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## Credit risk determinants and connections in the euro zone

Amina Ben Yahya

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THÈSE

Pour l'obtention du grade de Docteur de l'Université Paris Nord

*Discipline : Sciences économiques*

Presentée et soutenue publiquement par

Amina BEN YAHYA

le 04 Novembre 2014

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CREDIT RISK DETERMINANTS AND  
CONNECTIONS IN THE EURO ZONE

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*À mes parents, à ma famille et à mes amis.*





« An economist is an expert who  
will know tomorrow why the  
things he predicted yesterday  
didn't happen today. »

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Laurence J. Peter



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## Résumé

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Le déclenchement de la dette des Subprime en 2007, suivie de la crise de la dette Européenne en 2011, a attiré l'attention vers le risque de crédit, ses causes et ses implications. Depuis, Les décideurs des politiques économiques cherchent à trouver un moyen pour réguler les mouvements sur le marché des obligations et des dettes. Ainsi, sous l'impulsion du Conseil de stabilité financière, les accords de Bâle III sont apparus. Ce sont des réformes visant à renforcer le système financier afin d'affirmer la solidité financière des banques en imposant des conditions d'emprunt dont un niveau minimum de capitaux propres.

Les travaux étudiant les risque de crédit avec ses différentes façades ont connu un boom.

Il y a notamment la modélisation du risque de crédit qui s'est énormément développée. Cette thèse s'inscrit dans une branche macroéconomique à l'échelle Européenne. Nous essayons d'identifier les déterminants du risque de crédit aux niveaux souverains et bancaires et d'étudier les connections entre les deux.

Dans une première partie, nous utilisons une modélisation Autoregressive à retards échelonnés<sup>1</sup>(ARDL) afin de définir les déterminants macroéconomiques d'un échantillon de pays européens. Nous suggérons que le risque de crédit de ces derniers dépend largement des fondamentaux macroéconomiques avec des élasticités différentes selon les conditions économique du pays. Plus précisément, nous trouvons que le taux du chômage est la variable la plus influente notamment lorsqu'il s'agit des pays économiquement fragiles. Les relations déterminées sont significa-

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1. Autoregressive Distributed Lag Model

tives et globalement stable à long terme.

Dans la deuxième partie, nous nous intéressons aux déterminants du risque de crédit d'un échantillon de groupes bancaires Européens. Depuis 2007, Ces derniers ont été affectés par les deux crises (Subprime et la crise de la dette Européenne). Les relations de long terme définies selon les tests de cointégration via l'approche des Bounds Tests<sup>2</sup>, montrent qu'une dévaluation de l'Euro baisse le risque de crédit des banques étudiées en rendant leurs dettes libellées en Euro moins coûteuses. Aussi, notre analyse indique que la valeur de marché de l'entité ainsi que l'indice boursier dans lequel la banque est inscrite sont inconsistant dans l'explication du risque de crédit de cette dernière.

Dans la dernière partie nous étudions les relations de causalité entre les risques de crédit des entités souveraines et bancaires étudiées dans les chapitres précédents. Les tests de causalité au sens de Granger révèlent que les relations trouvées sont asymétriques et dynamiques. Ces liens varient considérablement en fonction de l'état de l'économie de la région. L'analyse montre aussi que juste avant les période de grandes turbulences financières, notamment les crises financières, le transfert du risque de crédit est très important augmentant ainsi les contagions et par la suite le risque systémique. Cependant, la propagation de la méfiance et de la prudence pendant les périodes d'incertitude et des crises, fait baisser significativement le transfert du risque de crédit. Ceci s'accroît dans une zone monétaire comme la zone Euro puisque les pays adoptent forcément les mêmes politiques monétaires voire fiscales malgré leur hétérogénéité.

**Mots-clés :** Risque de Crédit, La Zone Euro, Fondamentaux Macroéconomiques, Transfert du risque de crédit, Risque systémique, Connectivité.

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2. Bounds testing approach to cointegration

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## Abstract

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The outbreak of the Subprime debt in 2007, followed by the European debt crisis in 2011, drew attention to credit risk, its causes and implications. Since then, the economic policy makers are seeking to find a way to regulate the movements on the bond and debt market. Thus, the Basel III appeared under the guidance of the Financial Stability Board. These are reforms aiming at strengthening the financial system in order to assert the financial soundness of banks by imposing loan conditions and requirements including a minimum level of Capital.

Works studying the credit risk with its different fronts boomed. Credit risk modeling has expanded tremendously. This thesis fits into a macroeconomic branch on a European scale. We try to identify the determinants of credit risk on the sovereign and banking levels and to study the connections between both.

In the first section, Using Autoregressive Distributed Lag Modeling (ARDL), we empirically investigate the link between the macroeconomic fundamentals and sovereign credit risk for particular countries in the Euro zone. The studied sample was affected by disadvantageous economic conditions.

We did not retain the same macroeconomic factors to explain the risk of default for the selected countries. The results, indicate that the creditworthiness of the studied entities depends largely on macroeconomic fundamentals with various elasticities which require a different economic policy for each country. The assessment of the results shows that the unemployment rate is the most influential variable especially for countries with disadvantageous economic conditions. The estimated relationships are globally stable in the long run (for 7 out of 9 countries), while



the short run links are rare (except the unemployment rate).

In the second section, we investigate the long-run relationships between European Banks' Credit default swap spreads and contextual factors using Bounds testing approach to cointegration (ARDL-ECM). The results reveal that in the long run, an increase of the inflation and/or the home countries' credit risk rise the European banks' credit risk as measured by credit default swap spreads. The estimates suggest that the devaluation of the Euro, makes Euro-denominated debt less costly which lowers the credit risk of the European entities. Yet, unlike what is expected, our analysis shows that the market value of an entity as well as the stock index in which the firm is registered are becoming insignificant in explaining its credit risk. In this last section, we investigate the evolution and the expansion of the CDS network among the studied entities over the 2008 - 2013 period by splitting it into three sub-periods. We highlight the variation of the connectedness according to the financial and economic characteristics of each studied sub-period. We found that the resulting relationships are not symmetrical and that they vary considerably depending on the state of the region economy. We also show that just before huge financial turmoil phases, the risk transfer is very important increasing contagion and the systemic risk, while it drops significantly during uncertainty times marked by mistrust spread. This is particularly important in the European Union as countries adopt the same monetary policies while being heterogeneous.

**Keywords:** Credit Risk, Euro-Zone, Macroeconomic fundamentals, Credit risk transfer, Systemic Risk, connectivity.

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## Introduction générale

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### Introduction

L'étude du risque de crédit a connu un développement rapide en raison de son importance croissante et de ses effets de plus en plus globaux. Les individus, les banques, les organismes de crédit, voire les économies sont interliés à travers leurs endettements et leurs solvabilités. Le défaut ou le non remboursement d'une entité a un effet direct sur les entités prêteuses mais aussi un effet indirect sur les autres entités prêteuses et emprunteuses de celle-ci. Les activités d'endettements entraînent des liens étroits entre les contreparties qui s'accompagnent par un transfert du risque de crédit. Ceci se fait généralement par le biais des produits financiers complexes ce qui engendre une opacité quant à la qualité du produit.

Depuis la crise des Subprimes dont les manifestations sont devenues publiques à partir de 2007, une grande partie des sommets économiques, notamment les européens essayent d'étudier les causes de ce risque afin d'en limiter les effets et la propagation. En effet, cette crise a pris au dépourvu les régulateurs qui ne s'y attendaient pas d'où la déclaration des experts du Fonds monétaire international qu'" en dépit de la volatilité récente sur les marchés financiers, la croissance mon-



diale devrait rester vigoureuse en 2007 et en 2008".

La crise de la dette Européenne qu'a suivie, n'a fait qu'empirer la situation des systèmes financiers et économiques internationaux. Cette crise est une manifestation des effets du risque de crédit à l'échelle macroéconomique.

## Motivation

les chocs récents sur le marché de la dette européenne ont attiré l'attention des intervenants des marchés financiers sur la forte croissance des montants concernés par le risque de crédit bancaire et souverain dans le système financier global. Après la crise des Subprimes, Ces préoccupations se sont accrues avec l'élargissement rapide de tous les spreads de crédit dans toute l'Europe dans le sillage de la crise de la dette Grecque et Irlandaise. Cet élargissement a également soulevé des craintes que le risque de crédit souverain soit beaucoup plus de nature systémique que ce qui a été prévu.

Comprendre les causes, le transfert et les implications de ce risque est essentiel et fondamental pour les régulateurs et les décideurs politiques. Cependant quelques difficultés limitent notre capacité à étudier empiriquement le phénomène global. Par exemple, il n'y a toujours pas de consensus quant au meilleur estimateur du risque de crédit, ce qui est primordial dans l'appréciation de la qualité d'un créancier. Le choix d'un proxy fiable peut emmener les débiteurs à rentabiliser leurs investissements et tout en minimisant les risques.

Dans ce contexte, nous essayons de comprendre le risque de crédit dans la zone euro au niveau souverain ainsi qu'au niveau bancaire et les canaux de transmission entre les différentes entités.

Pour ce faire, nous nous proposons d'étudier empiriquement les déterminants du risque de crédit pour des échantillons de souverains et groupes bancaires Européens

et d'identifier comment se fait la contagion et comment le défaut d'une entité peut prendre des dimensions systémiques.

## Overview

### Chapitre I

Dans le premier chapitre, on présente la revue de la littérature la plus importante et la plus influente portant sur le sujet. Le risque de crédit a connu plusieurs modélisations s'inscrivant dans différentes approches. La première est la l'approche structurelle initiée par Merton 1974 en 1974. La deuxième famille de modèle à savoir les modèles de forme réduite a vu le jour avec celui de Jarrow and Turnbull 1995. La troisième approche est l'approche économétrique lancée par Wilson 1998, son modèle a été publié par McKinsey & company en 1998.

### Chapitre II

Dans ce chapitre, nous étudions empiriquement le lien entre les fondamentaux macroéconomiques et le risque de crédit souverain pour certains pays de la Zone euro, à savoir: l'Autriche, Pays-Bas, Luxembourg, Belgique, France, Allemagne, Italie, Espagne et Portugal. L'échantillon étudié a été affecté par des conditions économiques défavorables.

Ainsi, l'identification des déterminants du risque de crédit est cruciale et nécessaire pour une meilleure compréhension de la crise. À l'aide du modèle autorégressif à retards échelonnés (ARDL), nous n'avons pas validé les mêmes facteurs macroéconomiques pour expliquer le risque de défaut des pays sélectionnés. Les modèles retenus, en plus d'expliquer dans quelle mesure le risque de crédit réagit aux variations des variables explicatives, ils servent d'outils pour les stress tests. Les résul-

tats indiquent que la solvabilité des entités étudiées dépend en grande partie des fondamentaux macroéconomiques avec des élasticités différentes ce qui nécessite une politique économique distincte pour chaque pays. Par ailleurs, l'évaluation des résultats montre que le taux de chômage est l'une des variables les plus influente quant à la solvabilité des pays Européens étudiés, notamment quand il s'agit des pays ayant des conditions économiques assez critiques.

### **Chapitre III**

le chapitre 3 examine les relations de long terme entre les credit default swap CDS d'un échantillon de groupes bancaires Européens avec des facteurs contextuels macroéconomiques et spécifiques aux banques étudiée en utilisant les Bounds testing approach to cointegration (ARDL-ECM).

En utilisant les Credit default swap spreads comme proxy du risque de crédit, les résultats révèlent que dans le long terme, une augmentation de l'inflation et / ou du risque de crédit du pays d'origine s'accompagnent de l'accroissement du risque de crédit de l'entité étudié. Les estimations suggèrent que la dévaluation de l'euro, rend dette libellée en euros moins coûteuse ce qui baisse le risque de crédit des entités Européennes. Cependant, contrairement à ce qui est attendu, notre analyse montre que la valeur de marché de l'entité ainsi que l'indice boursier dans lequel la société est inscrite ne sont pas pertinents dans l'explication de son risque de crédit.

### **Chapitre IV**

Dans ce chapitre nous allons nous concentrer sur le transfert du risque de crédit entre les entités étudiées dans les chapitres précédents. En effet, la connectivité croissante des marchés mondiaux est due à plusieurs facteurs. Toutefois, après les dernières crises financières, le facteur du risque de crédit est devenu le plus

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déterminant. en utilisant les tests de causalité au sens de Granger, nous avons construit un réseau de Credit default Swap reliant des entités souveraines et bancaires européennes. Nous étudions l'évolution et l'expansion de ce réseau durant la période de 2008-2013. Nous soulignons la variation des connectivités en fonction des caractéristiques économiques et financières de chaque sous-période étudiée. Nous avons observé que les liens obtenus ne sont pas symétriques et qu'ils varient considérablement en fonction de l'état de l'économie de la Zone Euro. Nous montrons aussi que juste avant les phases de turbulences financières, le transfert de risque est très important ce qui engendre la montée de la contagion et favorisant le risque systémique. Néanmoins, ce transfert diminue de façon significative pendant les périodes d'incertitude marquées par la propagation de la méfiance. Ceci est particulièrement important dans l'Union européenne où des pays hétérogènes adoptent les mêmes politiques monétaires.



## Introduction

Le risque de crédit est le premier risque auquel est confronté un établissement financier dès lors qu'il décide d'accorder un crédit et de se mettre en situation d'attente de fonds en remboursement de la part d'une autre partie. Il est lié à l'ambiguïté quant aux conséquences futures du contrat établi. L'exposition au risque représente le montant de la perte que l'établissement prêteur peut encourir dans le cadre des opérations de crédit à partir du moment où l'emprunteur se trouve incapable d'honorer ses engagements au cours de la vie de l'opération; ainsi, le risque de crédit provient du défaut ou de la détérioration de la qualité de la contrepartie créancière.

Plus généralement, on peut dire que ce risque naît de l'incertitude quant à la possibilité ou la volonté des contreparties ou clients de remplir leurs engagements c à d le remboursement du crédit octroyé par l'institution prêteuse.

Le risque de crédit est alors fonction de trois paramètres principaux à savoir le montant de la créance, la probabilité de défaut et la partie qui ne pourra pas être recouvrée en cas de survenance de défaut ce qui correspond à  $(1 - R)$  où  $R$  est le

taux de récupération.

L'objectif est d'arriver à une estimation de la probabilité de défaut, pour ce faire il existe plusieurs modèles qui s'inscrivent dans différentes approches : modèles structurels, modèles de forme réduite, et modèles économétriques.

#### Les modèles structurels

Appelés aussi les modèles de valeur de la firme<sup>3</sup> dans la mesure où cette approche essaye d'expliquer le défaut par les variables économiques de la firme, ainsi cette dernière est en faillite dès lors que la valeur de ses actifs passe en dessous de la valeur de sa dette.

#### Les modèles de forme réduite

Dans ces modèles, le défaut est un événement imprévisible qui suit un processus de poisson qui se traduit par une baisse brusque de la valeur de la firme.

#### Les modèles économétriques

Ces modèles sont surtout utilisés pour un secteur de l'économie ou un pays et prennent en considération l'état de l'économie comme facteur provoquant le défaut, ainsi, la probabilité de défaut s'explique par différents facteurs macroéconomiques tels que le taux d'intérêt de long terme, le taux de croissance du PIB...

## **Les modèles structurels**

Initié par Merton 1974 en application directe du modèle Black-Scholes 1973, les modèles structurels sont purement dictés par la théorie, en effet, en évaluant la dette risquée, l'évènement de défaut survient lorsque les actifs de la firme (à savoir la valeur de marché de ses actions) perdent de la valeur de telle sorte que l'entreprise n'est plus en mesure de payer sa dette, concrètement on peut dire que ce qu'elle possède est inférieur à ce qu'elle doit rembourser. Dans cette approche,

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3. les composantes de son bilan comptable

l'évaluation de la dette se fait par la théorie des options. L'action ainsi que la dette de la firme s'analysent comme étant des produits dérivés sur la valeur totale de ses actifs.

Dans cette première partie théorique, nous allons présenter le modèle structurel de base à savoir celui de Merton 1974 ainsi que les extensions les plus marquantes. Black and Cox 1976 ont développé le premier prolongement du modèle initial en essayant de remédier à certaines limites de ce dernier. Sur le plan pratique, il y a notamment le modèle de KMV qui utilise le cadre structurel pour calculer la distance au défaut pour une entité donnée.

## le modèle de Merton

Les travaux de Robert Merton (Merton 1974) pour les quels il a reçu le prix Nobel en économie en 1997 ont aboutit au premier modèle structurel de risque de crédit, celui-ci se base sur le fait que les valorisations ainsi que les risques des actions et de la dette d'une entreprise sont rigoureusement liées puisqu'elles s'appuient sur les mêmes cashflow générés par les actifs de cette dernière, il adapte par la suite le modèle de Black-Scholes-Merton<sup>4</sup> sur les produits dérivés au risque de crédit.

### calcul de la probabilité de défaut

Si l'on considère une entreprise dont le bilan économique est représenté par le tableau suivant: Ainsi l'actif de cette entreprise est financé par des fonds propres

Actif	Passif
Actif... $V_t$	Capital... $S_t$ Dette... $D_t$

---

4. Le modèle Black-Scholes-Merton est un modèle mathématique du marché pour une action dans lequel le prix de l'action est un processus stochastique (see Black and Scholes 1973)



à la propriété des actionnaires (Capital  $S_t$ ) ainsi que par une dette zéro coupon détenue par les créanciers (Dettes  $D_t$ ) (valorisés tous les deux en valeur de marché). Les actifs de l'entreprise suivent un processus de diffusion<sup>5</sup> Wiener Standard qui est un processus continu, il est de la forme:

$$dV_t = rdt + \sigma_V dB_t \quad (1)$$

Où:

- $r$  est le taux d'intérêt sans risque (fixe)
- $\sigma_V$  est la volatilité de la valeur des actifs (supposée constante (voir GROUARD et al. 2003)<sup>6</sup>)
- $B$  est un processus de Wiener Standard<sup>7</sup>.

les hypothèses du modèle sont :

- la dette est constituée d'un zéro coupon<sup>8</sup> de valeur nominale  $D$  et de maturité  $T=1$  qui correspond à une période.
- L'entreprise est liquidée à l'échéance  $T$  de la dette.

