elisa, Fortum Power & Heat AB, Metsä Board, Metso, Nokia, Stora Enso, Teliasonera, UPM (The Biofore Company)	8
France	Accor, Airbus Group, Alcan France, Alcatel Lucent, Alstom, Arcelormittal, Bouygues, Cap Gemini, Carrefour, Groupe Casino, Saint-Gobain, Ciments Français, Danone, Electricité de France, GDF Suez, Havas, Kering, Lafarge, Lagardere, L'air liquide, Legrand France, L'oreal, Michelin, LVMH, Orange, Pernod Ricard, Peugeot, Publicis groupe, Rallye, Renault, Rexel, Rhodia, Sanofi, Schneider Electric, Securitas, Societe Air, Sodexo Alliance, Technip, Total, Unibail-Rodamco, Valeo, Veolia, Vinci, Vivendi	44
Germany	Adidas, BASF, Bertelsmann, Continental, Daimler, Deutsche Bahn, Deutsche Telekom, ENBW, Fresenius, Grohe, Heidelberg cement, Lanxess, Merck, Metro, Pilkington group, Prosiebensat, RWE group, Siemens, Suedzucker, Thyssenkrupp, TUI, UPC, Voith, Volkswagen	24
Greece	Hellenic Telecommunications, Public power corporation	2
Ireland	Covidien, Eaton corporation, Ingersoll-Rand co, Weatherford International ltd	4
Italy	Edison, Enel, ENI, Fiat, Finmeccanica, Gruppo Editoriale L'Espresso, Pirelli & co, Seat Pagine Gialle, Telecom Italia	9
Netherlands	Akzo Nobel, Alliander, E.ON, Eneco, Essent, Heineken, Koninklijke Ahold N.V., Koninklijke KPN N.V., Koninklijke Philips N.V., NXP, PostNL, Reed Elsevier plc, Royal Dutch Shell plc, UniLever, UPC holding, Wolters Kluwer	16
Portugal	EDP-Energias de Portugal, Portugal Telecom, Petrobras	3
Spain	Altadis, Endesa, Gas Natural, Iberdrola, Repsol, Telefonica	6

Note: The table reports the list of non-financial firms for which five years CDS spread data is available through the DataStream and Bloomberg for the period 2007-QIV till 2012-QIV. Further, for firm specific control variables, we use WorldScope to collect the data regarding firm's fundamentals by manually cross-matching with the CDS data, the firm name and a series of other identification information such as (BIC-Business Identifier Code and SIC-Standard Industrial Classification indicators')

**Table C.4: Data variables description and source**

Variables	Description	Source
Credit risk-sovereign	Credit Default Swap (CDS) premia of 5 years maturity for sovereigns	DataStream/Bloomberg
Credit risk-bank (1)	Weighted index of CDS premia of 5 years of banks with respect to specific euro zone countries	DataStream/Bloomberg
Credit risk-firm (2)	Weighted index of CDS premia of 5 years of non-financial firms with respect to specific euro zone countries	DataStream/Bloomberg
Inflation (PPI)	Inflation ratio indexed by Producer Price (PPI)	Eurostat
Inflation (CPI)	Inflation ratio indexed by Consumer Price (CPI)	World Development Indicators
GDP growth	GDP growth rate (%)	World Development Indicators
Real exchange rate	Natural logarithm of real exchange rate (euro/usd)	Fed. Reserve Bank of St. Louis
CA	Current account balance as a share of GDP	World Bank
PD to GDP	Total gross central government debt to GDP	ECB data warehouse
VIX	S&P 500 volatility index	Fed. Reserve Bank of St. Louis
<i>Bank-level</i>		
Return on assets	(Net income/total assets) in %	Bankscope
Z-score	Sum of the return on assets and capital ratio divided by income volatility	Bankscope
Provision for loss	provision for loan losses normalized by total loans	Bankscope
Interbank ratio	due from bank over due to other bank	Bankscope
Bank size	natural logarithm of total assets	Bankscope
<i>Firm-level</i>		
Firm size	Natural log of net asset value (mean)	Worldscope (Datastream)
Leverage ratio	total debt / EBITDA	Worldscope (Datastream)
Profitability ratio	change in net margin/last year net margin * 100	Worldscope (Datastream)
Growth multiple	Price earnings ratio	Worldscope (Datastream)
Liquidity ratio	Current ratio-one year percentage change	Worldscope (Datastream)

Note:

(1) For the bank credit risk index, refer to equation (4) in chapter III section (3.1.2) for the index methodology with respect to the individual country.

(2) For the non-financial firm credit risk index, refer to equation (3) in chapter III section (3.1.2) for the index methodology with respect to the individual country. Furthermore, the fundamental bank and firm data is available annually or bi-annually, in order to streamline with the CDS premia, we use cubic spline interpolation to harmonize the frequency of data observations in the sample. In addition, to obtain the residuals of CDS premia, macro-economic factors used interchangeably (for example: inflation through CPI or PPI, GDP level or growth) to verify the robustness of default risk proxies for the sovereign-bank-firm sectors of euro zone. Whereas, for the default risk proxies, natural log forms are used.

**Table C.5: Panel unit root test (Pesaran, 2007)**

Variables	t-bar	cv10	cv5	cv1	z[t-bar]	P-value
CDS_sovereign	4.39	2.14	2.25	2.44	9.66	0.00
CDS_bank	4.06	2.14	2.25	2.44	8.45	0.00
CDS_firm	3.39	2.14	2.25	2.44	5.95	0.00

Note: One-lag is suggested by the model selection criteria (proposed by Andrews and Lu, 2001) results which are outlined in table (C.1). The results of all the variables are available upon request. Since, the p-value is less than 1%, we reject the null hypothesis of non-stationarity.