À l'échéance, deux situations sont alors possibles:

1.  $V(T) < D$ : la société est en faillite, les actionnaires font défaut et paient les créanciers par la valeur des actifs.
2.  $V(T) > D$ : solder les actifs, rembourser les créanciers et empocher ce qui reste, le reliquat sera réparti entre les actionnaires au prorata de leurs parts

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5. Un processus de diffusion est un processus de Markov à trajectoires continues donc le processus est indexé selon un temps continu

6. hypothèse très forte et ne reflète pas la réalité puisqu'on a empiriquement constaté que les actifs financiers sont généralement très volatils

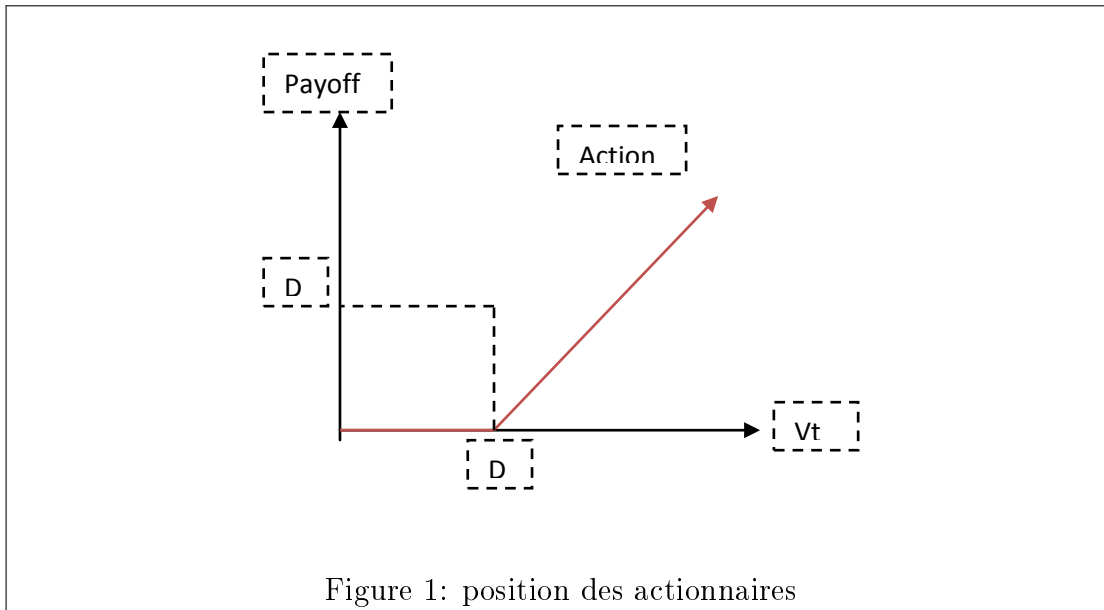
7. Nommé en l'honneur de Norbert Weiner, appelé aussi mouvement brownien d'après Robert Brown; C'est une description mathématique d'un mouvement aléatoire à temps continu.

8. Une obligation à zéro coupon se définit comme étant une obligation sans versement d'intérêts durant toute sa durée de vie, les intérêts sont versés en totalité à l'échéance de l'emprunt après capitalisation

du capital de la société.

Dans cette perception, les actions ainsi que la dette peuvent être interprétées comme étant des produits dérivés sur les actifs de la société comme sous-jacent.

**Pour les actionnaires :** La détention d'une action est équivalente à être long<sup>9</sup> sur un call<sup>10</sup> sur la valeur des actifs  $V_t$  de prix d'exercice<sup>11</sup>  $D$  et d'échéance  $T$ .



- $V_t$  c'est la valeur de l'actif qui varie.
- Le strike  $D$  qui représente le prix critique qui détermine s'il y a ou non exercice de l'option ( mise en faillite ou pas).
- Échéance  $T$  qui, dans le modèle de Merton, correspond a la date à laquelle l'entreprise peut ou non faire faillite.

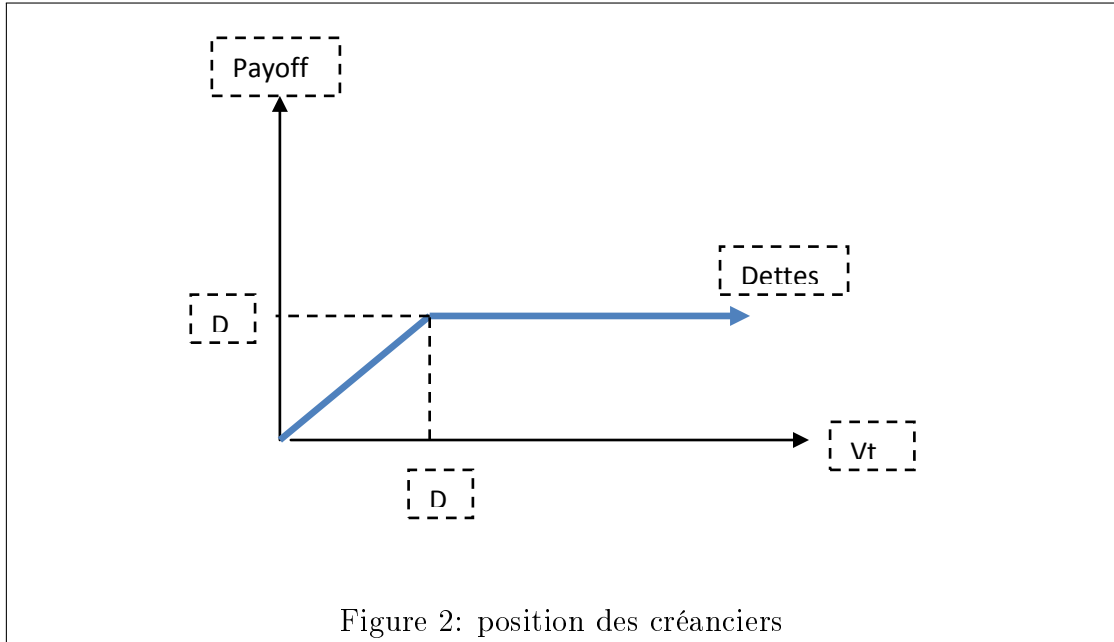
**Pour les créanciers :** leur position est équivalente à la détention d'une zéro-coupon sans risque de valeur nominale  $D$  avec une position courte sur un Put sur

9. Une position acheteuse prise sur le marché

10. Un Call est une option donnant à son acheteur le droit, mais non l'obligation d'acheter l'actif sous-jacent

11. Le Prix d'exercice d'une option correspond au prix auquel est convenu d'être acheté ou vendu l'actif sous-jacent, appelé également le Strike

la valeur des actifs de Strike D et d'échéance T. En appliquant la valorisation par



actualisation selon l'espérance des Cashflows sous probabilité risque-neutre à la valeur de la dette on obtient:

$$D_t = e^{-rT} * E[\text{Min}(V_T, D)] \quad (2)$$

$e^{-rT}$  est le facteur d'actualisation sans risque de date t et de maturité T:

$$D_t = e^{-rT} D - e^{-rT} E[\text{Max}(0, (D - V_T))] \quad (3)$$

car  $[\text{Min}(a, b) = a - \text{Max}(0, a - b)]$

Comme présenté ci-dessous, le modèle de Merton se base sur la théorie d'option pour valoriser la dette et les actions, notamment sur la formule de Black and Scholes 1973<sup>12</sup>

12. Formule de Black-Scholes pour un put :  $P(V_0, D, r, t, \sigma) = -V_0 \mathcal{N}(-d_1) + D e^{-rt} \mathcal{N}(-d_2)$

$$D_t = e^{-rt}D - e^{-rt}E[\text{Max}(0, (D - V_T))] \quad (4)$$

$$D_t = e^{-rt}D - [-V_t\mathcal{N}(-d_1) + De^{-rt}\mathcal{N}(-d_2)] \quad (5)$$

$$D_t = V_t\mathcal{N}(-d_1) + De^{-rt}[1 - \mathcal{N}(-d_2)] \quad (6)$$

$$D_t = V_t\mathcal{N}(-d_1) + De^{-rt}\mathcal{N}(d_2) \quad (7)$$

Où:

$$d_1 = \frac{\text{Ln}(\frac{V_0}{D}) + (r + 0,5\sigma_v^2)(T - t)}{\sigma_v\sqrt{T - t}} \text{ et } d_2 = d_1 - \sigma_v\sqrt{T - t} \quad (8)$$

Et  $\mathcal{N}(\cdot)$  : la fonction de répartition de la loi normale centrée réduite

**La valeur de marché des capitaux propres  $S_t$**

$$S_t = V_t\mathcal{N}(d_1) - De^{-rt}\mathcal{N}(d_2) \quad (9)$$

**Probabilité de défaut**

$$P = \mathcal{N}(-d_2) = 1 - \mathcal{N}(d_2) \quad (10)$$

### Calcul du spread de crédit

$$D_0 = De^{-r_i t} \iff e^{-r_i t} = \frac{D_0}{D} \iff r_i = \frac{\text{Ln} \frac{D}{D_0}}{t} \quad (11)$$

Où  $r_i$  : Le taux de rendement de la dette Et  $S$  : Le spread de crédit  $S = r_i - r$

### Calcul du taux de recouvrement $R$

$$S = \frac{1}{tQ(1 - R)} \quad (12)$$

Où  $Q$  : la probabilité cumulée de défaut.

### Limites du modèle

Le modèle de Merton est très restrictif et est critiqué pour ses hypothèses irréalistes. En effet, il s'appuie sur l'hypothèse de l'efficience du marché des actions, ainsi la firme est considérée correctement évaluée par le prix coté. Aussi, le fait que le défaut ne peut survenir qu'à la date de l'échéance de la dette est une hypothèse utopique. La structure plate des taux d'intérêt fait qu'ils soient considérés constants par l'application du modèle B-S. Le modèle de Merton ne prend en compte que les obligations zéro-coupon et le défaut est totalement endogène aux variables économique de l'entreprise, il est parfaitement prévisible à travers celles-ci, or dans la réalité, il y a des firmes qui survivent bien que leurs valeurs soit au-dessous de la valeur nominale de la dette et d'un autre côté, il y a des entreprise en faillite alors que leurs valeurs restent au-dessus de la valeur nominale de leurs dettes.

## Le modèle de Black et Cox

Black and Cox 1976 dans une extension du modèle de Merton 1974 ont réussi à abandonner l'hypothèse de la date unique de banqueroute à savoir l'échéance de la dette. Ainsi la faillite de la firme peut survenir dès que la valeur de celle-ci passe en deçà d'un seuil critique à n'importe quel instant entre l'accord de la dette et son échéance.

### calcul de la probabilité de défaut

B-C assument que les actionnaires reçoivent des dividendes continuellement et proportionnellement à la valeur de la firme ( $C = \kappa V$ ), ainsi, la valeur de cette dernière suit le processus :

$$dV_t = V(r - \kappa)dt + V\sigma_v dBt \quad (13)$$

Où  $\kappa$  : représente le taux continu de paiement de dividendes qui est considéré constant.

Comme le montre le graphique, le modèle de Merton ne permet pas une faillite avant l'échéance même si la valeur des actifs de la firme passent en dessous de la valeur de la dette à rembourser à une date antérieure au terme du contrat du prêt, ainsi le modèle de B-C est le premier des First-Passage modèles, ainsi, la spécificité de ce modèle par rapport au modèle de Merton est que le temps de défaut est une fonction du temps.

$$\tau = \inf_{t > 0} : V(t) < K(t) \quad (14)$$

$$K(t) = Ke^{-\gamma(T-t)}$$

avec  $K, \gamma > 0$  où  $K(t)$  est la barrière qui déclenche la faillite de l'entreprise, c'est-à-dire le premier instant où la valeur de celle-ci devient inférieure au seuil. si la firme fait défaut, les créanciers reçoivent alors un recouvrement proportionnel à la valeur de l'entreprise au moment du défaut :

$$\zeta_1 V(\tau) \text{ en } \tau \text{ si } \tau < T$$

$$\zeta_2 V(T) \text{ en } T \text{ si } \tau = T$$

avec  $\zeta_1, \zeta_2 > 0$

Black et Cox ont aussi introduit les pactes de sécurité (Safety covenants) qui donnent le droit aux créanciers de choisir, si l'entreprise se porte mal, entre la forcer à faire faillite et par la suite la liquider et vendre ses actifs dont le produit sera réparti entre les détenteurs de droits contre la firme selon leur classement, ou alors renégocier les termes du contrat.

#### Safety Covenants<sup>13</sup>

On parle de mauvaise performance selon B-C(76) en comparant la valeur de l'entreprise à une barrière déterministe.

$$K(t) = Ke^{-\delta(T-t)} \text{ Où } t \in [0, T] \text{ et } K, \delta > 0$$

Ainsi, la firme se porte mal dès que la valeur de ses actifs  $V_t$  touchent cette barrière et les créanciers peuvent s'en emparer sinon il y a défaut à la maturité ou pas selon la valeur des actifs (si  $V_T < D$  ou pas).

$$\text{La barrière} = K(t) \text{ si } \tau < T$$

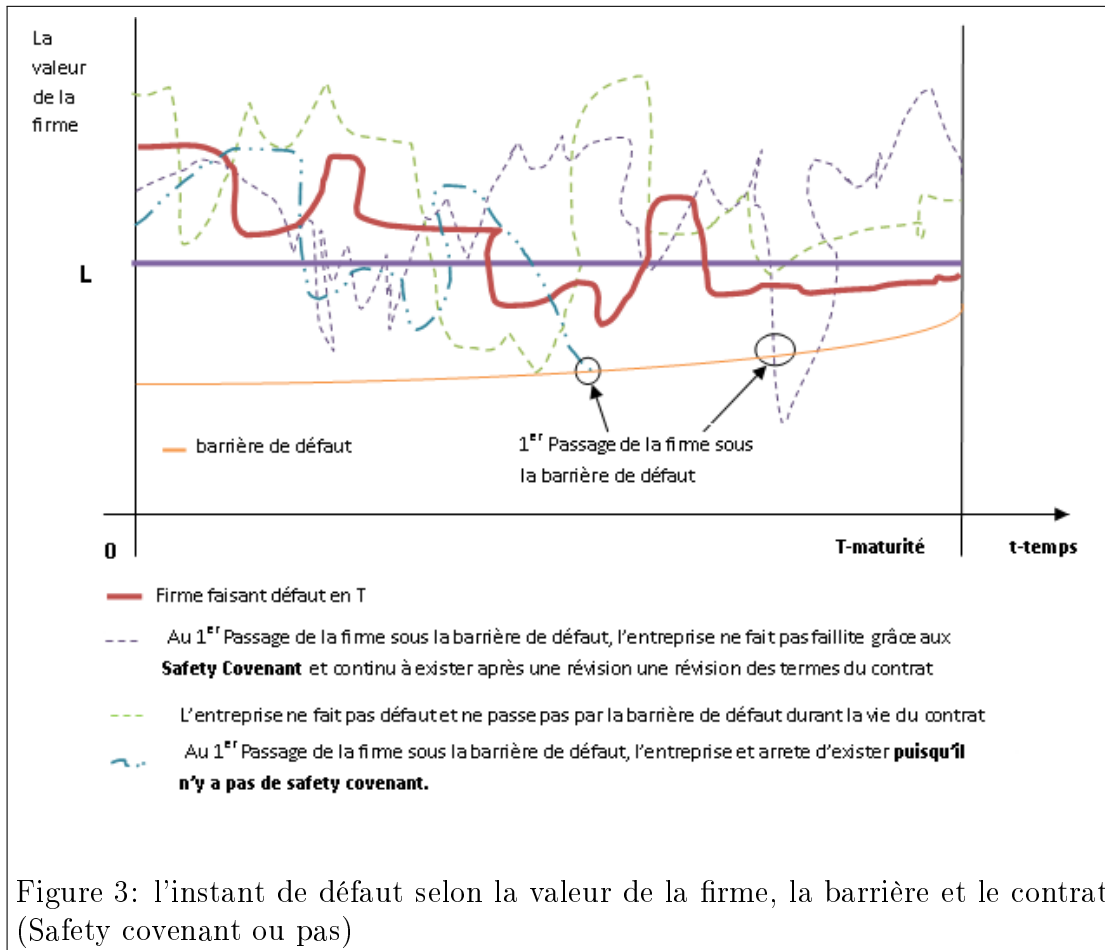
$$k(T) = D \text{ si } \tau = T$$

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13. M.Mahfoudhi, "the design of safety covenant-protected debts", Department of Finance, Laval University

L'instant de défaut  $\tau$  peut alors être écrit :

$$\tau = \inf t \in [0, T] : V_t \leq k(t)t \quad (15)$$



Sachant que dans ce papier B-C ont pris le cas exceptionnel où  $\zeta_1 = \zeta_2 = 1$  c. à. d. que s'il y a défaut les créanciers se partagent toute la valeur des actifs de l'entreprise.

Il va de soi qu'il faut mettre la condition :

$$Ke^{-\delta(T-t)} \leq De^{-r(T-t)} \quad (16)$$



Ce qui signifie que ce que perçoivent les créanciers ne peut en aucun cas dépasser la valeur de la dette actualisée au taux sans risque. On obtient alors :

$$D(t, T) = E_P^*(D(V_\tau, \tau)/F_t) \quad (17)$$

$$D(t, T) = E_P^*(De^{-r(T-t)} \sqcup \bar{\tau} \geq T, V_T \geq D/F_t)(A) \quad (18)$$

$$+ E_P^*(\zeta_1 V_T e^{-r(T-t)} \sqcup \bar{\tau} \geq T, V_T \leq D/F_t)(B)$$

$$+ E_P^*(\zeta_2 K e^{-\delta(T-\bar{\tau})} e^{-r(T-t)} \sqcup t \leq \bar{\tau} \leq T/F_t)(C)$$

- (A) : Valeur de la dette en cas de non défaut : puisque l'instant de défaut  $\tau$  est postérieur à l'échéance de la dette  $T$  et que la valeur des actifs de la firme dépasse le montant dû  $D$ .
- (B) : Valeur de la dette en cas de défaut à la maturité (ou après) : on parle de défaut puisqu'à l'échéance  $T$  la valeur des actifs est inférieure au montant dû  $D$ .
- (C) : Valeur de la dette en cas de défaut avant la maturité.

Ainsi, après défaut avant maturité c'est-à-dire dans le cas où  $\tau < T$ , ce qui présente le plus grand risque pour le prêteur, nous avons :

$$D(t, T) = \beta_2 K e^{-\delta(T-\bar{\tau})} e^{-r(T-t)} \quad (19)$$

La probabilité de défaut pour le modèle de Black et Cox sera donnée par :

$$P = \mathcal{N}(h_1) + e^{2[r - \frac{\sigma^2}{2}][Ln[\frac{K}{V_0}][\frac{1}{\sigma^2}]]} \mathcal{N}(h_2) \quad (20)$$

$$\text{Où } h_1 = \frac{\ln\left(\frac{K}{e^{rT}V_0}\right) + 0,5\sigma_v^2 T}{\sigma_v \sqrt{T}} \text{ et } h_2 = \mathcal{N}(h_1) - \sigma_v \sqrt{T}$$

### Limites du modèle de B-C

Même si le modèle de B-C corrige le défaut principal du modèle de Merton (Pas de défaut avant la maturité), cela n'empêche pas que Black et Cox se basent sur une hypothèse forte et pas réaliste à savoir celle de l'absence de coûts de faillite.

### le modèle de KMV

Le modèle KMV (Kealhofer, McQuown et Vasicek) qui est détenu par Moody's<sup>14</sup> depuis 2002. Il a été développé par Morgan and Hunt 1994 et se base sur le modèle de Merton dans la détermination de la probabilité du risque de défaillance dans la mesure où le défaut intervient lorsque la valeur des actifs sous un certain seuil.

Le modèle KMV considère les actions comme des Down-and-Out options<sup>15</sup>, c'est-à-dire qui cessent d'exister lorsque le prix du titre sous-jacent atteint une barrière de niveau de prix particulier.