**Table C.6: Panel VAR (1) estimation for sovereign-bank-firm credit risk in the euro zone**

Variables	I			II			III		
	(1) SV.rsk( <i>t</i> )	(2) BK.rsk( <i>t</i> )	(3) FM.rsk( <i>t</i> )	(4) SV.rsk( <i>t</i> )	(5) BK.rsk( <i>t</i> )	(6) FM.rsk( <i>t</i> )	(7) SV.rsk( <i>t</i> )	(8) BK.rsk( <i>t</i> )	(9) FM.rsk( <i>t</i> )
SV.rsk( <i>t-1</i> )	0.599*** (0.045)	0.069* (0.035)	-0.031 (0.036)	0.550*** (0.071)	0.148** (0.063)	-0.052 (0.035)	0.734*** (0.051)	0.096** (0.039)	-0.088 (0.061)
BK.rsk( <i>t-1</i> )	0.163*** (0.044)	0.602*** (0.049)	0.045 (0.032)	0.182*** (0.059)	0.592*** (0.061)	-0.046 (0.039)	0.087 (0.066)	0.681*** (0.073)	0.153*** (0.051)
FM.rsk( <i>t-1</i> )	0.085 (0.055)	0.018 (0.048)	0.640*** (0.053)	0.109* (0.064)	0.088** (0.043)	0.862*** (0.052)	0.031 (0.090)	-0.174** (0.077)	0.472*** (0.082)

The table reports results of PVAR system of sovereign, bank and non-financial firm risk in the euro zone. Definitions of variables are outlined in table (C.4), Appendix (C). The panel VAR model is estimated by using the GMM system approach whereas; country-time and fixed-effect are removed prior to the estimation (see section 3.1, chapter III for details). Panel I outlines the estimation results for the whole sample period (i.e. 2007/QIV-2012/QIV). In addition, panel II shows results of the PVAR estimation for the sub-prime period (i.e. 2007/QIV-2009/QIV), while panel III outlines estimation results for the sovereign crisis period (i.e. 2010/QI-2012/QIV). Dependent endogenous variables are in columns showing the coefficients of regressing them on row variables, that is, the lag variables. Robust standard errors are in parentheses, whereas \*\*\*, \*\*, and \* shows 1%, 5% and 10% significance level, respectively.

**Table C.7: Panel VAR credit risk granger causality between sovereign-bank-firm nexus in the euro zone**

Equation\Excluded	I			II			III		
	chi2	df	Prob>chi2	chi2	df	Prob>chi2	chi2	df	Prob>chi2
SV.rsk									
BK.rsk	13.584	1	0.000***	9.429	1	0.002***	1.722	1	0.189
FM.rsk	2.361	1	0.124	2.954	1	0.086*	0.115	1	0.735
BK.rsk									
SV.rsk	3.832	1	0.05**	5.549	1	0.018**	5.89	1	0.015**
FM.rsk	0.136	1	0.712	4.092	1	0.043**	5.151	1	0.023**
FM.rsk									
SV.rsk	0.732	1	0.392	2.153	1	0.142	2.085	1	0.149
BK.rsk	2.013	1	0.156	1.342	1	0.247	8.933	1	0.003***

The table shows panel VAR (PVAR-1) granger causality test for the credit risk contagion order between sovereign-bank-firm nexus in the euro zone. Panel I outlines results for the whole sample period (i.e. 2007-QIV to 2012-QIV). Panel II reports the sub-prime crisis period (i.e. 2007-QIV to 2009-QIV), whereas Panel III shows results of the sovereign debt crisis period (i.e. 2010-QI to 2012-QIV). Furthermore, SV.rsk, BK.rsk and FM.rsk represent the sovereign, bank, and firms credit risk premia. Whereas, \*\*\*, \*\*, and \* shows 1%, 5% and 10% significance level, respectively.