Si le prix du sous-jacent n'atteint pas cette barrière, l'investisseur a alors le droit d'exercer son call Européen ou son put au prix d'exercice du contrat. dans le modèle KMV, on peut assimiler les actions de l'entreprise à une option perpétuelle.

$$\text{Distance au défaut DD} = \frac{\text{valeur de marché des actifs} - \text{point de défaut}}{\text{valeur de marché des actifs} * \sigma}$$

Où le point de défaut représente la barrière qui peut absorber la valeur de tous les actifs de la firme. Le risque de défaut accroît à mesure que la valeur des actifs devient plus proche de la valeur comptable des engagements. Si la DD obtenue

14. Agence de notation qui fournit des ratings ainsi que le logiciel Credit Monitor qui permet de calculer les valeurs de EDF par émetteur pour des horizons de 1 à 5 ans

15. C'est un type d'options Knock-out barrier, c. à. d. une option à barrière qui s'active ou se désactive si le sous-jacent atteint ou n'atteint pas une valeur.

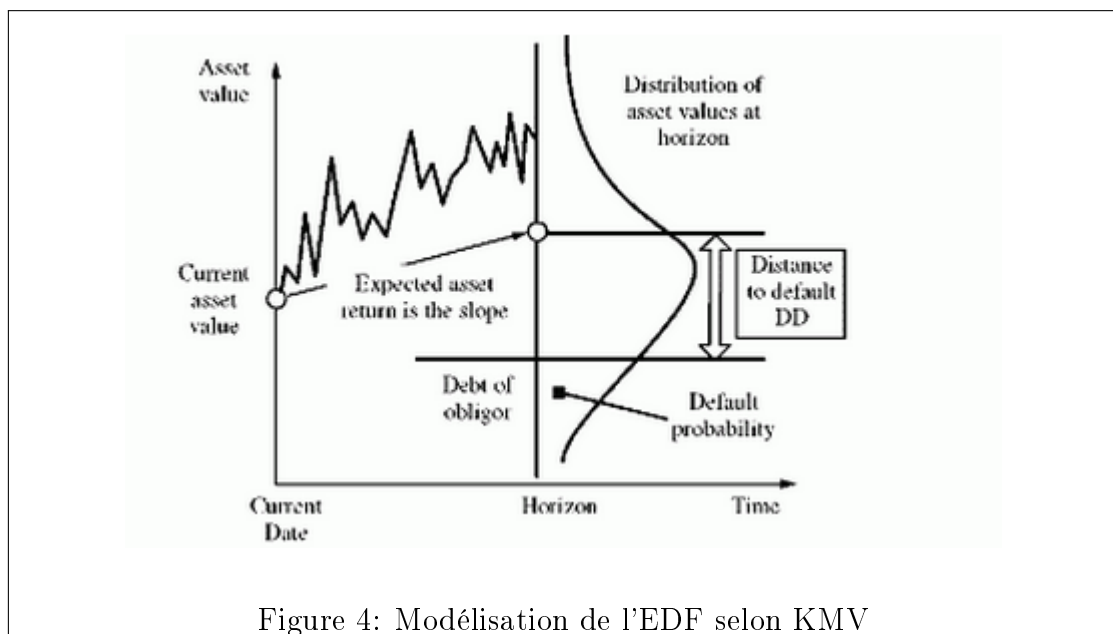
S.G.Kou, ON Pricing of discrete Barrier Options Statistica 13 (2003) 955-964

est égale à  $X$ , cela signifie, que pour atteindre le défaut, il faut que la valeur des actifs baisse de  $X\sigma$ .

les étapes suivies pour calculer la probabilité de défaut sont :

1. Estimation de la valeur des actifs de l'entreprise ainsi que leur volatilité
2. Calcul de la distance au défaut
3. Calcul de la probabilité de défaut

Dans le modèle de KMV, la structure de capital est très simplifiée, elle est financée par des actions et un zéro-coupon de maturité  $T$ . Si la valeur des dettes est connue et déterminée sur le marché, alors l'évaluation des actifs serait simple à savoir la somme des valeurs des actifs et de la dette. Or, pour la plupart des firmes, on ne peut observer que la valeur des actions, dans ce cas l'alternative est de passer par l'approche des Options-Pricing de Black-Scholes (1993) selon laquelle les actions sont des calls ayant pour sous-jacent les actifs de la firme. La figure 4 résume le processus entier :



C'est pourquoi, le modèle de KMV s'applique principalement aux firmes cotées en bourse.

Ainsi, on peut obtenir la valeur des Actifs et la volatilité de celle-ci d'après la relation:

$$E = f(V, \sigma_v, L, c, r)$$

$$\sigma_E = g(v, \sigma_v, L, c, r)$$

### Calcul de la probabilité de défaut

Etant donnée la valeur des actions et la volatilité de celle-ci (si cette dernière est observable) on arrive à déterminer  $V$  et  $\sigma_v$ .

Dans le cas contraire, c'est-à-dire le cas où la volatilité des actions n'est pas observable ce qui est le plus réaliste, la solution est de passer par le Lemme d'Itô pour calculer  $V$  et  $\sigma_v$  en fonction de  $E$  et  $\sigma_E$ , puisqu'il est indispensable de se doter d'une deuxième équation.

$r$ : le taux d'intérêt sans risque,  $L$ : le ratio de Levier,  $c$ : le coupon de long terme.

Les actifs de la firme suivent un processus :

$$Ln(V(t)) = Ln(V) + \left(\mu + \frac{\sigma^2}{2}\right)t + \sigma\sqrt{t}\varepsilon \quad (21)$$

Où  $\mu$  représente le rendement attendu des actifs de la firme(c'est à dire le t'intérêt risqué).

le défaut survient dès que la valeur de l'entreprise passe en deça de la valeur de ses engagements. C'est-à-dire :

$$\log(V(t)) \leq \log(D(t)) \quad (22)$$

$$\Leftrightarrow \log(V) + \left(\mu + \frac{\sigma^2}{2}t + \sigma\sqrt{t}\varepsilon\right) \leq \log(D(t)) \quad (23)$$

$$\Leftrightarrow \frac{\text{Ln}\left(\frac{V}{D(t)}\right) + \left(\mu - \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \leq -\varepsilon \quad (24)$$

Ainsi, la probabilité que la firme fasse défaut est :

$$P(t) = \text{Proba}\left[\frac{\text{Ln}\left(\frac{V}{D(t)}\right) + \left(\mu - \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \leq -\varepsilon\right] \quad (25)$$

$$\Leftrightarrow P(t) = \mathcal{N}\left[-\frac{\text{Ln}\left(\frac{V}{D(t)}\right) + \left(\mu - \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}\right] = \mathcal{N}[-d_2]$$

:EDF : Expected Default Frequency (26)

Où la distance au défaut  $DD = \frac{\text{Ln}\left(\frac{V}{D(t)}\right) + \left(\mu - \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$

En effet, plus la distance au défaut est grande, moins la probabilité de défaut est importante.

L'avantage que présente le modèle KMV c'est que contrairement à la majorité des approches de risque de crédit utilisées par les agences de notation, celle-ci fournit un classement cardinal. Si l'on a des informations exactes et opportunes sur le marché des actions, on peut réussir un suivi et un monitoring continu ce qui augmente le degré de vigilance.

### Limites du modèle

Bien que plus réaliste que la plupart des autres modèles structurels, dans le modèle KMV, il est indispensable de passer par l'hypothèse de la normalité des

rendement des actifs afin de construire de EDF théorique, ce qui n'est pas réaliste; Aussi l'un des problème de cette modélisation c'est qu'on distingue pas entre les différents types d'obligations à long terme en fonction de leur seniorité, les garanties, les engagements, ou la convertibilité.

Pour les entreprises qui ne sont pas cotées, on ne peut déterminer les EDF qu'en passant par une analyse comparative.

En pratique, la probabilité de défaut ne suit pas une loi normale ce qui explique les bases de données historiques utilisées par KMV. Dans ces Tables, on trouve pour chaque horizon temporel, le pourcentage d'entreprise ayant fait défaut pour une distance au défaut donnée.

## Les modèles de forme réduite

Cette approche essaye de modéliser le défaut mais pas à partir de ses causes, elle néglige notamment les origines économiques de la défaillance; En effet, on considère qu'il n'y a pas de lien entre la structure de l'entreprise et le risque de défaut. Ainsi on se base principalement sur les données que l'on observe sur le marché.

Pour les modèles de cette approche, le défaut est un événement imprévisible, de ce fait, ils supposent qu'il survient au premier saut d'un processus de poisson (Jacod 2003) (qui est un processus de diffusion continu généralement utilisé pour modéliser les événements rares). Ceci va nous permettre d'identifier la date de défaut, et plus le saut est important, plus l'ampleur du défaut est grande.

L'intensité de défaut que l'on cherche à déterminer correspond à l'intensité du processus de poisson étudié qui n'est autre que la probabilité instantannée de défaut, c'est pourquoi ils sont aussi appelés modèles d'intensité. Le premier modèle de forme réduite est celui de Jarrow and Turnbull 1995 suivi par celui de Duffie

and J Singleton 1999

## Cadre général des modèles de forme réduite

L'hypothèse principale est l'absence d'arbitrage qui se traduit par le fait que les prix des actifs financiers actualisés sont égaux aux espérances des pay-offs futurs actualisés. Ainsi on se place dans le cadre d'un espace probabilisé  $(\Omega, \mathcal{G}, \mathbb{P})$ <sup>16</sup> où  $\mathbb{P}$  est une probabilité risque-neutre pour que les prix des actifs financiers actualisés soient des martingales.

On considère en outre une première filtration<sup>17</sup> entraînée par les prix des actifs financiers.

$\mathbb{F} := (\mathcal{F}_t)_{t \geq 0}$  : C'est à dire l'ensemble des informations apportées par le marché à travers les données et les prix des actifs (comme une information apportée par la baisse des prix...).

L'instant de défaut  $\tau$  est modélisé par une variable aléatoire positive définie sur  $(\Omega, \mathcal{G}, \mathbb{P})$ .

$(\mathcal{H}_t) := 1_{\tau < t}$  : Le processus qui vaut 1 si le défaut survient c'est à dire lorsque  $\tau < t$  et 0 sinon.

D'où la filtration engendrée par ce processus :

$$\mathbb{H} := (\mathcal{H}_t)_{t \geq 0} \text{ où } \mathcal{H}_t = \sigma(H_u, u < t) \quad (27)$$

Cette filtration nous donne des informations apportées par l'instant de défaut. Les modèles de forme réduite supposent l'existence d'une filtration  $(\mathcal{G}_t)$  contenant l'ensemble des informations à propos du défaut. On introduit alors cette filtration

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16.  $\Omega$  : L'univers,  $\mathcal{G}$  : événements

Philippe Briand : "Espaces Probabilisés", Septembre 2003

17. Olivier Roustant "Martingales" Janvier 2009

$\mathbb{G} := \mathbb{F} \vee \mathbb{H}$  qui nous donne une information encore plus riche contenant à la fois des renseignements provenant des prix des actifs et de l'instant de défaut.

$H_t$  est une sous-martingale  $\forall t < s$  on a

$$1_{\tau < s} = 1_{\tau < t} + 1_{t < \tau < s} \quad (28)$$

En appliquant l'espérance conditionnelle des deux côtés de l'égalité, on obtient :

$$E * (H_s / \mathcal{G}_t) = E * (1_{\tau < t} / \mathcal{G}_t) + E * (1_{t < \tau < s} / \mathcal{G}_t) > H_t \text{ puisque } t < s \quad (29)$$

La propriété du théorème Doob-Meyer (voir Karatzas 1991) assure qu'une sous-martingale notamment le processus de défaut  $H_t$  peut être décomposée en la somme d'une martingale et d'un processus continu prévisible et croissant tel que :

$$H_t = M_t + A_t \text{ Où } M_t : \text{ La martingale, et } A_t : \text{ Le processus prévisible croissant.}$$

Ainsi, il existe un seul processus positif  $\mathbb{F}$ -adapté  $(\lambda_t)$  tel que :

$$M_t := H_t - \int_0^t 1_{u < \tau} \lambda_u \cdot d_u \quad (30)$$

La valorisation risque-neutre de la dette risquée:

On traite dans le cas général des modèles de forme réduite des zéro-coupons risqués de maturité  $T$  et de nominal 1 qui sont introduits par le couple  $\tau, Z$ :

- $\tau$  : l'instant de défaut
- $Z$  : Le processus de recouvrement du zéro-coupon s'il y a défaut avant la maturité  $T$ .
- $r_t$  : Le taux sans risque
- $B_t = \exp(\int_0^t r_u \cdot du)$

Soit  $D$  : Le processus de dividendes, donc

$$D = Z : \text{ Le processus de recouvrement en cas de défaut}$$



= 1 (Le nominal de la dette) s'il n'y a pas de défaut et que la dette est remboursée

$$\implies D_t := \int_0^t Z_u dH_u + (1 - H_T)1_{t=T}$$

Or, le prix du titre risqué actualisé s'écrit comme l'espérance sous la probabilité risque-neutre du pay-off actualisé :

$$V_t := B_t \mathbb{E} \left[ \int_t^T B_U^{-1} dD_u | \mathcal{G}_t \right] \quad (31)$$

$$V_t := B_t \mathbb{E} \left[ \int_t^T B_U^{-1} Z_u dH_u + B_T^{-1} 1_{T < \tau} | \mathcal{G}_t \right]$$

$$V_t := B_t \mathbb{E} \left[ B_\tau^{-1} Z_\tau 1_{t < \tau < T} + B_T^{-1} 1_{T < \tau} | \mathcal{G}_t \right]$$

$$V_t := B_t \mathbb{E} \left[ \int_t^T B_U^{-1} Z_u (dM_u + 1_{u < \tau} \lambda_u \cdot d_u + B_T^{-1} 1_{T < \tau} | \mathcal{G}_t) \right]$$

Or  $M_t$  est une martingale donc  $\implies dM_u = 0$

$$\implies V_t := B_t \mathbb{E} \left[ \int_t^T B_U^{-1} Z_u 1_{u < \tau} \lambda_u \cdot d_u + B_T^{-1} 1_{T < \tau} | \mathcal{G}_t \right] \quad (32)$$

Le prix de la dette risquée: On pose

$$\Lambda_t = \exp\left(\int_0^t \lambda_u du\right), \text{ sachant que } B_t = \exp\left(\int_0^t r_u du\right)$$

alors

$$\implies \tilde{B}_t = \Lambda_t B_t = \exp\left(\int_0^t (r_u + \lambda_u) du\right) \quad (33)$$

$$S_t = \tilde{B}_t \mathbb{E} \left[ \int_t^T \tilde{B}_U^{-1} Z_u \lambda_u du + \tilde{B}_T^{-1} | \mathcal{G}_t \right] \quad (34)$$

$$S_t := B_t \mathbb{E} \left[ \int_0^T B_U^{-1} Z_u \lambda_u du + B_T^{-1} | \mathcal{G}_t \right] - \int_0^t B_U^{-1} Z_u \lambda_u du \quad (35)$$

En appliquant le Lemme d'Itô<sup>18</sup> on obtient :

$$dS_t = (r_t + \lambda_t) S_t - Z_t \lambda_t dt + B_t dE \int_0^T B_U^{-1} Z_u \lambda_u du + B_T^{-1} | \mathcal{G}_t \quad (36)$$

Ceci nous permet la valorisation du zéro-coupon risqué:

$$V_t = 1_{t < \tau} B_t E \int_t^T B_U^{-1} Z_u \lambda_u du + B_T^{-1} | \mathcal{G}_t \quad (37)$$

## Le modèle de Jarrow et Turnbull(95)

Jarrow and Turnbull 1995 est le premier modèle de forme réduite. Ce modèle ainsi que les autres modèles d'intensité, cherchent à modéliser la brusquerie et la soudaineté de la survenance de l'évènement de défaut. Le processus de défaut dans ce premier modèle correspond à un simple saut Poissonien, d'où la constance du taux instantané de défaut dans le temps ( $= \lambda$ )

### Probabilité de défaut, probabilité de survie

$$\tilde{B}_t = B_t e^{-\lambda t}$$

Particulièrement  $1_{t < \tau} \mathbb{P}^*(T < \tau | \mathcal{G}_t) = e^{-\lambda t}$

C'est la probabilité de ne pas faire défaut jusqu'à l'échéance sachant que l'entité

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18. L'un des principaux résultats de la théorie des calculs stochastiques. Geneviève Gauthier :Le Lemme d'Itô, les méthodes stochastiques dans les sciences de la gestion. Juin 2003

n'en a pas encore fait jusqu'à l'instant actuel  $t$ . D'où la probabilité de faire défaut c'est à dire  $\mathbb{P}[\tau < t] = 1 - e^{-\lambda t}$

### Processus de recouvrement

Robert A. Jarrow et Stuart Turnbull supposent que le recouvrement capitalisé au taux sans risque vaut une fraction déterministe  $\delta$  du paiement total normalement du à savoir 1 qui est la valeur du nominal de la dette dans ce modèle. ceci s'écrit :

$$\delta = Z_u e^{\int_u^T r_s ds} = Z_u B_T B_u^{-1}$$

D'où l'exogénéité et l'indépendance du taux de recouvrement du processus de défaut. Ainsi 37

$$\begin{aligned} V_t &= 1_{t < \tau} B_t \mathbb{E} \left[ \int_t^T B_u^{-1} Z_u \lambda_u du + B_T^{-1} / \mathcal{G}_t \right] \\ &= 1_{t < \tau} B_t e^{\lambda t} \mathbb{E} \left[ \int_t^T B_u^{-1} e^{-\lambda u} Z_u \lambda_u du + B_T^{-1} e^{-\lambda T} / \mathcal{G}_t \right] \\ &= 1_{t < \tau} B_t e^{\lambda t} \mathbb{E} \left[ \int_t^T B_u^{-1} e^{-\lambda u} \delta B_T^{-1} B_u \lambda du + e^{-\lambda T} B_T^{-1} / \mathcal{G}_t \right] \\ &= 1_{t < \tau} \mathbb{E} \left[ (B_t B_T^{-1} (\delta (\int_t^T e^{-\lambda(u-t)} \lambda du + e^{-\lambda T} e^{\lambda t})) / \mathcal{G}_t \right] \end{aligned}$$

Or on a  $B_{(t,T)} = \mathbb{E} [B_t B_T^{-1} | \mathcal{G}_t]$  C'est le prix à l'instant  $t$  d'un zéro coupon sans risque d'échéance  $T$ . Ce qui nous permet la décomposition :

$$V_t = 1_{t < \tau} B_{(t,T)} (\delta (1 - e^{-\lambda(T-t)}) + e^{-\lambda(T-t)})$$

### Calcul du spread

Pour calculer le spread adéquat à l'entité en question, il faudra trouver celui annule la valeur initiale du swap du CDS portant sur cette entité, ceci revient à égaliser les deux jambes de ce contrat savoir la jambe payeuse et la jambe de protection. Concrètement: Si l'on pose :

- C : l'entité sur laquelle porte la protection de nominal 1
- A : l'acheteur de protection
- B : le vendeur de protection
- $T_N$  : la date de maturité du CDS
- $\tau$  : l'instant potentiel de défaut de l'entité C

L'acheteur de protection A paie aux différentes dates de paiement  $T_n$  :

$$\bar{s} \delta_n 1_{(T_n < \tau)}$$

Où

- $\bar{s}$  : le taux du CDS forward
- $\delta_n$  : les intérêts produits entre  $T_{(n-1)}$  et  $T_n$

A l'instant de défaut A verse à B un dernier paiement qui est égal à la somme due entre le dernier paiement effectué et l'instant de défaut.