**Table C.8: Variance decompositions for sovereign, bank and non-financial firm risk in the euro zone**

Response variable	I			II			III		
	SV.rsk	BK.rsk	FM.rsk	SV.rsk	BK.rsk	FM.rsk	SV.rsk	BK.rsk	FM.rsk
SV.rsk									
Step									
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.9719	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000
2	0.9835	0.0138	0.0027	0.9807	0.0146	0.0046	0.9962	0.0035	0.0003
3	0.9634	0.0304	0.0062	0.9570	0.0290	0.0141	0.9905	0.0091	0.0004
4	0.9474	0.0434	0.0091	0.9360	0.0379	0.0261	0.9849	0.0147	0.0004
5	0.9367	0.0520	0.0112	0.9189	0.0423	0.0388	0.9803	0.0194	0.0004
6	0.9301	0.0573	0.0126	0.9052	0.0440	0.0508	0.9768	0.0228	0.0004
7	0.9262	0.0603	0.0135	0.8944	0.0444	0.0611	0.9743	0.0251	0.0005
8	0.9241	0.0619	0.0139	0.8860	0.0443	0.0697	0.9727	0.0267	0.0006
9	0.9229	0.0628	0.0142	0.8796	0.0440	0.0764	0.9716	0.0277	0.0007
10	0.9223	0.0633	0.0144	0.8747	0.0438	0.0816	0.9709	0.0283	0.0008
BK.rsk									
Step									
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0205	0.9794	0.0000	0.0254	0.9746	0.0000	0.0238	0.9762	0.0000
2	0.0353	0.9645	0.0002	0.0790	0.9165	0.0046	0.0455	0.9391	0.0155
3	0.0465	0.9530	0.0005	0.1185	0.8670	0.0145	0.0705	0.8996	0.0299
4	0.0538	0.9453	0.0009	0.1416	0.8306	0.0278	0.0943	0.8672	0.0385
5	0.0581	0.9405	0.0013	0.1532	0.8046	0.0422	0.1140	0.8435	0.0424
6	0.0605	0.9378	0.0016	0.1581	0.7858	0.0562	0.1288	0.8272	0.0439
7	0.0618	0.9363	0.0018	0.1595	0.7719	0.0686	0.1393	0.8164	0.0444
8	0.0620	0.9355	0.0020	0.1593	0.7617	0.0789	0.1463	0.8093	0.0444
9	0.0627	0.9350	0.0021	0.1585	0.7542	0.0873	0.1509	0.8048	0.0443
10	0.0630	0.9348	0.0022	0.1577	0.7487	0.0937	0.1538	0.8019	0.0442
FM.rsk									
Step									
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0075	0.0015	0.9909	0.0295	0.0000	0.9705	0.0012	0.0003	0.9985
2	0.0056	0.0053	0.9891	0.0199	0.0016	0.9785	0.0053	0.0262	0.9685
3	0.0050	0.0083	0.9867	0.0152	0.0043	0.9804	0.0105	0.0525	0.9370
4	0.0049	0.0101	0.9849	0.0135	0.0076	0.9789	0.0132	0.0687	0.9180
5	0.0049	0.0111	0.9839	0.0135	0.0109	0.9755	0.0142	0.0765	0.9093
6	0.0049	0.0116	0.9834	0.0144	0.0140	0.9715	0.0144	0.0797	0.9059
7	0.0049	0.0119	0.9832	0.0157	0.0167	0.9675	0.0144	0.0809	0.9048
8	0.0049	0.0120	0.9830	0.0171	0.0190	0.9639	0.0144	0.0812	0.9044
9	0.0050	0.0120	0.9830	0.0184	0.0208	0.9608	0.0144	0.0814	0.9042
10	0.0050	0.0120	0.9830	0.0195	0.0223	0.9583	0.0144	0.0814	0.9042

Row variables are the response variables whereas, column variables are impulse variables. Percentage variation in the row variables are explained by the column variables (10 periods ahead). Panels I, II, and III represent the full sample (i.e. 2007/QIV-2012/QIV), the sub-prime period (2007/QIV-2009/QIV) and the sovereign debt crisis period (2010/QI-2012/QIV), respectively. Furthermore, SV.rsk, BK.rsk and FM.rsk represent the sovereign, bank, and firms credit risk premia.



**Table C.9: VAR (1) estimation results for sovereign, bank and firm credit risk in Greece**

Variables	I			II			III		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SV.rsk( $t-1$ )	0.944*** (0.104)	0.200*** (0.07)	-0.012 (0.071)	0.989*** (0.144)	0.311 (0.227)	-0.049 (0.127)	0.904*** (0.235)	0.220*** (0.084)	0.310* (0.173)
BK.rsk( $t-1$ )	0.121 (0.196)	0.494*** (0.132)	0.364*** (0.135)	0.024 (0.121)	0.458** (0.191)	0.420*** (0.106)	0.335 (0.605)	0.423* (0.218)	0.084 (0.383)
FM.rsk( $t-1$ )	-0.042 (0.164)	-0.080 (0.111)	0.756*** (0.113)	0.029 (0.106)	0.029 (0.167)	0.814*** (0.093)	0.086 (0.409)	0.136 (0.147)	0.564** (0.259)

The table reports results of VAR system of sovereign, bank and non-financial firm credit risk in Greece. Definition of all the variables used in the chapter III is outlined in table (C.4) in Appendix (C). Furthermore, three-variables VAR model is estimated by the GMM-approach, whereas, the country-time and fixed-effect are removed prior to the estimation (see section 3.1, chapter III for details). Panel I outlines the results of VAR model for the whole sample period (i.e. 2007/QIV-2012/QIV). Panel II reports the results of period preceding the sovereign debt crisis or time period of the sub-prime effect (i.e. 2007/QIV-2009/QIV), whereas panel III shows the results of VAR estimation for the sovereign crisis period (i.e. 2010/QI-2012/QIV). Dependent endogenous variables are in columns which show the coefficients of regressing these variables on the row variables that is the lag variables. Robust standard errors are in parentheses, whereas \*\*\*, \*\*, and \* shows 1%, 5% and 10% significance level, respectively.

**Table C.10: Credit risk granger causality between sovereign-bank-firm nexus in Greece**

Equation\Excluded	I			II			III		
	chi2	df	Prob>chi2	chi2	df	Prob>chi2	chi2	df	Prob>chi2
SV.rsk									
BK.rsk	0.380	1	0.537	0.039	1	0.842	0.306	1	0.58
FM.rsk	0.066	1	0.797	0.076	1	0.782	0.044	1	0.833
BK.rsk									
SV.rsk	8.178	1	0.004***	1.880	1	0.170	6.768	1	0.009***
FM.rsk	0.527	1	0.468	0.031	1	0.860	0.856	1	0.355
FM.rsk									
SV.rsk	0.029	1	0.863	0.151	1	0.697	3.199	1	0.074*
BK.rsk	7.292	1	0.007***	15.583	1	0.000***	0.048	1	0.826

The table shows VAR (1) granger causality test for the credit risk contagion order between the sovereign-bank-firm nexus in Greece. Panel I outlines the results for the whole sample period (i.e. 2007-QIV to 2012-QIV). Panel II reports the sub-prime crisis period (i.e. 2007-QIV to 2009-QIV), whereas Panel III shows results of the sovereign debt crisis period (i.e. 2010-QI to 2012-QIV). Furthermore, SV.rsk, BK.rsk and FM.rsk represent the sovereign, bank, and firms credit risk premia. Whereas, \*\*\*, \*\*, and \* show 1%, 5% and 10% significance level, respectively.