Ainsi si l'on pose  $n^*$  : la date du dernier versement avant le défaut, alors :

$$\Rightarrow n^* = \max(n/T_n < \tau) \quad (38)$$

B reçoit alors

$$V_t = \mathbb{E}^Q \left[ \sum_{n=1}^N \frac{1}{B_{Tn}} \delta_n 1_{(T_n < \tau)} + \frac{1}{B_\tau} \delta_{n^*} 1_{(0 < \tau < T_N)} | \mathcal{G}_t \right] \quad (39)$$

On détermine alors la valeur de la jambe de paiement avant défaut à savoir  $\bar{s} V_t$ , la valeur de cette jambe après défaut est nulle puisqu'il n'y aura plus de paiement. Pour la jambe de protection, le vendeur de celle-ci perç des versements jusqu'au défaut et si ce dernier survient il indemnise l'acheteur de protection. Donc B paie A  $(1-R)$  à l'instant de défaut où  $R$  est le recouvrement de l'entité C  $\Rightarrow (1 - R) 1_{(0 < \tau < T_N)}$

Or, en  $t$  avant défaut ( $t < \tau$ ), cette jambe de protection vaut :

$$V_t^{Prot} = \mathbb{E}^Q\left[\frac{1}{B_\tau}(1 - R)1_{(0 < \tau < T_N)} / \mathcal{G}_t\right] \quad (40)$$

On obtient ainsi la valeur du "Fair Spread" c'est à dire celui qui annule le prix de ce swap :  $s = \lambda(1 - R)$

Parmi les modèles de forme réduite les plus utilisés en pratique, on note CreditRisk+.

## Le modèle CreditRisk+

Le modèle CreditRisk+ de Crédit Suisse First Boston a été développé en 97. Dans ce modèle, on se restreint à modéliser les probabilités de défaut c'est-à-dire qu'on n'étudie pas le cas de détérioration de la solvabilité des contreparties ce qui revient à ne pas prendre en considération les transitions des ratings dans la modélisation des probabilités de défaut.

Ainsi, entre les risques liés aux obligations, CreditRisk+ tente de modéliser uniquement le risque de crédit sans prendre en considération le risque de spread.

### Les hypothèses du modèle

1. Deux états possibles pour chaque crédit individuel (par débiteur) : défaut avec une probabilité  $P_A$ , ou bien pas de défaut avec une probabilité  $(1 - P_A)$
2. Les probabilités de défaut prises une par une sont faibles, fixes et indépendantes.
3. Indépendance du nombre de défaut dans un portefeuille entre les différentes périodes étudiées, ce qui nous permettra de supposer que le nombre de défaut suit une distribution de poisson.

### Calcul de la probabilité de la réalisation d'un nombre de défauts

Si  $X$  : Le nombre de défaut, alors la distribution de probabilité de  $X$  suit une loi de poisson de moyenne  $\mu$  et d'écart type  $\sqrt{\mu}$ .

La probabilité que  $P(X = n) = \frac{\mu^n e^{-\mu}}{n!}$

Où  $n$  = le nombre de défauts (dont on cherche la probabilité de se réaliser) et  $\mu$  = le nombre attendu de défauts. ainsi, si par exemple, si le nombre de défaut attendu pour le portefeuille étudié est de 5 ( $\mu = 5$ ), alors, la probabilité de ne pas faire défaut (0 défauts :  $n=0$ ) est de :

$$: P(X = 0) = \frac{5^0 e^{-5}}{0!}$$

CreditRisk+ regroupe les débiteurs dans des bandes en fonction de leurs niveaux expositions en arrondissant à la bande la plus proche.

Pour analyser la distribution de perte d'un portefeuille, on passe par la fonction génératrice du nombre de défaut.

$$F(Z) = \sum_{n=0}^{\infty} P(X = n) Z^n$$

Or, comme on l'a déjà précisé, un débiteur peut ou bien faire défaut ou bien non, d'où la fonction génératrice d'un débiteur:

$$F_A(Z) = (1 - P_A) + P_A Z = 1 + P_A(Z - 1)$$

D'autre part, si l'on considère que le portefeuille est un ensemble de crédits individuels, c'est-à-dire des débiteurs à une obligation chacun et comme les événements de défaut sont indépendants, alors la fonction génératrice d'un portefeuille sera le produit de toutes les fonctions génératrices des débiteurs qui le composent :

$$F(Z) = \prod_A F_A(Z) = \prod_A (1 + P_A(Z - 1))$$

$$\log(F(Z)) = \sum_A \log(1 + P_A(Z - 1))$$

Et puisque le modèle suppose que chaque probabilité de défaut prise séparément est très petite, alors on peut obtenir cette écriture par approximation :

$$\log(1 + P_A(Z - 1)) = P_A(Z - 1)$$

$$\log(F(Z)) = \sum_A \log(1 + P_A(Z - 1)) = \sum_A (P_A(Z - 1))$$

$$F(Z) = e^{\sum_A P_A(Z-1)}$$

$\mu = \sum$  (les défauts des différents débiteurs qui composent le portefeuille)

$$\mu = \sum_A P_A$$

$$\Rightarrow F(Z) = e^{\sum_A P_A(Z-1)} = e^{\mu(z-1)} = e^{-\mu} e^{\mu z}$$

$$\text{Or, } e^{\mu z} = 1 + \mu z + \frac{(\mu z)^2}{2!} + \frac{(\mu z)^3}{3!} + \dots = \sum_{n=0}^{\infty} \frac{(\mu z)^n}{n!} \quad 19$$

$$\text{Donc } F(Z) = e^{-\mu} e^{\mu z} = e^{-\mu} \sum_{n=0}^{\infty} \frac{(\mu z)^n}{n!} = \sum_{n=0}^{\infty} \frac{e^{-\mu} (\mu z)^n}{n!}$$

D'autre part, on peut partir du fait que CreditRisk+ dévise le portefeuille en bandes selon différents niveaux d'exposition.

$m$  : Le nombre de bandes dans le portefeuille étudié.

$j$  : Le numéro de la bande :  $j \in [1, m]$

$L$  : Exposition standard

$\nu_j$  : Le degré d'exposition exprimé en multiple de  $L$  pour la bande  $j$

$\mu_j$  : Le nombre de défauts standard attendu pour la bande  $j$

$\epsilon_j$  : Pertes attendues pour la bande  $j$  exprimée en multiple de  $L$

on obtient alors pour la bande  $j$

$$\epsilon_j = \nu_j * \mu_j \Rightarrow \mu_j = \frac{\epsilon_j}{\nu_j}$$

Pour le nombre de défauts attendus pour le portefeuille composé des différentes bandes on aura :

$$\mu = \sum_{j=1}^m \mu_j = \sum_{j=1}^m \frac{\epsilon_j}{\nu_j}$$

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19. Expansion Maclaurin  $e^x = 1 + x + \frac{(x)^2}{2!} + \frac{(x)^3}{3!} + \dots = \sum_{n=0}^{\infty} \frac{(x)^n}{n!}$

Le fait que les évènements de défauts sont indépendants, donc il y a aussi indépendance des évènements de défauts entre les bandes, ce qui nous permet d'écrire :

$$F(Z) = \prod_j^m F_j(Z) \text{ avec } F_j(Z) = \sum_{n=0}^{\infty} \frac{e^{-\mu_j} \mu_j^n z^n}{n!}$$

Si l'on veut déterminer la fonction génératrice des pertes dans le portefeuille, on va pouvoir agréger la totalité des pertes des différentes bandes. Ainsi si  $G_j(Z)$  est la fonction de distribution des pertes dans la bande  $j$  alors, la fonction de distribution des pertes du portefeuille étudié sera  $G(Z) = \prod_j^m G_j(Z)$  puisque les expositions sont indépendantes. Avec :

$$G_j(Z) = \sum_{n=0}^{\infty} P(Y_j = k) z^k \text{ Où } k = n\nu_j$$

Ceci signifie que la distribution des pertes dans une bande est égale à la somme des probabilités que le montant des pertes subit par la bande  $j$  à savoir  $Y_j$  soit égal à  $k$  qui est une perte possible de la bande  $j$  en fonction de son niveau exposition  $\nu_j$  et de  $n$  : le nombre de défauts.

$$G_j(Z) = \sum_{n=0}^{\infty} P(Y_j = n\nu_j) z^{n\nu_j}$$

Or dire  $P(Y_j = k)$  est équivalent à dire  $P(X_j = n)$  (qui se lit la probabilité que le nombre de défaut dans la bande  $j$  soit égal à  $n$ )

$$\begin{aligned} P(Y_j = k) &= P(X_j = n) = \frac{\mu_j^n e^{-\mu_j}}{n!} \\ \Leftrightarrow G_j(Z) &= \sum_{n=0}^{\infty} \frac{\mu_j^n e^{-\mu_j}}{n!} z^k = \sum_{n=0}^{\infty} \frac{\mu_j^n e^{-\mu_j}}{n!} z^{n\nu_j} = e^{-\mu_j + \mu_j z^{\nu_j}} \end{aligned}$$

Ainsi la fonction de distribution des pertes de tout le portefeuille peut s'écrire :

$$G(Z) = \prod_{j=1}^m G_j(Z) = \prod_{j=1}^m e^{-\mu_j + \mu_j z^{\nu_j}} = e^{-\sum_{j=1}^m \mu_j + \sum_{j=1}^m \mu_j z^{\nu_j}}$$

L'approche suivie par CreditRisk+ est applicable à n'importe quel portefeuille dès que la probabilité de défaut individuelle des emprunteurs est faible.



### Limites du modèle

- CediRisk+ ne prend pas en considération le risque de marché.
- Le modèle ne considère pas les changements de rating.
- Les taux d'intérêt sont supposés être fixes.

## Les modèles économétriques

Alors que les modèles structurels font dépendre le défaut des composantes de la firme, et que les modèles de forme réduite négligent la cause du défaut; les modèles économétriques lient le défaut au cycle de l'activité de l'économie et ses facteurs macroéconomiques.

Dans la pratique, le modèle économétrique le plus connu est CreditPortfolioView<sup>20</sup> de McKinsey<sup>21</sup>

### Le modèle CreditPortfolioView de McKinsey

Ce modèle développé par Thomas Wilson et publié par McKinsey & company en 1997 stipule que les probabilités de défaut ne peuvent pas être neutres par rapport aux facteurs macroéconomiques tels que le taux de chômage, le taux de croissance du PIB... et ce avec des élasticités différentes de chaque secteur aux conditions économiques.

### Calcul de la probabilité de défaut

Ce modèle considère que les probabilités de défaut sont suréstimées pendant les bonnes périodes du cycle économique et souséstimées pendant les périodes de

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20. Thomas C. Wilson, Portfolio Credit Risk, Economic Policy Review, October 1998

21. Cabinet de conseil auprès des directions générales, Fondé à Chicago en 1926 par Oscar McKinsey

recession, et que les conditions financières des firmes jouent fortement, dans le sens que celles ayant une position faible sur le marché sont plus vulnérables aux recessions que celles ayant une bonne position compétitive.

Le calcul de la probabilité de défaut dans ce modèle passe par trois étapes, en effet, CPV nécessite l'examen du portefeuille comme étant un ensemble de sous-portefeuilles fractionnés selon plusieurs critères dont principalement la qualité du crédit. En outre, le cadre de CPV exige un modèle pour prévoir les valeurs futures des variables économiques, ensuite, grâce à ces valeurs estimées des différents facteurs on calcule les probabilités de défaut. Ainsi ces taux de défaut déterminés sont liés à ces facteurs et varient quand ces derniers changent

1. Dans un premier temps, on essaye d'estimer les valeurs futures des facteurs macroéconomiques sur l'horizon temporel souhaité et ce à partir des valeurs historiques de ces dernières.
2. On modélise la relation liant les taux de défaut des firmes aux facteurs macroéconomiques par un modèle économétrique multifactoriel.
3. Finalement, on utilise les résultats trouvés pour calculer les probabilités de défaut pour chaque année et chaque pays et/ou industrie.

Pour s'assurer que la valeur de la probabilité de défaut, estimée dans la dernière étape, soit comprise entre zéro et un; Wilson a opté pour une fonction logit où l'on explique le taux de défaillance par un indice composite caractérisant chaque pays et chaque industrie et il est déterminé à partir des variables macroéconomiques.

Soit  $y_{j,t}$  : l'indice composite qui explique l'état général de la santé par différentes variables macroéconomiques<sup>22</sup>.

$$y_{jt} = b_{j0} + b_{j1}X_{j1t} + b_{j2}X_{j2t} + b_{j3}X_{j3t} + \nu_{jt}$$

Avec :

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22. dans la pratique, on a montré que trois variables sont capables d'expliquer l'état général de l'économie

- $b_{ji}$  : les paramètres spécifiques pour chaque secteur et/ou pays (j) à estimer par la méthodes des MCO.
- $X_{jit}$ : Les variables explicatives à l'instant t pour l'industrie et/ou le pays (j)
- $\nu_{jt}$ : Un bruit blanc  $\nu_{jt} \sim \mathcal{N}(0, \sigma_{\nu_j}^2)$

Or, dans la première étape, les facteurs macroéconomiques sont calculés à partir de leurs historiques, c'est pourquoi on opte pour un processus retard tel qu'un Processus Autoregressif suggéré par Crouhy et al. 2001:

$$X_{jit} = \delta_{ji0} + \delta_{ji1}X_{j,1,t-1} + \delta_{ji2}X_{j,i,t-2} + \varepsilon_{jt} \quad (41)$$

Avec  $\varepsilon_{jt} \sim \mathcal{N}(0, \sigma_{\varepsilon_j}^2)$

$X_{j,1,t-1}$  et  $X_{j,i,t-2}$  sont les valeurs retardées de la variable macroéconomique  $X_{jit}$

Où l'on estime les paramètres :  $\delta_{ji0}, \delta_{ji1}, \delta_{ji2}$

La probabilité de défaut du pays (secteur) j pour l'année t sera donnée par :

$$P_{jt} = \frac{1}{1 + e^{-y_{jt}}} \quad (42)$$

Avec le vecteur d'innovations  $E_t = \begin{pmatrix} \nu_t \\ \varepsilon_t \end{pmatrix} \sim \mathcal{N}(0, \Sigma)$

Avec

$$\mathcal{A} = \begin{pmatrix} \Sigma_{\nu} & \Sigma_{\nu,\varepsilon} \\ \Sigma_{\varepsilon,\nu} & \Sigma_{\varepsilon} \end{pmatrix}$$

Où  $\Sigma_{\nu,\varepsilon}$  et  $\Sigma_{\varepsilon,\nu}$  sont les matrices de corrélation croisée.

On commence par calculer les probabilités moyennes de défaut au cours d'un an grâce aux probabilités de défaut historiques obtenues à travers la matrice de transition inconditionnelle de Markov qui est elle même basée sur les données historiques des agences de notations notamment Moody's ou encore Standard & Poor's ce qui nous permettra d'obtenir des probabilités inconditionnelles de défaut

qu'on notera  $\phi M$ .

Les probabilités de transition inconditionnelles sont appelées ainsi puisque ce sont des moyennes historiques calculées sur des données de vingt ans pour différents secteurs, différentes industries et plusieurs pays.

On dérive par la suite les probabilité de défaut courantes simulées par les probabilités inconditionnelles pour obtenir un ratio supérieur à 1 quand on s'attend à une probabilité de défaut plus que la moyenne c'est à dire en période de récession et inférieur à 1 en période d'expansion de l'économie, et on ajuste ainsi via l'opérateur de déplacement (Shift Operator) défini par Tom Wilson les probabilités de défaut des portefeuilles. Ainsi quand l'économie se contracte le Shift Operator fait varier les probabilités de migration vers la droite c'est à dire qu'il y a plus de chance de se dégrader ou se déclasser et vice versa.

Et puisque l'on peut estimer  $P_{jt}$  sur n'importe quel horizon de temps donc on peut générer une matrice de transition multipériode:

$$M_T = \Pi_{1...T} M(P_{jt}/\phi M)$$

### Limites du modèle:

Les données macroéconomiques indispensables pour ce modèle peuvent être indisponibles ou difficile à trouver pour une industrie ou un pays donnée.

C'est un modèle macroéconomique qui ne peut être appliqué pour un émetteur.

Dans la pratique ce modèle est utilisé pour déterminer les taux de défaut des contreparties de qualité inférieure (Speculative grade).

## Conclusion

Avec le comité de Bâle<sup>23</sup>, l'intérêt à la mesure du risque de défaut s'est vu croître, et ce afin de refléter au mieux le contexte interne et externe d'une entité donnée et qui est susceptible d'affecter sa solvabilité et le risque qu'elle ne soit plus en mesure d'honorer ses engagements.

Dans les modèles structurels, la valeur de la firme qui est utilisée comme in-put principal pour mesurer le risque de crédit n'est pas simple à valoriser; En plus, il y a un certain nombre d'hypothèses fortes qui rendent cette approche peu réaliste. Le statisme est aussi un inconvénient important dans le sens où s'il y a un changement de la qualité de l'emprunteur traduit par un changement du rating par exemple, ces modèles ne sont pas capable de l'intégrer dans les calculs alors qu'en réalité les prix des actifs sont très sensibles à ces informations. Le problème majeur des modèles structurels est le fait de ne pas prendre en compte le caractère imprévisible de l'évènement de défaut en considérant que celui-ci est prédictible grâce au processus continu de la firme.

Le caractère imprévisible est modélisé dans l'approche de forme réduite et ce par le processus de poisson généralement employé pour les évènements rares. Mais le grand problème de cette classe de modèle c'est que les changements des termes des contrats, une éventuelle renégociation entre prêteur et emprunteur des conditions de remboursement ou encore le rééchelonnement du crédit, ne peuvent pas être pris en compte dans cette approche, en effet, Duffie and J Singleton 1999 montre que ces modèles n'expliquent pas la structure par terme des spreads de crédit. Il y a eu ensuite, des modèles voulant améliorer la prévisibilité de l'instant de défaut et ce

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23. Comité de Bâle sur le contrôle bancaire (Basel committee on banking Supervision, BCBS) est un forum où sont traités de manière régulière les sujets relatifs à la supervision bancaire. Il est hébergé par la Banque des règlements internationaux et formule les accords de Bâle qui sont un ensemble de recommandations visant à assurer la stabilité du système bancaire

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en essayant de réconcilier les modèles structurels avec ceux de forme réduite dont on cite le modèle de Zhou 1997 dans le quelle la valeur de la firme est modélisée par la somme d'un processus continu et d'un processus de poisson.

Ces deux approches ne prennent pas en considération l'état général de l'économie pour expliquer le risque de crédit, en revanche, les modèles économétriques présentent l'avantage d'expliquer le risque de défaut par le contexte économique ce qui est plus réaliste, le problème est que la logique économique derrière le choix de la fonction Logit pour calculer la probabilité de faire faillite, n'est pas justifiée.



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# Macroeconomic Determinants of Sovereign Credit Risk

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## Introduction

Credit risk is the possibility to failure in credit payment. When the borrower is a country, this is called sovereign credit risk and it measures the ability and the tenacity of a state to fulfill its obligations. This case has been examined for a long time and has led to several findings like the evaluation systems of the borrower quality by giving scores to individuals and ratings to States and important corporates. The Basel committee on banking supervision - whose aim is to strengthen the regulation through the Basel accords<sup>24</sup> - tries to improve these latter to adapt them to innovations and movements on the market. Nevertheless, Credit risk models aiming to estimate a borrower default probability are being developed very quickly and widely. Structural, stochastic or econometric models try to predict the probability that a borrower will default on maturity and / or when this event is most likely to occur. This paper attempts to explain what happens in an economy before seeing its risk of bankruptcy increases. As documented in Asghar and Kevin 2010 in their research on the United States of America and Aus-

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24. <http://www.bis.org/bcbs/basel3.htm>



tralia where the variable used to measure the default risk is the ratio of provisions for risky debt to total debt, there is a negative relationship between the GDP level and the default rate, as well as a positive link between this latter with the debt with more responsiveness of the American economy to macroeconomic shocks. A number of recent studies like Hilscher and Nosbusch 2010 have investigated the empirical determinants of Sovereign credit spreads as a proxy for credit risk, and they found a significant link with the macroeconomic fundamentals. Plank 2010 applies a structural model of sovereign credit risk with macroeconomic fundamentals as determinants on a sample of emerging economies. He defines the repayment capacity of a country as the maximum amount of foreign currency available for the payment of external debts. This ability improves with the expectations of future exports as well as foreign exchange reserves. However, it is negatively correlated with the present value of future imports. Nevertheless, the model is not validated for Turkey which is the most developed country in the sample. To follow the default probabilities evolutions, Canuto et al. 2012 use ratings provided by rating agencies. The authors confirm that a good rating (i.e low risk) is associated with a low inflation, high economic growth, unimportant level of debt, significant trade openness, and a low past events of default since 1975. The choice of In-Mee et al. 2005 is rather focused on the bond yield spread as a dependent variable to describe the evolution of default risk. Their conclusion is that a higher GDP growth, larger foreign reserves, and an appreciation of domestic currency lead to a decrease in the bond yield spread. On the other hand, the more important the inflation is, the higher the bond yield spread is also. GAPEN et al. 2008 extended the Merton Model to implement it for countries using Sovereign Bond Yields to measure credit risk. On the basis of this, Kilponen et al. 2012 developed a model to study the effects of the European Central Bank monetary policy and the European Crisis on the default risk of a sample of European countries using the 10 year Sovereign

Bond Yield as a proxy for default risk. In this chapter, we choose the same proxy for credit risk (i.e Sovereign Bond Yields). In what follows, we present the evolution of the default probabilities and Bond yields for the same sovereigns and the same period. We notice a significant similarity in the trends of the two curves. This makes us think of a certain consistency in our choice of proxy. Next, we present our modeling, the choice, the tests of variables, and the regression results for each country of the sample. The graphs below show the 10 year default probabilities (in percentage) and the 10 year bond yield (in percentage) evolutions<sup>25</sup> of a sample of Euro zone countries. They confirm what states the modern portfolio theory, that return and risk are inseparable concepts, taking additional risk is only accepted if coupled with a higher Yield. Countries are no exceptions to the rule, the greater the risk that a state will default and finds itself unable to honor its commitments, the more the lenders require higher Treasury bond Yield. Indeed, the risk premium is a part of the required return. It represents what claims an investor willing to place his funds in risky assets. The more the risk incurred is, the higher the premium is, which leads the demand of greater yield.

## Data and model specification

As suggested by the graphs above, the chosen dependent variable in this modeling, is the 10 Year Treasury bond yield. This choice is justified by the fact that this variable reflects the sovereign default risk and by data availability. Selected explanatory variables are:

1. Long term (10 years) Government Bond Yield.
2. Exports growth rate.

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<sup>25</sup>. traced from default probabilities calculated by CMA Credit Market Analysis Ltd <http://www.cmavision.com>

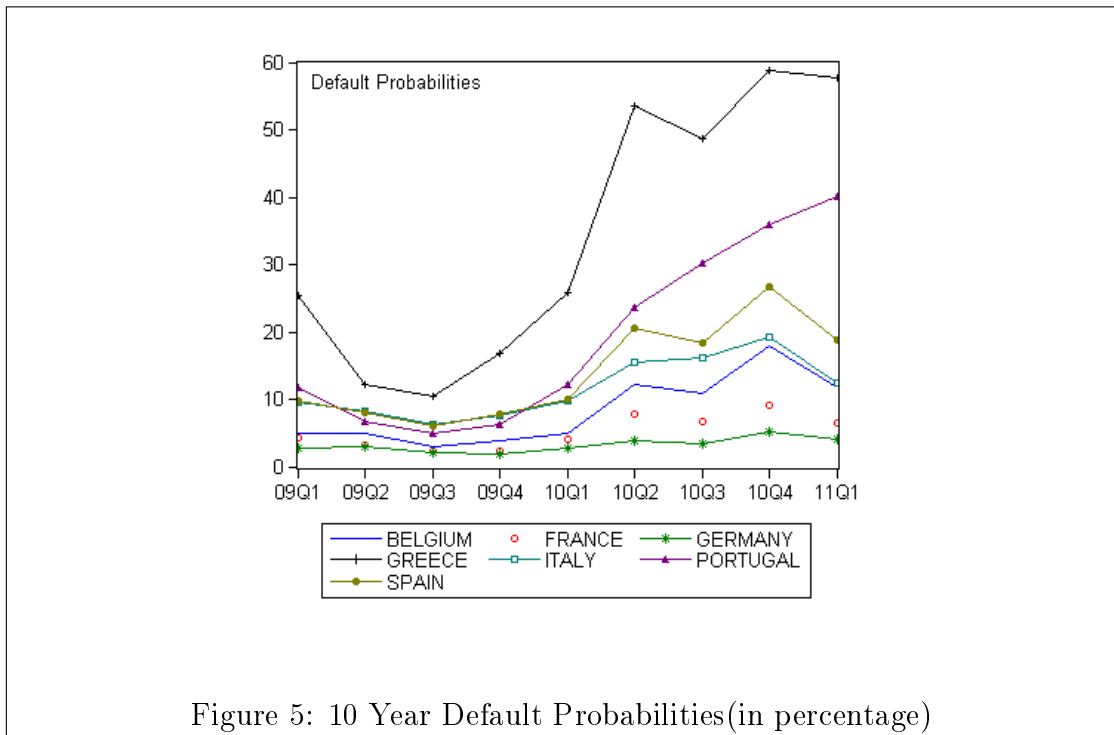


Figure 5: 10 Year Default Probabilities(in percentage)

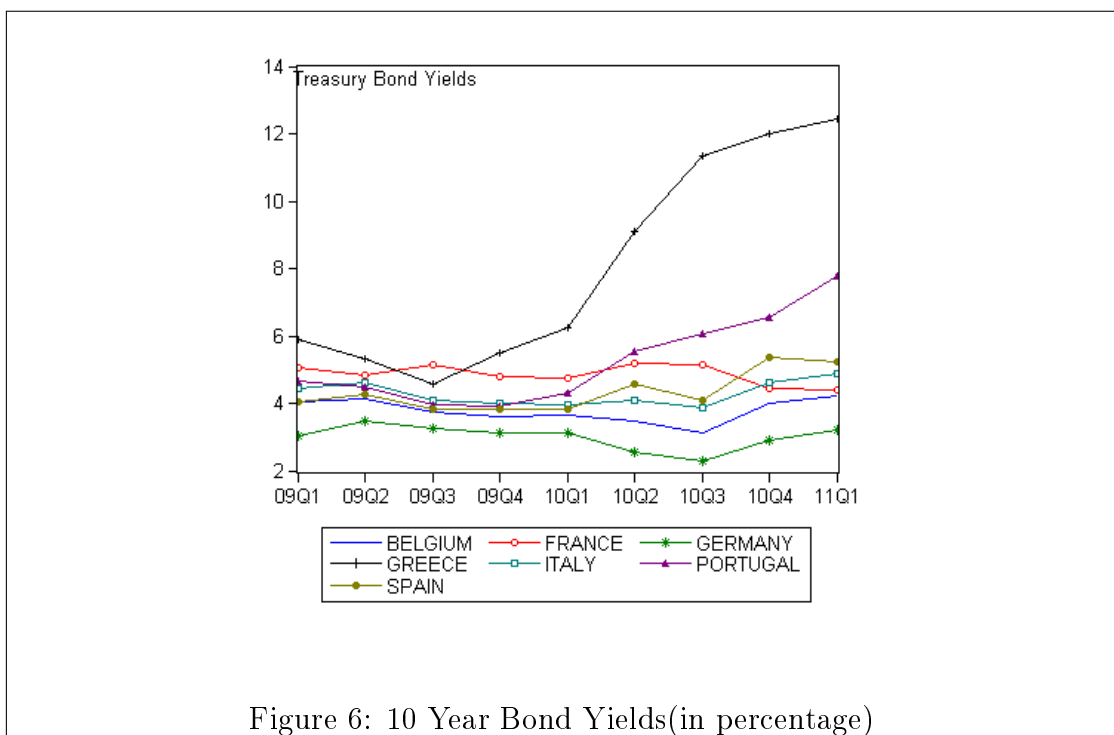


Figure 6: 10 Year Bond Yields(in percentage)

3. Real Gross domestic product.
4. Government Long Run Debt in percentage of GDP.
5. Unemployment to population rate.

Appendix A.1 provides data description and expected signs for each of these determinants. For reasons of data availability, estimates are done using quarterly frequency over the 1999-2014 period.

The sample on which we work is: Austria, Germany, Netherlands, Luxembourg, Belgium, Spain, France, Italy, and Portugal. The unavailability of recent data and the disrupted economic context of the Greece, make it impossible to identify a valid model which has forces us to exclude it from the sample.

After testing the presence of unit root and the order of integration of the data, the chosen model to explain the link between the treasury bond yield and the macroeconomic variables is an Autoregressive Distributed Lag Model (ARDL)<sup>26</sup>. In this modeling we can work with a mixture of  $I(0)$  and  $I(1)$  variables. ARDL is a dynamic model combining distributed lag models and autoregressive ones (see Hendry et al. 1984). In this modeling the regressors may include lagged values of the dependent variable and current and lagged values of one or more explanatory variables. It is a dynamic model since it describes the time path of the dependent variable by its history. In economics, there are not a lot of instantaneous relationships between regressors and dependent variable. The variations of the values taken by the dependent variable are an answer to observed changes in the explanatory variables, but after a time interval. This represents the duration necessary for the new information to be integrated into the replica of the endogenous variable. This duration, also called delay, depends on the speed of response to new information received from different evolutions of explanatory variables. The

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26. Hendry and Pagan and Sargan 1984, Dynamic specification. In Griliches, Z. and M. D. Intriligator ed Handbook of Econometrics, vol.2 Ch.18, Amsterdam, North Holland

coefficients corresponding to regressors in first difference are called short-term multipliers. The coefficients of the lagged variables are the long run multiplier, and it provides us with a full description, or long-term relationship between exogenous and endogenous variables.

The general form of an ARDL model

$$Y_t = b_0 + \sum_{i=1}^p b_i Y_{t-i} + \sum_{j=1}^m \sum_{i=0}^{n_j} a_{ji} X_j t_{-i} + \epsilon_t \quad (43)$$

The condition  $\sum_{i=1}^p b_i < 1$  is regularly imposed in the ARDL literature to ensure that the dependent variable  $Y_t$  is stationary.

In our modeling:

- $Y$  = Long-Term Government Bond Yields.
- $p$  = Lags of dependent variable (autoregressive).
- $X_j$  = The explanatory macroeconomic variable number  $\mathbf{j}$ .
- $m$  = The number of selected exogenous variables (Distributed lags).
- $n_j$  = lags of regressor  $\mathbf{j}$ .

Our model can be rewritten as shows the equation 44 In order highlight the short-term and long term effects:

$$D(Y_t) = b_0 + \sum_{i=1}^p b_i D(Y_{t-i}) + \sum_{j=1}^m \sum_{i=1}^{n_j} a_{ji} D(X_j t_{-i}) + Y_{t-1} + \sum_{j=1}^m c_j X_j t_{-1} + \epsilon_t \quad (44)$$

In the equation 44, the variables in level enable us to identify the long-term relationships, whereas those that are differentiated are used to extract the short-term effects.

## The regression results

Before performing estimates, we conducted unit root tests (results are reported in Appendix A.2) to be sure that there is no series Integrated of order 2 (I(2)). In order to identify the number of lags to consider, we use VAR Lag Order Selection Criteria (results are reported in Appendix A.3). Considering the selected lag number, we can conduct our estimates using our variables that, necessary, are I(0) or I(1).

Table 1 reports results that are presented by country.

At this point, we have to check the the residuals correlation and the stability (see Brown et al. 1975) of the models (Results are reported in Appendix A.4). Outcomes affirm the non-autocorrelation of residuals and the stability of the estimated models.

## Interpretation

### Gross Domestic Product

The Gross Domestic Product GDP is the global output of services and goods created within a country's borders in a time span. Following this definition, this indicator is commonly used to evaluate an economy performance since it measures the added value. Higher GDP means that the economy is improving and that its activities are more cost-effective. Hence, it is intuitive to think that an increase of this fundamental leads to an upswing in the creditworthiness of an entity. Using GDP in current prices can be misleading because inflation (contained in prices) can distort the effect of it. Thus our choice was rather focused on the GDP in volume (Real GDP).

As expected, The. Real GDP is adversely linked with the credit risk as measured

Country	Real GDP	Exports variation	LR-Gvrnmt-Debt%GDP	Unemployment rate
Austria	-0,0435*** (-2.041)	-0,114*** (-2.196)	0,398** (2.0017)	1,791 (1.376)
France	-0,183*** (-2.608)	-0,0661** (-2.003)	0,07 (0.132)	2,027*** (2.281)
Germany	-0,304*** (-2.975)	-0,0241** (-1.985)	0,225*** (2.067)	2,178*** (2.591)
Italy	-0,0045 (-0.0108)	0,078 (0.661)	0,101** (1.8567)	4,924*** (3.559)
Luxembourg	-0,248*** (-2.455)	-0,00189 (-0.0229)	0,559 (1.67)	1,328*** (2.674)
Netherlands	-0,0458*** (-3.482)	-0,0843*** (-2.141)	0,173*** (2.098)	0,917** (1.738)
Spain	0,018 (0.155)	-0,065*** (-2.063)	0,901*** (2.505)	3,922*** (2.189)
Portugal	-1,561*** (-2.527)	0,431 (1.391)	1,335*** (2.71)	8,91*** (2.704)
Belgium	-0,074*** (-2.77)	-0,0053 (-0.221)	0,242*** (2.081)	1,509*** (3.928)

Source: Author calculation.

t-statistics are between parentheses.

Table 1: Results Summary: Explanatory variables' Long-run relationships

by the sovereign bond yield. For most of the studied European countries, this variable is statistically significant. GDP varies between (-0.0435) for Austria and (-1.561) for Portugal. In this our results meet the findings of Asghar and Kevin 2010. For Italy and Spain that have critical economic situations and solvency

issues, the Real GDP appear to be not consistent in explaining the credit risk of these countries.

## Exports change

Exports to the rest of the world represent all goods and services produced within a country and furnished to other ones.

They are composed of valuable commodities attracting sales worldwide, what makes them one of the most important sources of Foreign-Exchange Reserves. Basically, their primary reason for being is to maintain market confidence in the national currency and to show that the country has the capacity to resist any shock (rising prices of raw materials or manufactured goods, credit crisis, foreign trade, etc.). These reserves are increasingly held and used as a means to influence their domestic exchange rate or to pay off international debt obligations, in fact, If a country has consequential foreign debt, detaining foreign currency reserves can help to give more confidence in the country's reimbursement capacity. More Exports of goods and services to the World shows a the country's industrial and economic developments and generates an influx of cash especially in foreign currencies. Hence the increase of this variable is expected to be beneficial and to have positive effects on the creditworthiness of the Country. Thus, it is sensible to think that the relationship between credit risk and the change in exports is negative.

According to our estimates, this variable appears significant for 5 out of the 9 countries on which we worked. The coefficient associated to this variable is, as expected, negative, confirming that treasury bond yields vary inversely with Exports.



## **Unemployment rate**

The unemployed population is a portion of the active one, that are not occupying a position. Further information about the economic conditions impact on the creditworthiness of an entity can be provided by the unemployment rate. Indeed, its increase reflects adverse economic conditions. Higher rates of this latter lead to the lowering of cash flows in the economy. For firms, this stands for the decline in production due a decrease of the employed staff, but mainly because of the fall of the effective demand.

Therefore, we expect this variable to move in the same direction with the treasury bond yields. Castro 2013 concludes that the credit risk increases significantly when the unemployment rate rises.

It is one of the variables that proved to be most significant for most countries. The link between the dependent variable and this one is, as awaited, positive. Also, the coefficients associated with this variable are the most important (up to 8, 91 for Portugal). An upsurge in this independent variable is accompanied by a rise in the country's credit risk. This attests of the meaningful weight of the economic conditions on the creditworthiness of a country.

Higher Unemployment rate denotes a slump in the economy and generates the slowdown of the economic cycle. Growth depends, inter alia, on the increase of productivity per capita and the evolution in the workforce. These parameters go down with the rise of this explanatory variable. Hence the economy becomes less profitable and there will be a drop in the generated cash flows.

## **Long Run Debt in percentage of GDP**

The government long-run debt in percentage of GDP, is a ratio of a country's national debt to its gross domestic product. It can be used as an indicator of the

country's adeptness to reimburse its debts. In fact, this ratio measures what a country produces to to which extent it is beholden to its creditors. An increase of this ratio can make it more complicated to pay back a country's external debts. This could push lenders to ask for greater compensation for additional risk taking which translates into the requirement oh higher interests. This makes governments strive to take down their debt-to-GDP ratios.

Jakubik and Schmieder 2008 used this variable in his study about the credit risk in Czech Republic and Germany. The authors found this variable significant for both countries and associated to important positive coefficient. Studying the credit risk of six developed countries (i.e US, France, Germany, Italy, Spain, and the U.K.), Chinn and Frankel 2005 found that the link of the debt-to-GDP ratio with the sovereign bond yields is positive. The effect differs on a small scale from one country to another with a greater impact among European countries. Regressions performed by Kinoshita 2006 show that an increase of the ratio of debt-to-GDP rises the interest rates of 19 developed sovereigns by around 2-5 basis points.

Our results join the previous works in the change directions of the credit risk and the debt-to-GDP ratio. The most important effect is on the Portuguese and Spanish Treasury bond yields (coefficients are respectively 1,335 and 0,901). Portugal and Spain are among the countries with the less stable economic conditions and having issues to pay back their debts.

## **Long run evidence and short run relationships**

Roughly, the obtained results are, as evidenced by Appendix A.5, are stable in the long term. At at least a 90% level of confidence, there is a confirmation of the stability for the estimated relationships (Except for Italy and Luxembourg).

In the short run, the relationships keep the same directions (see the Appendix A.6). Coefficients associated to the real Gross domestic product are negative without

being significant for most countries (Only for Austria and France with two lags and Netherlands with one lag). With as expected, a positive link with the credit risk, in the short term, more countries are affected by the change in exports to the world (5/9 countries). For Austria and Netherlands, it is even significant for both first and second lags.