**Table C.11: Variance decompositions for sovereign, bank and non-financial firm risk in Greece**

Response variable	I			II			III		
	BK.rsk	SV.rsk	FM.rsk	BK.rsk	SV.rsk	FM.rsk	BK.rsk	SV.rsk	FM.rsk
BK.rsk									
Step									
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000
2	0.9571	0.0421	0.0008	0.9852	0.0148	0.0000	0.8587	0.1301	0.0112
3	0.8785	0.1197	0.0018	0.9545	0.0454	0.0001	0.6473	0.3159	0.0368
4	0.7901	0.2074	0.0025	0.9136	0.0860	0.0004	0.4568	0.4690	0.0742
5	0.7074	0.2898	0.0028	0.8673	0.1320	0.0007	0.3108	0.5679	0.1213
6	0.6358	0.3614	0.0029	0.8185	0.1803	0.0012	0.2066	0.6181	0.1753
7	0.5755	0.4218	0.0027	0.7691	0.2291	0.0018	0.1366	0.6320	0.2314
8	0.5251	0.4724	0.0025	0.7203	0.2772	0.0025	0.0922	0.6235	0.2843
9	0.4829	0.5148	0.0022	0.6727	0.3240	0.0033	0.0655	0.6044	0.3301
10	0.4475	0.5505	0.0020	0.6270	0.3689	0.0041	0.0501	0.5830	0.3669
SV.rsk									
Step									
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0135	0.9865	0.0000	0.0444	0.9556	0.0000	0.0000	1.0000	0.0000
2	0.0293	0.9705	0.0002	0.0562	0.9433	0.0005	0.0151	0.9847	0.0001
3	0.0435	0.9560	0.0005	0.0696	0.9290	0.0014	0.0315	0.9683	0.0002
4	0.0552	0.9440	0.0008	0.0835	0.9140	0.0025	0.0445	0.9553	0.0002
5	0.0648	0.9341	0.0011	0.0973	0.8991	0.0036	0.0542	0.9457	0.0002
6	0.0725	0.9260	0.0015	0.1102	0.8850	0.0048	0.0612	0.9385	0.0003
7	0.0789	0.9192	0.0018	0.1222	0.8719	0.0059	0.0664	0.9327	0.0008
8	0.0843	0.9135	0.0021	0.1330	0.8600	0.0069	0.0702	0.9274	0.0024
9	0.0889	0.9087	0.0025	0.1427	0.8494	0.0079	0.0726	0.9212	0.0061
10	0.0928	0.9044	0.0028	0.1513	0.8400	0.0087	0.0739	0.9125	0.0136
FM.rsk									
Step									
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0093	0.0443	0.9464	0.0476	0.0579	0.8946	0.0149	0.0012	0.9839
2	0.1046	0.0230	0.8724	0.3470	0.0545	0.5985	0.0088	0.0715	0.9197
3	0.1797	0.0254	0.7949	0.5026	0.0433	0.4541	0.0093	0.1769	0.8138
4	0.2274	0.0347	0.7379	0.5848	0.0338	0.3814	0.0124	0.2695	0.7181
5	0.2560	0.0457	0.6983	0.6321	0.0277	0.3402	0.0161	0.3394	0.6444
6	0.2727	0.0571	0.6703	0.6602	0.0261	0.3138	0.0194	0.3894	0.5912
7	0.2817	0.0686	0.6498	0.6757	0.0295	0.2947	0.0221	0.4243	0.5536
8	0.2858	0.0801	0.6341	0.6822	0.0386	0.2792	0.0241	0.4486	0.5273
9	0.2867	0.0918	0.6215	0.6814	0.0533	0.2654	0.0255	0.4655	0.5089
10	0.2856	0.1036	0.6108	0.6744	0.0735	0.2521	0.0266	0.4773	0.4961

Row variables are the response variables whereas; column variables are the impulse variables. The percentage variation in the row variables are explained by the column variables (10 periods ahead). Panels I, II and III represent full sample (i.e. 2007/QIV-2012/QIV), the sub-prime period (2007/QIV-2009/QIV), and the sovereign debt crisis period (2010/QI-2012/QIV), respectively. Furthermore, SV.rsk, BK.rsk and FM.rsk represent the sovereign, bank and firms credit risk premia, respectively.