The debt-to-GDP, that is significant for most countries in the long run, appears not to be consistent in the short run. This variable affects in a much more meaningful way in the long term. Information provided by this ratio does not instantly affect the treasury bond Yields, but once integrated, the impact lasts long.

As in long term, the unemployment rate in the short term is the most significant among the studied explanatory variables (consistent for 8 out of 9 countries). Only one quarter is selected as significant lag.

## Conclusion

The creditworthiness of the sample of countries in the Euro zone depends largely on macroeconomic fundamentals. As attests the table below (2), estimated models explain a considerable part of the evolution of the treasury bond yields for European countries. The long-term multipliers, once computed, the stability of

	Aust	Belg	Fra	Ger	Italy	Lux	Nether	Port	Spn
$R^2$	0.47	0.568	0.42	0.501	0.207	0.458	0.471	0.47	0.244

Table 2: Coefficient of determination

long-term relationships hypothesis has been tested and accepted for most countries (7 out of 9). This informs us about the long run equilibrium. In that saying that the obtained relationships between the variables are still valid and applicable in the long term. The retained models, besides explaining how the Treasury bond yields respond to the increases and decreases of the macroeconomic regressors,

they provide a base for scenario analysis to determine the economies reactions to different situations by stress testing.

The short-term effects are rare and mainly concern unemployment rate. Its immediate impact is, as its long-term one, important and significant.

The Gross domestic product evaluates, in a country, the total added value of the production by economic agents residing within its territory. Overall, an increase in the real GDP positively affects the economic conditions of a country. It means an increase in the investment, revenues and subsequently a country's ability to fulfill its commitments.

A rising debt-to-GDP increases the country's engagements compared to its production and hence the creditor's risk of failure. The long-term effect of this variable is much more important than its short-run one.

The unemployment rate is the most influential variable in both short-run and long-run. This is especially important among the least creditworthy countries with the weakest economic conditions (between 3,9 for Spain and 8.9 for Portugal). It affects treasury bond yields through the channel of the economic cycle. less investment discourages recruitments and rises this rate. This lowers cash flows in the economy and brakes the growth.

Exports to word is selected to explain the evolution of 5 out of to 9 countries' treasury bond yields. This variable is favorable to improve the solvency of the studied entities. This occurs mainly through the increase of the country incomes especially in foreign currencies.



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## What drives European Banks' CDSs?

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### Introduction and Literature

The recent global financial crisis has emphasized the importance of understanding financial instability particularly in the context of managing credit risk with special attention on the banking sector. The latter crisis has critically harmed the banking industry. Banks have played a major role in fuelling and propagating the recent financial crisis<sup>27</sup>. This was done especially through credit derivatives. Banks that went bankrupt or who have almost failed were all very active in the Credit Default Swap (CDS) market. This has brought special consideration for this credit derivative and his association to the credit risk. Dickinson 2008 argues that CDS have participated largely in worsening and accelerating the financial crisis, specially the subprime one. Indeed, he showed that the CDS contracts have generated the possibility for relatively few market participants to shake and disturb the global economic system. Since the credit crisis triggering, the CDS market has aroused more attention as a measure of credit risk. In fact, a credit default swap (CDS) is a kind of insurance against credit risk. The buyer hedges against

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27. Subprime and European debt crisis

the eventual default of the underlying entity whose default probability perception following a credit event is reflected in the price of the instrument. The higher the risk of default is, the more the buyers are willing to pay to protect themselves against this risk. In return, the protection seller is obliged to refund the purchaser if the credit event occurs. In doing so, the default risk is transmitted from the holder of the fixed income security to the seller of the swap. Hence, The price of the credit default swap, also called the premium or the spread reveals what level of risk do market operators associate with the reference entity. In this sense, market prices can be used to compute default probabilities, namely in the reduced-form approach which is based on the work of Jarrow and Turnbull 1995. The credit event (failure to pay, bankruptcy...) is treated as a sudden surprise and thus is modelled as the first event of a Poisson Counting Process that takes place at a default instant  $\tau$  situated in the time interval  $[t, t+dt]$  with a probability  $P$  specified as :

$$P = Pr[\tau < t + dt | \tau > t] = \lambda(t)dt \quad (45)$$

Where :

- $\lambda(t)$  : A time dependent function (assumed to be deterministic for simplification).
- $\tau > t$  : Means that there was no default until time  $t$ .

Therefore, the probability that the entity does not default at  $\tau$  is:

$$1 - P = 1 - Pr[\tau < t + dt | \tau > t] = 1 - \lambda(t)dt \quad (46)$$

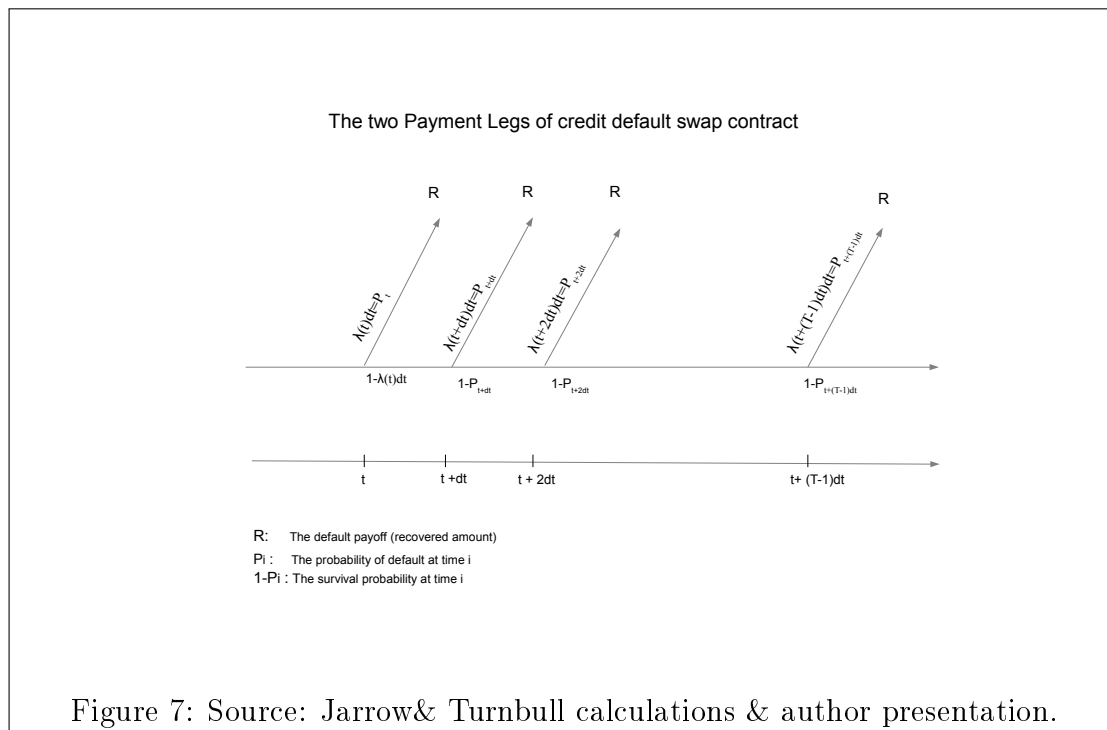
In a continuous timing economy where  $dt \rightarrow 0$ , the probability that an entity does not default (i.e the survival probability) until maturity  $T$  knowing that it did not

bankrupt until  $t_p$  is given by:

$$\bar{P}(t_p, T) = \left[ - \int_{t_p}^T \lambda(s) ds \right] \quad (47)$$

Hence, a CDS contract has two Cash Flow legs: The fee premium leg and the contingent Cash flow leg. Here we'll outline how the premium of the CDS is determined to understand its link to the default probability.

The figure (fig24) shows the payoff ratio process in multi-period model.



This allows us to value the CDS premium Leg which is the leg of the regular fee payments (in opposition to the contingent leg in case of default) The horizontal leg in the figure 7.

To do so, let's assume :



- $n = 1 \dots N$  : the contractual payment dates ( $t_1 \dots t_N$ )
- $S_{p_N}$  : The maturity contractual default swap spread (CDS premium for the maturity N)
- $\bar{P}_{t_n}$  : The No-Default probability
- $RFD_n$  : The risk-free discount factor from valuation date to premium payment date n
- $AP_n$  : The accrual period from  $t_{n-1}$  to  $t_n$

The present value of the Non-Default Premium Leg is:

$$PL_{pv} = S_{p_N} \sum_{n=1}^N AP_n \cdot RFD_n \cdot \bar{P}_{t_n} \quad (48)$$

According to the no-arbitrage principles that have to be respected, the two legs must have the same value. This can be rearranged to find the CDS spread formula (to understand the development and the steps, see Jarrow and Turnbull 1995) :

$$S_{p_N} = \frac{(1 - R) \sum_{n=1}^N RFD_n \cdot (\bar{P}_{t_{n-1}} - \bar{P}_{t_n})}{\sum_{n=1}^N RFD_n \cdot \bar{P}_{t_n} \cdot AP_n + RFD_n \cdot (\bar{P}_{t_{n-1}} - \bar{P}_{t_n}) \cdot \frac{AP_n}{2}} \quad (49)$$

The following table shows a numerical example of a CDS spread computation. It reveals that the no-default probability ( $PND_i$ ) and the spread of CDS ( $S_N$ ) change oppositely attesting of a negative link between these two variables.

Another model attesting of the good predictive power of the default probability of an entity by the CDS spread above, is the J.P.Morgan<sup>28</sup> one.

In the J.P.morgan model *THE J.P. MORGAN GUIDE TO CREDIT DERIVATIVES* no date, Credit default swaps are used to make Credit Default Curves

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28. J.P. Morgan is offering services in asset management, investment banking, private banking, treasury and securities services, and commercial banking.

Period	Yield%	$DF_i$	$PND_i$	Annuity $_N$	Default accrual $_N$	Contingent leg $_N$	$s_N$
0.5	2.33	0.9884	93.05%	0.47	0.008	0.048	988
1	2.52	0.9763	86.56%	0.901	0.016	0.093	998
1.5	2.87	0.9628	81.51%	1.300	0.022	0.127	945
2	3.22	0.9478	77.30%	1.673	0.028	0.155	896
2.5	3.52	0.9317	74.32%	2.024	0.032	0.175	837
3	3.82	0.9144	71.45%	2.355	0.036	0.193	794
3.5	4.02	0.8964	69.90%	2.672	0.038	0.203	737
4	4.22	0.8779	68.37%	2.975	0.040	0.213	695
4.5	4.37	0.8591	68.06%	3.269	0.040	0.215	639
5	4.52	0.8407	67.76%	3.555	0.040	0.217	594

Source : Choudhry 2004 page 83

Figure 8: An example of CDS Spread pricing premium

that are used to estimate the implied default probabilities. As for the Jarrow and Turnbull 1995 model, two states are distinguished here. The default and the no-default states for which the cashflows should be modelled to obtain the credit spreads. These are market Credit Default Swap spreads that have to be converted into default probabilities.

To do so, we have to withdraw the recovery effect, since in reality, the protection seller will disburse only  $(100\% - R)$  if a credit event occurs. As shown in equation 50, this gives us a positive link between CDS spread and default probability:

$$DP = 1 - \frac{1}{[1 + [\frac{CDS_s}{1-R}]^t]} \quad (50)$$

As Callen et al. 2007 point out that, although the CDS premium is linked to credit ratings issued by the rating agencies, relatively more variation in CDS spreads are

noticed for entities having given ratings. In fact, CDS spreads are more responsive to fluctuations in the credit risk quality. Hull et al. 2004 join this point of view, the authors outline that since CDS are quoted directly in term of spreads on credit contract, this makes them more representative of the credit risk of these contracts. Considering these models, in this paper we investigate the determinants of CDS spreads as a proxy for credit risk. Indeed, Annaert et al. 2010, in their study of the determinants of the Euro area bank CDS spreads, confirm that the rising CDS spreads are due to increased credit risk. The empirical works to date, sustain the important impact of the structural variables on the credit spreads. Yet, other researchers argue that only a small part of the credit spreads changes can be explained by the structural variables. Alok Kumar et al. 2008 tried to model the default probabilities and credit spreads for selected Indian firms in the Merton framework (see Merton 1974). The authors found that the model spreads are small relative to the observed spreads in the secondary market for these bonds. Second, the model severely underpredicts the spreads for low leverage and low volatility firms. Collin Dufresne et al. 2001 show that these latter variables explain not more than about 25% of the global variation of the dependant variable. Bonfim 2009 illustrates that even if the firms' financial situation has a central role in explaining default probabilities, macroeconomic conditions are also very important when assessing default probabilities over time.

In this paper we try to capture other important determinants of the credit default swap spreads. In fact, we think that the variables specific to the country or to the region in which a bank is based significantly affects its credit risk. This should be all the more noteworthy that the banking group is large and active. We tend to expect bank located in uncertain area to be affected and to become riskier. Actually, the economic and financial turmoil that Greece experienced have severely affected the entire financial system of the country or even the entire Euro zone.

We witnessed serious difficulties with some Greek financial institutions that were almost dry and demanded urgently liquidity to the Greek Central Bank. If it were able to meet their requests, their situations would have improved and these institutions would not have gone bankrupt.

All this leads us to ask ourselves what are the country specific or region specific variables that affect the credit risk of the studied banking groups and to what extent their effects are Important. Castro 2013, in his study tried to examine the link between macroeconomic factors and the banking credit risk for the GIIPSI<sup>29</sup> countries. He concluded that this risk is significantly affected by the macroeconomic environment. He also found that the credit risk increases with an appreciation of the real exchange rate. The same finding is confirmed by Yurdakul 2014 who used a set of macroeconomic variables to model the credit risk for banks in Turkey. The author assumed that growth rate and the ISE-100 index<sup>30</sup> are the variables that lower, banks credit risk in the long run. However the variables that are positively linked to M2 money supply, unemployment rate, inflation rate and the interest rate. Ejsinga and Lemke 2011 in their study of the sovereigns' and banks' credit risk premiums, show that there is a considerable risk transfer in both ways between banks and governments. The authors demonstrate that bank CDS premium are sensibly reactive to changes to the sovereign credit risk mainly during financial turmoil periods. This is also confirmed by De Bruyckere et al. 2013 who tried to investigate contagion between bank and sovereign default risk in Europe over the period 2007-2012. Their analysis revealed a significant risk spread in the two directions. Aktug et al. 2013 highlight very robustly that financial sector variables are related to sovereign credit risk measured by credit ratings. This proxy for credit risk is also used by Williams et al. 2013. The authors analysed the effects of sovereign rating actions on the credit ratings of banks in emerging markets. They

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29. Greece, Ireland, Portugal, Spain and Italy

30. Istanbul Stock Exchange : The country's exchange, home to 320 national companies

demonstrate that sovereign rating upgrades (downgrades) have strong effects on bank rating upgrades (downgrades). Calmess and Théoret 2014 investigate how banks, as a group, react to macroeconomic risk and uncertainty for the US and the Canadian cases. Their results confirm that banks tend to behave more homogeneously towards macroeconomic uncertainty.

To empirically investigate the long-run relationships and dynamic interactions among the variables of interest, the model has been estimated by using the bounds testing (or autoregressive distributed lag (ARDL)) cointegration procedure, developed by Pesaran 1995. This choice is maintained for the following motives . In the first place, the simplicity of the bounds test procedure. As opposed to other multivariate cointegration techniques such as Johansen and Juselius 1990 test. Once the lag order of the model is determined, we can easily conduct the cointegration relationship by OLS. Secondly, and this is particularly important when dealing with financial variables, the bounds testing procedure is less constraining regarding the stationarity since it does not necessitate the variables included in the model to be integrated of the same order unlike other techniques. It is applicable irrespective of whether the regressors in the model are purely  $I(0)$ , purely  $I(1)$  or mutually cointegrated. Thirdly, the test is relatively more efficient even in small or finite sample data sizes. Note that the procedure will however crash in the presence of  $I(2)$  series.

This study empirically investigates the possible co-integration between European banking groups CDSs and their potential contextual determinants namely : the entity's equity value, the country's CDSs, the country's stock index, the country's inflation. And since all the studied entities are based in the Eurozone, we will also try to explain their CDSs by the European Stock Index, the global European inflation as well as the USD/EUR exchange rate.

The paper proceeds as follows. Section II defines methodology of the study. Sec-

tion III provides data and modelling. Section IV presents results and discussions and the paper concludes with Section V.

## Autoregressive Distributed Lag - Error Correction Model

### From the traditional to the EC- ARDL model

The Autoregressive Distributed Lag Model (ARDL) is one of the main dynamic single-equation regressions. Engle and Granger 1987 proved that for the non stationary variables, the cointegration techniques is analogous to an error-correction modelling. Hassler and Wolters 2005 show that the estimation of a cointegrating vector from an ARDL specification is equivalent to that from an Error-Correction Model (ECM). Starting from the classic autoregressive distributed lag model, we'll use it to make an Error correction model. Working on the regression of a dependent variables  $Y$  with two independent variables  $X_1$  and  $X_2$ , here is the traditional ARDL modelling :

$$Y_t = \beta_0 + \sum_{p=1}^P \beta_p Y_{t-p} + \sum_{l=0}^L \alpha_l X_{1,t-l} + \sum_{j=0}^J \gamma_j X_{2,t-j} + \epsilon_t \quad (51)$$

The variables in question may include a mixture of stationary and non-stationary time-series.

As aforesaid, variables in the ARDL modelling may have different integration order  $I(0)$  or  $I(1)$  but not  $I(2)$ . Hence, the first thing to do is to identify the order of integration of the studied variables. Here we can conduct the ADF<sup>31</sup> and KPSS<sup>32</sup>

31. Augmented Dickey-Fuller test (ADF) is a test for a unit root in a time series

32. Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are used for testing a null hypothesis that an observable time series is stationary around a deterministic trend

tests (see Hatanaka 1996).

After having been assured that all the variables are either I(0) or I(1), it is possible now to transform our traditional ARDL model in an error correction one (equation 52).

When dealing with non-stationary variables, an Error Correction Model (ECM) is generally used. The conventional error correction model:

$$\Delta Y_t = \beta_0 + \sum_{p=1}^P \beta_p \Delta Y_{t-p} + \sum_{l=0}^L \alpha_l \Delta X_{1,t-l} + \sum_{j=0}^J \gamma_j \Delta X_{2,t-j} + \phi c_{t-1} + r_t \quad (52)$$

Transforming the ARDL model (51) to an EC model is replacing the error correction term  $c_{t-1}$  by the terms  $Y_{t-1}$ ,  $X_{1,t-1}$ , and  $X_{2,t-1}$ . Where  $c_t$  is the OLS estimate residuals of the regression (53) :

$$Y_t = \alpha_0 + \alpha_1 X_{1t} + \alpha_2 X_{2t} + c_t \Leftrightarrow c_t = Y_t - \alpha_0 - \alpha_1 X_{1t} - \alpha_2 X_{2t} \quad (53)$$

Here is the new ARDL model:

$$\begin{aligned} \Delta Y_t = \beta_0 + \sum_{p=1}^P \beta_p \Delta Y_{t-p} + \sum_{l=0}^L \alpha_l \Delta X_{1,t-l} + \sum_{j=0}^J \gamma_j \Delta X_{2,t-j} \\ + \theta_0 Y_{t-1} + \theta_1 X_{1,t-1} + \theta_2 X_{2,t-1} + e_t \end{aligned} \quad (54)$$

The first part of the model (54), that is with the variables in first difference is used to capture the relationships of short-run, while the part with the variables in level rather serves to identify the long-run relationships.

According to Pesaran et al. 2004 equation (51) is considered as a conditional ECM. At this level, we need to verify the optimal number of lags. The use of information

criteria<sup>33</sup> is necessary to choose the lag length (see Khim and Liew 2004). Once the lag specification is done, we can regress our variables in the conditional ECM (EC-ARDL model) using the appropriate number of lags. In order to validate this model, we have to make sure that the error terms are independent. We can't apply the bounds testing (ARDL) approach to cointegration if the independency of the residuals is not accepted.

## Long-Run Effects

To examine empirically the existence and significance of long-term relationships between the studied variables, we use the techniques of bounds tests introduced by Pesaran et al. 2001. We can then confirm or reject the correlation of the variables' long-run trends. Considering equation (54), to conduct a bound test, we have to implement an  $F$ -test<sup>34</sup> with the absence of long-run equilibrium relationships as the null hypothesis (55). The rejection of this hypothesis means the existence of long-run equilibrium relationships which corresponds to the alternative hypothesis (56).

$$H_0 : \theta_0 = \theta_1 = \theta_2 = 0 \quad (55)$$

$$H_1 : \theta_0 \neq 0 \quad \text{and/or} \quad \theta_1 \neq 0 \quad \text{and/or} \quad \theta_2 \neq 0 \quad (56)$$

Note that F-test critical values aren't available when dealing with a mixture of integration orders (i.e I(0) and I(1)) variables. Nevertheless, Pesaran et al. 2001

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33. These criteria are based on a high log-likelihood value. like AIC, HQ, BIC...

34. An F-test is any statistical test in which the test statistic has an F-distribution under the null hypothesis. It is most often used when comparing statistical models that have been fitted to a data set, in order to identify the model that best fits the population from which the data were sampled



(page 300) provide bounds on the critical values for the asymptotic distribution of the F-statistic<sup>35</sup>.

Suppose now that the bound tests are conclusive (cointegration is confirmed). We can then use the coefficients obtained in equation (65) to identify long-term relationships.

Note that in the long run the change quantities (equation 57) will be null.

$$\Delta Y_t = \Delta X_1 = \Delta X_2 = 0 \quad (57)$$

Thus, from the equation (54) we can derive the long-run elasticities which are  $(\frac{-\theta_0}{\theta_1})$  for  $X_1$  and  $(\frac{-\theta_0}{\theta_2})$  for  $X_2$ .

## Data and Modelling

### Data

The data we used in our investigation are collected through Thomson Reuters Datastream and Thomson Reuter's Ecowin databases. We used European contextual variables to calculate their implied effects on our sample of European banks Credit Risk. The Credit risk is studied through The Credit default swap spread (5-year senior CDS). We applied the estimates on monthly frequency CDSs data over the December 2008 - September 2013 period. Lately, the Euro-zone has witnessed an important period that was rich in financial turmoil. The sample of the banking groups was chosen in this area from different countries with mixed economic situations. Below a table summarizing the data and the expected sign for

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<sup>35</sup>. If the computed F-statistic falls below the lower bound we would conclude that the variables are I(0), so no cointegration is possible, by definition. If the F-statistic goes beyond upper bound, we conclude that we have cointegration. Finally, if the F-statistic falls between the bounds, the test is inconclusive.

each explanatory variable. :

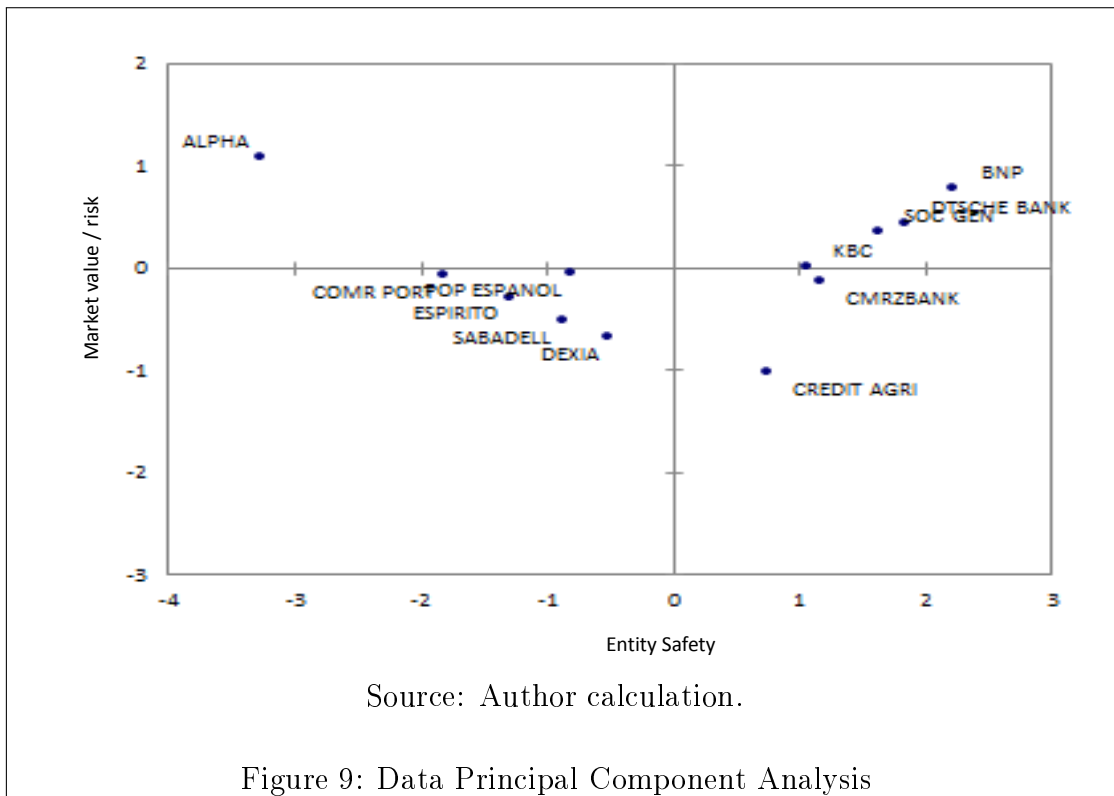
Variables	Description	Abbreviation	Expected sign
<b>Banks' variables</b>			
Bank's CDSs (the dependent variable)	Credit default swap premium (spread) of the studied banking group	Entity CDSs	
Equity Value	The Market Value of the equity of the bank	Entity Equity	-
<b>Countries' variables</b>			
Sovereign CDSs	For each bank, its home country's credit default swap spread	CTR CDSs	+
Country's Stock Index	For each country a benchmark stock market index <sup>a</sup> . It is a capitalization-weighted measure of the most significant values among the highest market caps on the Bourse.	CTR DEX	-
Country inflation	The annual rate of inflation is the price of a total basket in a given month compared TO its price the same month one year before.	CTR INFL	+
<b>European Variables</b>			
Europ Stock Index	Euro Stoxx 50 : a stock index of Eurozone	EUR INDEX	-
European Inflation	The Harmonised Index of Consumer Prices (HICP) in the Euro area.	EUR INFL	+
USD/EUR exchange rate	Ex- The rate at which one US dollar will be exchanged for the Euro.	USD/EUR	-

<sup>a</sup>. BEL 20 for Belgian Banks, IBEX 35 for Spanish Banks, PORTUGAL PSI-20 for Portuguese Banks, FTSE MIB INDEX for Italian Banks, FRANCE CAC 40 for French Banks, and DAX 30 PERFORMANCE Index for German Banks

Table 3: Data Summary & Description of the variables

## Data Principal Component Analysis

We use the principal component analysis (PCA) to highlight similarities or contrasts between the studied entities and identify the most correlated between them. Variables close to each other are positively correlated, while remote variables are negatively correlated. With reference to the horizontal factor, we can clearly distinguish two groups, risky banks in the left side and safe ones in the right



side. The first are characterized by high Credit Default Swaps Spreads coinciding automatically with bad ratings, whereas the second have lower CDSs corresponding to banks with good ratings.

Entities having a relatively high value on the market, relative to its default risk lie above the vertical factor that is a kind of combination between the market value of the entity and its risk. The entities located below this line have a low market value relative to its risk.

Globally, The lower left square regroups banks with higher risk and a low market value relatively to its credit risk. The lower right one contains safe entities still undervalued.

Alpha Bank which lies in the upper left square is the riskiest one but overvalued in the market. In the upper right square we find the safest banks with correct market valuation.

The Principal component Analysis suggest that vertical line ie, the market value relative to its risk doesn't represent a good factor to separate the studied banks.

## Modelling

We worked on time -series Data. The very first step is to check the order of integration of the studied variables. We conducted Augmented Dickey-Fuller tests and the results show that the variables are all integrated of order 0 or 1. This allows us to apply ARDL model to verify the long-run relationships.

We assume that the banks long-run CDSs function for one entity:

$$CDS_{sit} = \alpha_{0t} + \sum_{d=1}^D \gamma_{it} X_{dit} + \mu_i + \epsilon_{it} \quad (58)$$

Where

– CDSs : Credit Default Swap spread

- $X_d$  : The independent variables.
- $i = 1, 2, \dots, I$  : The number of the bank.
- $t=1, 2, \dots, T$  : The number of periods.

$X_d$  : The selected explanatory variables are listed above (see tale 3)

The conventional ARDL model corresponding to our regression for each bank is :

$$CDS_{s_t} = \beta_0 + \sum_{p=1}^P \beta_p CDS_{s_{t-p}} + \sum_{d=1}^D \sum_{l=0}^L \alpha_{dl} X_{d,t-l} + \epsilon_t \quad (59)$$

Where

- p..P : The autoregressive number of lags.
- d..D : The number of the explanatory variable.
- l..L : The number of the distributed lags.
- $X_d$  : The explanatory variables that could be one of the variables of the table 3.

In order to construct our Autoregressive Distributed Lag - Error Correction model (ARDL-ECM), we need to move to the variation version, as explained above, to be able to capture the long-term effects. The model 59 is then written as follows:

$$\Delta CDS_{s_t} = \beta_0 + \sum_{p=1}^P \beta_p \Delta CDS_{s_{t-p}} + \sum_{d=1}^D \sum_{l=0}^L \alpha_{dl} \Delta X_{d,t-l} + \quad (60)$$

$$\theta_0 CDS_{s_{t-1}} + \theta_1 EQ_{t-1} + \theta_2 CTRCDS_{s_{t-1}} + \theta_3 CTRDEX_{t-1} +$$

$$\theta_4 CTRINFL_{t-1} + \theta_5 EURDEX_{t-1} + \theta_6 EURINFL_{t-1} + \theta_7 XR_{t-1} + e_t$$

Where  $\beta_0$  is the drift component and  $e_t$  are the random errors. In the model 60, the  $\theta_i$  are long-run multipliers while  $\Delta$  denotes the first difference operator.

## Results

Prior to conducting the ARDL bounds test, it is necessary to compute Unit roots tests. We test the stationarity status of all variables to identify their order of integration. This is to make sure that the variables are not I(2) stationary so as to prevent spurious estimates. If it turns out that there are I(2) variables, then the computed F-statistics provided by the cointegration test are not conclusive in that the bounds test is based on the presumption, that the variables are I(0) or I(1). Hence it is indispensable to exclude the possibility that any of the series are I(2). Appendices B.1, B.2 and B.3 report the augmented Dickey-Fuller (ADF) tests' results where we tested the presence of a unit root for the variables' processes in different levels (in level to test the I(0) stationarity and in first difference to verify the I(1) stationarity). In this test the Null Hypothesis ( $H_0$ ) is that the series has a unit root(not stationary in level). If rejected then the studied variable is stationary, else it is not integrated of order 0 and hence we have to test the stationarity in first difference and so forth (see Dickey and fuller 1979).

For all banks, the processes of the credit default swap spreads CDSs is integrated of first order I(1) except Deutsche Bank that is stationary in level at the 90 % level (and it is I(0) at the 99% confidence level). Testing the banking groups' market values, ie the equity price processes, we accepted the null hypothesis of the presence of unit root, and we rejected  $H_0$  for these variables in first difference, hence they are all I(1). The countries' Credit default swap spread processes are I(1) at the risk level of 1%. The German Stock index is I(0) at the risk level of 10 % and all the others are I(1). The countries' inflation processes are stationary in difference, hence I(1). This is also true for the common European Variables.

## The ARDL -ECM results

Having done stationarity tests, we can now verify the lag order before applying the ARDL-ECM modelling on our variables. Pesaran et al. 2001 recommend to select the optimal order of lags of the model on the basis of the Schwarz-Bayesian (SBC) and Akaike Information (AIC) information criteria.. The results of the lag selection criteria<sup>36</sup> indicate that the optimal number of lags is two. The table 4 summarizes the computed explanatory variables' Long run incidences on the CDSs for the studied European banks. What is immediately apparent is that sovereign credit risk as measured by countries' credit default swap spreads is statistically significant for all entities except the Greek one "Alpha Bank" (For this bank, it wasn't possible to take into account since the Greek Government Credit Default Swap Spread are no more available since 2011). This allows us to confirm the effect of sovereign credit risk on banks risk of default. For these banking groups, the coefficient associated to this variable is positive and statistically significant at at least 95% (at the 90% level for "Banco Espirito Santo SA"). A deterioration in the credit quality of the country engenders the decline in credit quality of banks. Indeed, as the graphic 7 shows, banks in the Euro area hold important amounts of bonds issued by their own state. This implies that market tensions in sovereign debt can easily spread to the national banking system.

The estimates suggest that the CDSs of the considered banks (except Alpha Bank and Banco COMR Portugues) depend on inflation. They are explained either by the inflation of the home country or of the Euro area (but not both). This variable has the expected sign, ie positive. An increase in banks' credit risk is associated to a rise of the inflation. About this variable, our results confirm those of Demirguc

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36. results are not reported here to conserve space and are available upon request

Entity CDSs	Entity Equity	CTR CDSs	CTR DEX	CTR INFL	EUR IN-DEX	EUR INFL	USD/EUR
BNP Paribas		0,7149 (0,002)		0,0713 (0,0047)			-0,0024 (0,0412)
Credit Agricole		0,7335 (0,0016)		0,0683 (0,0089)			
Société Générale	-0,4492 (0,0683)	0,605 (0,0003)		0,0708 (0,0022)			-0,00144 (0,0014)
Deutsche Bank AG		0,5435 (0,0066)		0,1312 (0,0397)			
Commerzbank		0,3627 (0,0021)			-2,7657 (0,002)	0,1113 (0,0063)	-0,00111 (0,0036)
Banco de Sabadell SA		0,5628 (0,0009)				0,0872 (0,0097)	-0,000601 (0,013)
Banco POP Espanol SA		0,5012 (0,0002)				0,0812 (0,0025)	-0,00054 (0,003)
Dexia Credit Local		0,43252 (0,0002)		0,00755 (0,0212)			
KBC Bank		1,2908 (0,0017)			-4,0469 (0,0109)		-0,00061 (0,0012)
Banco COM Portugues	-0,0006 (0,0337)	0,8986 (0,0278)	-3,0263 (0,0005)				-0,000467 (0,0007)
Banco Espirito Santo SA		1,248 (0,056)	-4,0846 (0,0037)			0,0214 (0,0778)	
Alpha Bank A,E							-3,92E-05 (0,0018)

Source: Author calculation.

P-value are between parentheses.

Table 4: Results Summary: Explanatory variables' Long-run coefficients



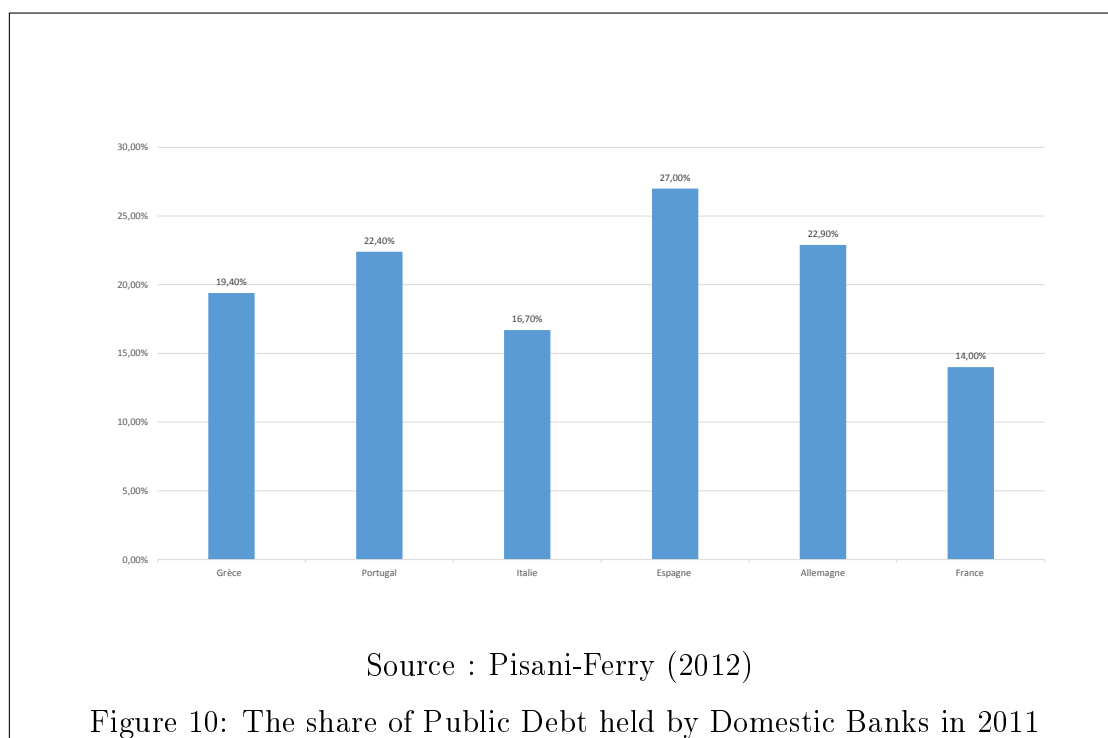


Figure 10: The share of Public Debt held by Domestic Banks in 2011

Kunt and Detragiache 1998 that argue that higher inflation is strongly significant in increasing the banking credit risk. This takes place especially through the effect of inflation on sovereign risk. Indeed, important inflation rates have a big impact on sovereign debt crises. All of the countries that experienced a default or debt restructuring in the past had swelling inflation. The negative effects of inflation involve weakening the real value of money, discouraging investment and saving.

All the parameters for the USD/EUR exchange rate have the same sign but are significant only for eight out of the twelve studied banking groups. An increase in this rate, i.e. a devaluation of the Euro, makes Euro-denominated debt less costing. Yet the coefficient associated to this variable is not high. However, it has a greater effect on the less risky entities ie those on the right side in the graph 9. The USD/EUR exchange rate reflects the competitiveness and the health of Eurozone economy. Hence an increase in this rate, ie a devaluation of the Euro reveals uncertainty in Europe as an economic union.