**Table C.12: VAR (1) estimation results for sovereign, bank and firm credit risk in Spain**

Variables	I			II			III		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	SV.rsk( <i>t</i> )	BK.rsk( <i>t</i> )	FM.rsk( <i>t</i> )	SV.rsk( <i>t</i> )	BK.rsk( <i>t</i> )	FM.rsk( <i>t</i> )	SV.rsk( <i>t</i> )	BK.rsk( <i>t</i> )	FM.rsk( <i>t</i> )
SV.rsk( <i>t-1</i> )	0.478*** (0.155)	0.153* (0.091)	0.006 (0.058)	0.558*** (0.191)	0.015 (0.084)	0.010 (0.031)	0.228* (0.191)	0.506*** (0.164)	0.034 (0.198)
BK.rsk( <i>t-1</i> )	0.508** (0.238)	0.529** (0.236)	-0.108 (0.129)	0.946*** (0.327)	0.321** (0.149)	0.059 (0.164)	0.521* (0.271)	0.546*** (0.209)	-0.258 (0.219)
FM.rsk( <i>t-1</i> )	0.403 (0.326)	0.155 (0.239)	0.117* (0.228)	0.410 (0.591)	0.089 (0.256)	0.534** (0.250)	0.238 (0.386)	0.675*** (0.249)	0.057* (0.382)

The table reports results of VAR system of the sovereign, bank and non-financial firm credit risk in Spain. Definition of all the variables used in the chapter III is outlined in table (C.4) in Appendix (C). Furthermore, the three-variable VAR model is estimated by GMM method whereas; the country-time and fixed-effect are removed prior to the estimation (see section 3.1, chapter-III for details). Panel I outlines the results of VAR model for the whole sample period (i.e. 2007/QIV-2012/QIV). Panel II reports results of the sub-prime crisis period (i.e. 2007/QIV-2009/QIV), whereas; panel III shows results of the VAR estimation for the sovereign crisis period (i.e. 2010/QI-2012/QIV). Dependent endogenous variables are in columns which show the coefficients of regressing these variables on the row variables that is their lag variables. Robust standard errors are in parentheses, whereas \*\*\*, \*\*, and \* shows 1%, 5% and 10% significance level, respectively.

**Table C.13: Credit risk granger causality between sovereign-bank-firm nexus in Spain**

Equation\Excluded	I			II			III		
	chi2	df	Prob>chi2	chi2	df	Prob>chi2	chi2	df	Prob>chi2
SV.rsk									
BK.rsk	4.540	1	0.033**	8.392	1	0.004***	3.708	1	0.054*
FM.rsk	1.530	1	0.216	0.482	1	0.488	0.381	1	0.537
BK.rsk									
SV.rsk	2.821	1	0.093*	0.032	1	0.857	9.477	1	0.002***
FM.rsk	0.419	1	0.518	0.121	1	0.728	7.353	1	0.007***
FM.rsk									
SV.rsk	0.013	1	0.91	0.106	1	0.744	0.029	1	0.864
BK.rsk	0.699	1	0.403	0.131	1	0.718	1.39	1	0.238

The table shows VAR (1) granger causality test for the credit risk contagion order between sovereign-bank-firm nexus in Spain. Panel I outlines results for the whole sample period (i.e. 2007-QIV to 2012-QIV). Panel II reports the sub-prime crisis period (i.e. 2007-QIV to 2009-QIV), whereas Panel III shows the results of sovereign debt crisis period (i.e. 2010-QI to 2012-QIV). Furthermore, SV.rsk, BK.rsk and FM.rsk represent the sovereign, bank, and firms credit risk premia. Whereas, \*\*\*, \*\*, and \* show 1%, 5% and 10% significance level, respectively.

**Table C.14: Variance decompositions for sovereign, bank and firm credit risk in Spain**

Response variable	I			II			III		
	BK.rsk	SV.rsk	FM.rsk	BK.rsk	SV.rsk	FM.rsk	BK.rsk	SV.rsk	FM.rsk
BK.rsk									
Step									
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.9514	0.0486	0.0000	0.9976	0.0024	0.0000	0.4825	0.5175	0.0000
2	0.8640	0.1283	0.0077	0.9938	0.0022	0.0040	0.2705	0.6439	0.0856
3	0.8099	0.1761	0.0140	0.9938	0.0023	0.0040	0.2278	0.6782	0.0940
4	0.7804	0.2018	0.0177	0.9936	0.0023	0.0041	0.2125	0.6911	0.0964
5	0.7646	0.2156	0.0198	0.9936	0.0023	0.0041	0.2048	0.6974	0.0978
6	0.7559	0.2231	0.0209	0.9936	0.0023	0.0041	0.2006	0.7009	0.0985
7	0.7512	0.2273	0.0215	0.9936	0.0023	0.0041	0.1982	0.7028	0.0989
8	0.7485	0.2296	0.0219	0.9936	0.0023	0.0041	0.1969	0.7040	0.0992
9	0.7470	0.2309	0.0221	0.9936	0.0023	0.0041	0.1960	0.7046	0.0993
10	0.7461	0.2317	0.0222	0.9936	0.0023	0.0041	0.1955	0.7050	0.0994
SV.rsk									
Step									
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000
2	0.0635	0.9128	0.0237	0.1040	0.8844	0.0117	0.0697	0.9170	0.0133
3	0.1007	0.8668	0.0325	0.0994	0.8818	0.0188	0.0771	0.8840	0.0388
4	0.1200	0.8440	0.0360	0.1009	0.8753	0.0238	0.0795	0.8728	0.0477
5	0.1301	0.8321	0.0377	0.1005	0.8732	0.0263	0.0809	0.8671	0.0520
6	0.1356	0.8258	0.0386	0.1004	0.8721	0.0275	0.0818	0.8639	0.0543
7	0.1386	0.8223	0.0391	0.1003	0.8716	0.0281	0.0822	0.8621	0.0557
8	0.1403	0.8204	0.0393	0.1003	0.8714	0.0283	0.0825	0.8610	0.0565
9	0.1413	0.8193	0.0395	0.1003	0.8713	0.0284	0.0826	0.8604	0.0570
10	0.1418	0.8187	0.0396	0.1003	0.8713	0.0285	0.0827	0.8600	0.0572
FM.rsk									
Step									
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0370	0.0434	0.9196	0.012	0.1044	0.8835	0.0015	0.0004	0.998
2	0.0642	0.0416	0.894	0.0095	0.1131	0.8774	0.0667	0.0457	0.8875
3	0.0718	0.0433	0.8849	0.0088	0.1176	0.8734	0.0680	0.1289	0.8031
4	0.0742	0.0454	0.8804	0.0088	0.1198	0.8714	0.0693	0.1658	0.7647
5	0.0753	0.0469	0.8779	0.0088	0.1208	0.8705	0.0705	0.1855	0.7439
6	0.0758	0.0477	0.8764	0.0088	0.1212	0.8701	0.0711	0.1970	0.7319
7	0.0761	0.0483	0.8756	0.0088	0.1213	0.8699	0.0715	0.2037	0.7248
8	0.0763	0.0486	0.8752	0.0088	0.1214	0.8698	0.0717	0.2077	0.7206
9	0.0764	0.0487	0.8749	0.0088	0.1214	0.8698	0.0718	0.2101	0.7180
10	0.0764	0.0488	0.8748	0.0088	0.1214	0.8698	0.0719	0.2116	0.7165

Row variables are the response variables whereas; column variables are the impulse variables. Percentage variation in the row variables are explained by the column variables (10 periods ahead). Panels I, II and III represent full sample (i.e. 2007/QIV-2012/QIV), the sub-prime period (2007/QIV-2009/QIV), and the sovereign debt crisis period (2010/QI-2012/QIV), respectively. Furthermore, SV.rsk, BK.rsk and FM.rsk represent sovereign, bank and firms credit risk premia, respectively.

**Table C.15: Greek sovereign risk contagion to the rest of euro zone sovereign, bank and firm credit risk**

Variables	I		II		III	
	SV.rsk.rst( <i>t</i> )	SV.rsk.gr( <i>t</i> )	BK.rsk.rst( <i>t</i> )	SV.rsk.gr( <i>t</i> )	FM.rsk.rst( <i>t</i> )	SV.rsk.gr( <i>t</i> )
SV.rsk.rst( <i>t-1</i> )	0.547*** (0.202)	-0.279 (1.123)				
BK.rsk.rst( <i>t-1</i> )			0.859*** (0.131)	-0.413*** (1.57)		
FM.rsk.rst( <i>t-1</i> )					0.543*** (0.203)	-0.833 (3.044)
SV.rsk.gr( <i>t-1</i> )	0.069* (0.035)	0.974*** (0.199)	0.022*** (0.008)	0.815*** (0.119)	0.006 (0.009)	0.940*** (0.136)

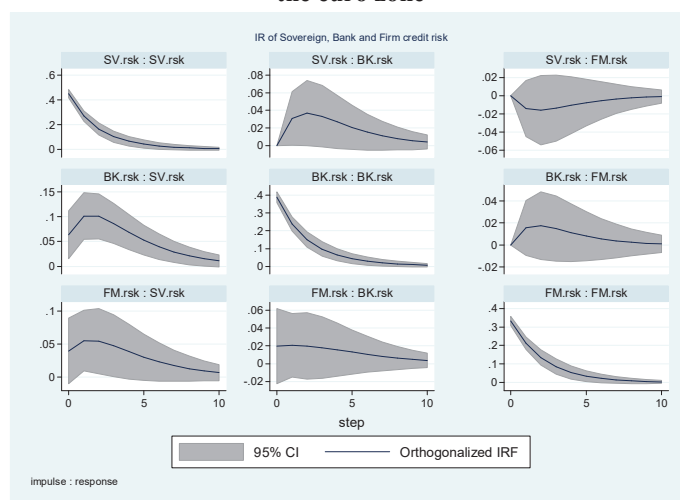
The table reports results of the Greek sovereign risk contagion to the rest of euro zone's sovereign, bank and non-financial firm credit risk during the recent crisis period (i.e. 2010/QI-2012/QIV). The variables: *SV.rsk.gr* is the Greek sovereign risk, whereas; *SV.rsk.rst*, *BK.rsk.rst*, and *FM.rsk.rst* are sovereign, bank and non-financial firm risk in the rest of euro zone. Dependent endogenous variables are in columns that show the coefficients of regressing these variables on the row variables that is the lag values. Robust standard errors are in parentheses, whereas \*\*\*, \*\*, and \* show 1%, 5% and 10% significance level, respectively.

**Table C.16: Sovereign risk contagion from Germany to the rest of euro zone sovereign, bank and non-financial firm sectors during the public debt crisis**

Variables	I		II		III	
	SV.rsk.rst( <i>t</i> )	SV.rsk.de( <i>t</i> )	BK.rsk.rst( <i>t</i> )	SV.rsk.de( <i>t</i> )	FM.rsk.rst( <i>t</i> )	SV.rsk.de( <i>t</i> )
SV.rsk.rst( <i>t-1</i> )	0.914*** (0.113)	-0.202*** (0.040)				
BK.rsk.rst( <i>t-1</i> )			0.930*** (0.134)	-0.607*** (0.157)		
FM.rsk.rst( <i>t-1</i> )					0.176 (0.253)	-0.217 (0.223)
SV.rsk.de( <i>t-1</i> )	0.622*** (0.251)	0.908*** (0.090)	0.332*** (0.102)	0.672*** (0.119)	0.409** (0.196)	0.978*** (0.174)

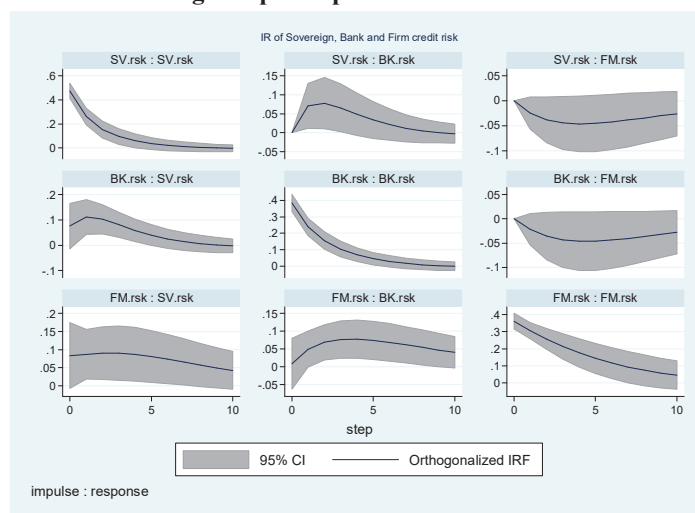
The table reports results of VAR system of one standard deviation shock to the sovereign risk of Germany towards the rest of euro zone's sovereign, bank and non-financial firm sectors during the recent crisis period (i.e. 2010/QI-2012/QIV). The variables: *SV.rsk.de*, is German sovereign risk premia, whereas; *SV.rsk.rst*, *BK.rsk.rst*, and *FM.rsk.rst* are sovereign, bank and non-financial firm credit risk in the rest of euro zone. Dependent endogenous variables are in columns which show the coefficients of regressing these variables on the row variables that is their lag variables. Robust standard errors are in parentheses, whereas \*\*\*, \*\*, and \* show 1%, 5% and 10% significance level, respectively.

**Figure C.1: Impulse-response (IR) functions of PVAR (1) estimation for sovereign-bank-firm credit risk in the euro zone**



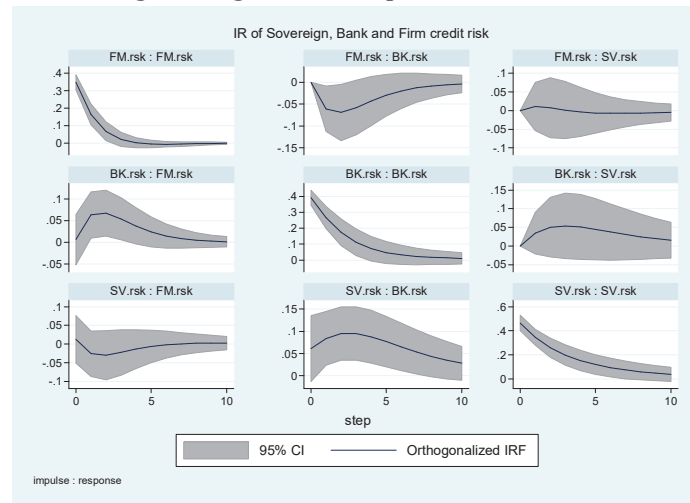
Note: Impulse response functions estimated from focused three-variable panel vector autoregression (PVAR), controlling for country-fixed effects, with identification through Cholesky Decomposition of one-standard deviation. The highlighted area in figure shows two-standard error bands. Forecast horizons are in quarters. Whereas: SV.rsk, BK.rsk, and FM.rsk represents sovereign, bank, and firm credit risk, respectively. The sample period includes full time frame from 2007-QIV to 2012-QIV

**Figure C.2: Impulse-response (IR) functions of PVAR (1) estimation of sovereign-bank-firm credit risk during sub-prime period in the euro zone**



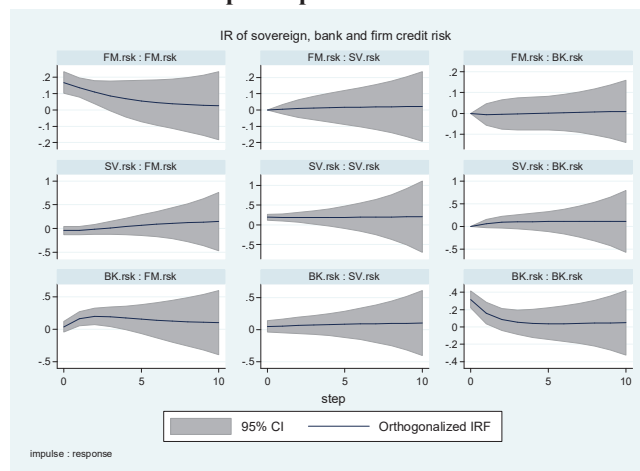
Note: Impulse response functions estimated from focused three-variable panel vector autoregression (PVAR), controlling for country-fixed effects, with identification through Cholesky Decomposition of one-standard deviation. The highlighted area in figure shows two-standard error bands. Forecast horizons are in quarters. Whereas: SV.rsk, BK.rsk, and FM.rsk represents sovereign, bank, and firm credit risk, respectively. The sample period spans from 2007-QIV to 2009-QIV

**Figure C.3: Impulse-response (IR) functions of PVAR (1) estimation for sovereign-bank-firm credit risk during sovereign debt crisis period in the euro zone**



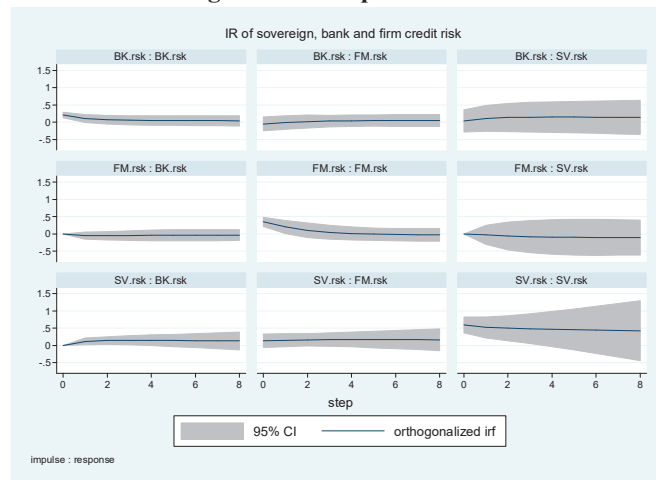
Note: Impulse response functions estimated from focused three-variable panel vector autoregression (PVAR), controlling for country-fixed effects, with identification through Cholesky Decomposition of one-standard deviation. The highlighted area in figure shows two-standard error bands. Forecast horizons are in quarters. Whereas: SV.rsk, BK.rsk, and FM.rsk represents sovereign, bank, and firm credit risk, respectively. The sample time period spans from 2010-Q1 to 2012-Q4

**Figure C.4: Impulse-response (IR) functions of VAR (1) estimation of sovereign-bank-firm credit risk during sub-prime period in Greece**



Note: Impulse response functions estimated from focused three-variable vector autoregression (VAR), controlling for country-fixed effects, with identification through Cholesky Decomposition of one-standard deviation in Greece. The highlighted area in figure shows two-standard error bands. Forecast horizons are in quarters. Whereas: SV.rsk, BK.rsk, and FM.rsk represents sovereign, bank, and firm credit risk, respectively. The sample period spans from 2007-Q4 to 2009-Q4.

**Figure C.5: Impulse-response (IR) functions of VAR (1) estimation of sovereign-bank-firm credit risk during sovereign debt crisis period in Greece**



Note: Impulse response functions estimated from focused three-variable vector autoregression (VAR), controlling for country-fixed effects, with identification through Cholesky Decomposition of one-standard deviation in Greece. The highlighted area in figure shows two-standard error bands. Forecast horizons are in quarters. Whereas: SV.rsk, BK.rsk, and FM.rsk represents sovereign, bank, and firm credit risk, respectively. The sample time period spans from 2010-Q1 to 2012-Q4





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**Syed Muhammad Noaman Ahmed SHAH**

**Analyse des effets d'interdépendance des secteurs publics, bancaires et réels dans la crise de la zone euro**

Résumé:

Alors que le début de la crise de l'euro a relancé le débat sur l'interdépendance du risque de crédit et la relation dette bancaire-dette souveraine, l'importance du secteur réel est négligée dans l'élaboration des mesures de relance de la croissance économique dans la zone euro. Cette thèse se concentre sur ces questions au sein de la zone euro. D'abord, nous évaluons les effets «spillover» de la crise souveraine sur le coût de crédit des entreprises non financières en présence des mesures d'austérité (*Chapitre-I*). Nos résultats indiquent un effet significatif de la dette publique sur le coût des prêts. En outre, en période de crise, les mesures d'austérité impactent significativement le coût de crédit tandis qu'avant la crise, on note une petite illustration de la demande agrégée de Keynes. Ensuite, nous montrons que les fonctions traditionnelles des banques, notamment celle de création de liquidité fragilisent le secteur souverain (*Chapitre-II*). En particulier, nous montrons que le risque de liquidité des banques agit comme un canal de propagation de l'incertitude vers les sociétés non financières et inversement. Enfin, nous examinons la dynamique du risque de crédit sur la dette souveraine, les entreprises et les banques (*Chapitre-III*). Nos résultats montrent qu'il existe un risque de contagion sur les secteurs et les marchés financiers de l'union monétaire. Par ailleurs, les résultats des simulations de chocs de primes de risque des pays «noyaux» de la zone euro confirment l'existence d'effets indirects sur le reste de la zone. De plus, nous constatons un phénomène de fuite des investisseurs vers les valeurs refuges.

Mots clés: dette souveraine, «spread» des prêts-syndiqués, CDS, modèle d'équations simultanées, contagion, la crise de l'euro

**Analyzing spillover effects between sovereign, financial and real sectors during the euro zone crisis**

Abstract:

The onset of euro crisis has rekindled the policy debate regarding credit risk interdependence among sovereign-bank nexus. In this vein, the importance of real sector is overlooked while formulating corrective measures for the recovery of economic growth in EMU. This thesis presents a study that examined these issues in euro zone. First, we evaluate spillover effect of euro crisis on borrowing cost of non-financial firms in presence of austerity measures (*Chapter-I*). Our results suggest significant effect especially where creditor rights protection are weak. In addition during recent crisis, results indicate presence of credibility channel due to austerity measures whereas; there is slight indication of aggregate demand channel before crisis. Second, we find traditional function of bank's liquidity creation as a significant conduit of sovereign distress to real sector (*Chapter-II*). Particularly, our main finding shows that bank liquidity risk acts as a conduit which propagates uncertainty towards non-financial firms and re-channels it back to respective government. Finally, we examine cross-market credit risk dynamics among sovereign-bank-firm nexus to identify presence of contagion during euro crisis period (*Chapter-III*). Our results report grave evidence of credit risk contagion across sectors and member states in corresponding financial markets in EMU. Moreover like peripheral countries, simulation results to shock in core countries risk premia strongly provide evidence of contagion towards remaining euro zone.

Keywords: sovereign debt, syndicated-loan spread, bank liquidity risk, CDS spread, simultaneous equations model, contagion, euro crisis



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