In the structural approach, Merton 1974 presented firm's equity as a call option on the enterprise with the strike price equal to the face value of a single payment debt issue (zero coupon debt). In this model, if at maturity  $T$ , the assets' value  $V_T$  is insufficient to repay creditors, then the firm is in default (Note that  $V_T$  is an increasing function of  $E_T$  the firm's equity market price). When a company value raises, the distance-to-default of the respective entity increases. Hence the stock price is considered a significant credit risk determinant. Our results indicate that the equity price variable is not significant for most of the entities studied. As expected, it is negative for "Société Générale" et "Banco COMR Portugues". It should also be noted that for the second bank, the coefficient associated to the equity price is very low.

The relation between the stock market index and the banking credit risk as measured by the CDSs is only confirmed for the Portuguese banks. The coefficient in both cases are as predicted negative indicating that an improvement in the overall performance of a stock index enhances the perception of the safety of the registered companies and hence reduces their credit risk.

The stock market index provides information about how stocks in the index have performed. The Capital asset pricing model (CAPM) that is one of the major achievements of the financial theory stipulates that the risk of a stock index is inversely related to its market values. This model for pricing an individual security or portfolio takes into account the market risk while estimating the risk of the studied asset. The formula of this model in terms of risk premium is as follows:

$$E(R_i) - R_f = \beta_i(E(R_m) - R_f) \quad (61)$$

Where :

- $E(R_m) - R_f$  : The market premium.

- $E(R_i) - R_f$  : The asset's risk premium
- $\beta_i$  : Measures the relation of the expected return of the asset and the systematic risk, ie the sensitivity of the expected excess asset returns to the expected excess market returns.

Hence, according to this model there is a part of the risk of the asset that is explained by the market's risk. Our assessment indicates that the European Stock index "Euro Stoxx 50" is not significant for the most part of the studied banking groups. The relation is only valid for Commerzbank and KBC bank that are among the least risky entities.

## Bounds testing approach to cointegration

We opted for the bounds testing approach to cointegration in order to ascertain the existence of long-run relationship between the studied variables. The advantage of this approach other techniques for its flexibility since it allows us to test cointegration regardless the integration order of the variables (I(0) or I(1)).

The cointegration test under the bounds testing approach involves comparing the F-statistics against critical values. The calculated F-statistics, together with the critical values, are reported in table 5. As the table 5 shows, at the 5% level, the null hypothesis of no cointegration among variables for most studied European banking groups cannot be accepted, while in the "Banco Espírito Santo SA" model where calculated F-statistics are less than critical values (between the lower and the upper bounds), results are not conclusive. Hence the long-run equilibrium is rejected for the latter and accepted for the other banks of the sample at at least the 90% level of confidence.

Entity's model	F-statistic	0.05% F-test statistic bounds	LR evidence
BNP Paribas	5.535527	3.23- 4.35	YES**
Credit Agricole	5.390232	3.79 - 4.85	YES**
Ssociété Générale	5.714959	2.86-4.01	YES***
		(0.01% 3.74 - 5.06)	
Deutsche Bank AG	5.522104	3.79 - 4.85	YES**
Commerzbank AG	3.727195	2.04 - 3.24	YES**
Banco de Sabadell SA	4.827298	2.45 - 3.63	YES**
Banco Pop Espanol SA	6.085657	2.45 - 3.63	YES***
		(0.01% 3.42 4.84)	
Dexia Credit Local	8.723674	4.87 - 5.85	YES***
		(0.01% 6.34 - 7.52)	
KBC Bank	4.956741	4.45 -5.07	YES*
		(0.1% 3.47 - 4.45)	
Banco COM Portugues	4.239751	2.26 -3.48	YES**
Banco Espirito Santo SA	3.262054	3.23 - 4.35	NO
Alpha Bank A,E	6.315583	6.56 - 7.30	YES*
		(0.1% 5.59 - 6.26)	

Source: Author calculation.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 5: Bound cointegration test

## Conclusion

This paper investigates the long-run links between European Banks CDS spreads as a proxy for credit risk with some common factors. Using the bounds testing approach to cointegration in order to analyse equilibrium relationships between the variables taken into account. We found that the home country credit risk is the most common determinant of European banks' credit risk. Inflation (whether those of countries or of the Eurozone but not both at once) also seems important in determining credit risk with a positive coefficient that means an increase in inflation is associated with the rise of credit risk. Besides, the exchange rate USD/EUR that is significant for most studied entities with a negative coefficient but not high especially for riskier banks. This means that a devaluation of the Euro (higher USD/EUR exchange rate) makes Euro-denominated debts less costing. Our results suggest that the link of the credit risk with the Market value of the equity or of the stock index in which the company is listed is becoming less essential in explaining the credit risk of the European banks. This confirms the entities' distribution found in the Principal component Analysis (18) which propounds that it is irrelevant to sort the studied entities by the factor of [Market value/ Risk].





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# How does the Connectivity in the Credit Default Swap Market move?

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## Introduction and Literature

This topic has not been, as far as we know, widely studied. But it has come to light since the Subprime crisis, where there was an important Domino effect that it was necessary to look into the matter. Indeed, one of the teachings of this crisis is that it is not enough to be solvent or to have creditworthy creditors to avoid default or credit risk. Financial entities are so interconnected, that when one is affected by an event, several others will be touched. As banks operate in the same market, they are continuously interrelated through exchanging securities, conducting joint operations and extending credit to each other. Besides, debts are securitized, which means they are converted into tradable shares and other credit derivatives on the market. In fact, it is necessary for each bank to get protected against the credit risk through credit derivatives.

Getmansky et al. 2010 try to capture the interconnectedness among the monthly returns of hedge funds, banks, brokers, and insurance companies. The authors found that these sectors have become extremely interrelated over the past decade,



increasing the level of systemic risk.

Battiston et al. 2009 follow the evolution over time of a network of credit relations among financial agents as a system of coupled stochastic processes. They concluded that, because of the diversification of risk, a tension emerges between individual risk and systemic risk. As the number of counterparties in the credit network increases beyond a certain value, both individual and systemic default probabilities start to increase. Bowden 2010 shares this point of view and demonstrates that, in practice, in the credit default swaps market apparent risk sharing lead to a faster collapse. This opinion is also confirmed by Jorion and Zhang 2009. Working on CDS market, they suggest that counterparty risk is an important additional channel of credit risk contagion.

The special case of uniform demand of liquidity addressed to banks is treated by Allen and Carletti 2006, where they argue that credit risk transfer for the banking and insurance sector can be beneficial if this condition is respected.

The Subprime crisis<sup>37</sup> that occurred in 2007 is a representative example of contagion between banks and sovereigns. In fact, during and after this crisis, several banks have filed for bankruptcy and others were very close to it. Thereby, this crisis has weakened the global banking and economic systems by creating a widespread mistrust between banks and the financial system. The bankruptcy of some banks has created a snow ball effect that precipitated the economic crisis. As, on one hand, the weight of the banking system is very substantial in developed countries (the most affected by the crisis), and on the other hand, the economic sphere was critically affected, therefore the monetary authorities and governments had no choice but to intervene by setting up rescue measures. Indeed, rather than placing the entire failing financial sector under public control, governments agree to bail it out in the state. States get into debt out of proportion to rescue banks and stimu-

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37. Patrice Fontaine, Understanding the Euro Crisis: How did the Subprime crisis become a sovereign debt crisis in Europe? Redesis, Paris North University

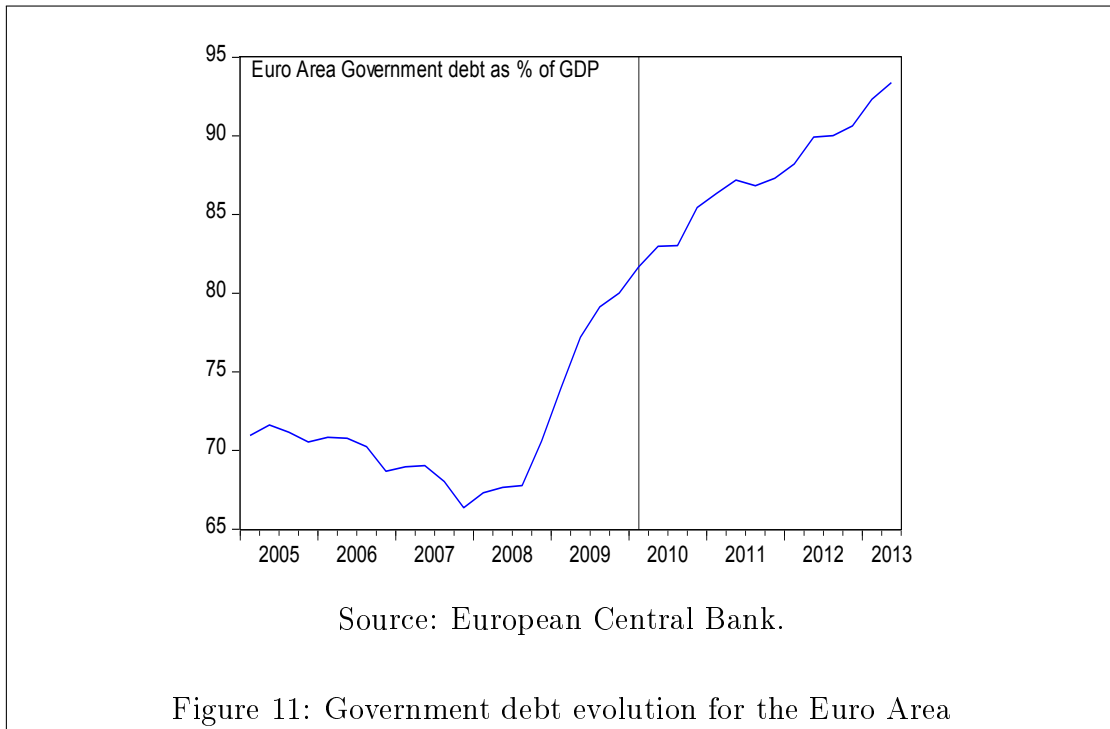
late the economy. The private financial crisis became a swelling of the public debt and led to a social crisis. Mody and Sandri 2011 demonstrate the emergence of financial tensions within the Eurozone. The authors show that the Subprime crisis has broken boundaries between the sovereign and the financial sector. De Bruyckere et al. 2013 investigated contagion as defined by excess correlation<sup>38</sup> between bank and sovereign default risk in Europe over the period 2007-2012. The authors noticed an increased correlation between sovereign and bank CDS spreads during the beginning of the recent sovereign financial crisis then the risk transfer started decreasing.

In addition to regulatory measures, governments were forced to make capital injections, liquidity provisions and vouch for some cases, to prevent the collapse of an economy battered by the Subprime crisis. For example, the French government has deployed about 428 billion euros including 360 just to rescue banks, while the German government approved a stimulus plan including bank bailout fund of 500 billion to restore confidence in the financial system.

As the graph below (11) shows, these measures led to an increase of the European governments' debt and this was felt from the beginning of 2010, when some of them began to experience difficulties in honoring their own debts. In this paper, we'll focus on the Credit Risk Transfer between European Sovereign and Corporate entities over the 2008-2013 period. Based on the phase of the crisis and the trend of CDS variation, three main sub-periods have been distinguished. This study focuses on Sovereigns and banks as they play an increasingly important role in the determination of credit risk. We opted for this choice given the different turbulence that have occurred in this area either on the bank or sovereign level. Billio et al. 2013 apply several econometric measures of connectedness using the

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38. Correlation between banks and sovereigns over and above what is explained by common factors.



Merton<sup>39</sup> Model (contingent claims analysis Merton et al. 2007) to estimate sensitivities to external shocks on the network entities. Their findings are that the system of entities on which they worked, namely European countries, major European, U.S., Japanese banks, brokerages, and insurance companies are dynamically connected. Sovereign risk seems to become significant well before the European Sovereign crisis. They also concluded that network measures help for early warnings and the evaluation of the system complexity.

Our work falls under this approach of considering the connectedness, ie Granger causality, however we focus on three periods and we use the Credit default swap variation to show the links between the credit risk of the studied entities. Actually, Kallestrup et al. 2013 demonstrate that financial linkages across borders are priced in the CDS market beyond what can be explained by exposure to both global and

<sup>39</sup>. Robert Cox Merton is an American economist, Nobel laureate in Economics. He is known for his pioneering contributions to continuous-time finance, especially the first continuous-time option pricing model, the Black-Scholes-Merton formula.

country specific factors.

## Credit default Swaps

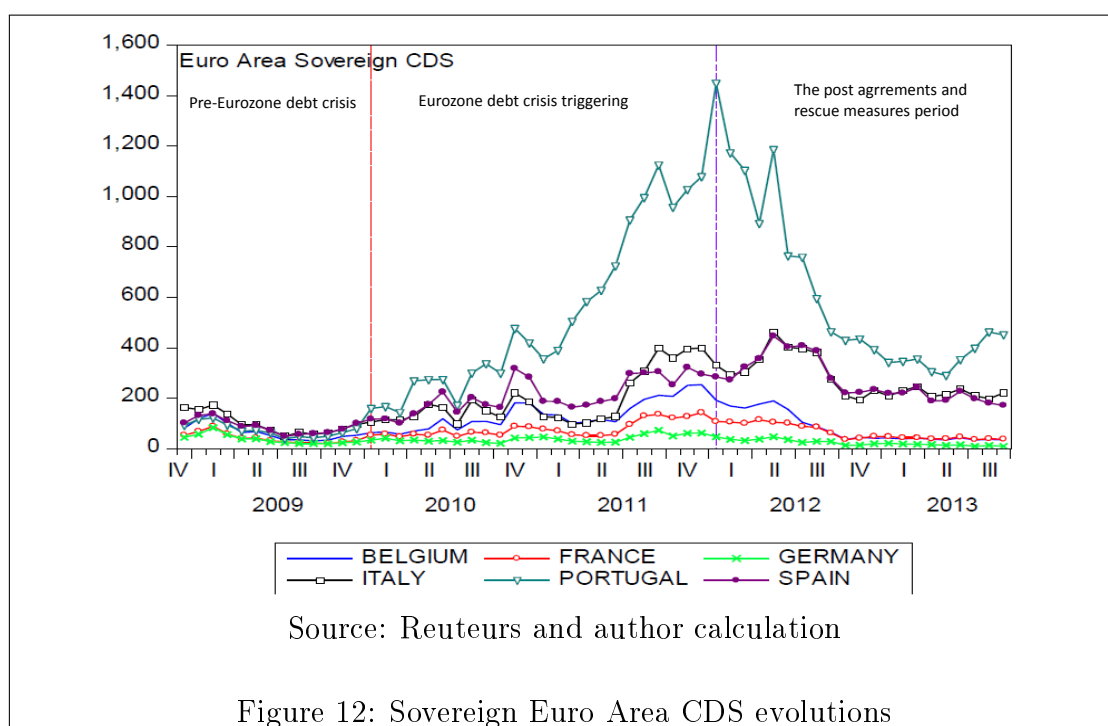
Credit Default Swaps (CDS) (see Cont 2010 ) were initially intended to be hedging and management instruments of credit risk. CDS markets now play an informative role in the credit markets, where CDS are often considered as a reflection of market consensus on the creditworthiness of the underlying entity (corporate or government). This is also confirmed through market practice of calculating the implied default probability of an entity from its CDS spreads. These probabilities are used for the valuation of credit derivatives. CDS are contracts used by their buyers to transfer the default risk of a creditor. The higher the risk involved, the greater the value of these contracts is. Thus this credit derivative is an adequate proxy for credit risk.

As shown in the figures below(12) (13), there is a correlation of changes of the European sovereigns' and banks' CDS. This makes us wonder about the links between the different entities of the two groups. We can also distinguish by the naked eye three main periods, namely:

- Until 2009: Period of implementation of the bailout following the Subprime crisis: With the introduction of governments' rescue packages for the financial system around early October 2008, the levels of sovereign issuers' CDS escalated quickly. This was commonly seen as a risk transfer from the financial to the public sector.
- 2010-2011: The bursting of the European debt crisis and first try of rescue plan: The first event is raised in 2010, with the Greek debt crisis, this period was marked by rapid increase in the CDS for both sovereigns and banks.
- 2012-2013: the post October 27<sup>th</sup> agreement: Altera and Beyer 2014 show that the Contagion Index, measured as the average response in a spillover

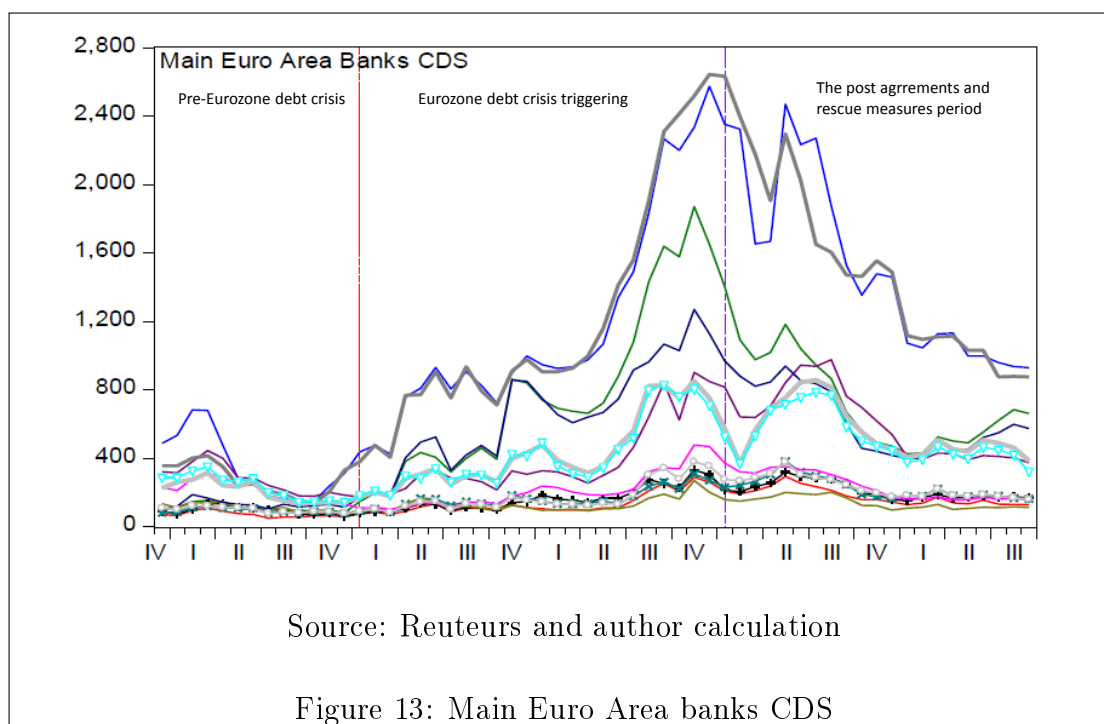
matrix, fluctuates over the period October 2009-July 2012. It becomes notable following important policy events specially August 2011 and June 2012 events.

Credit default swap contracts create connections among issuers and buyers. In this sense, we assume that the CDS market can be perceived as a structure where agents are interlinked by their contracts. The best way to consider such a structure is to analyse it as a network where agents are schematized by its nodes and the credit nexus are represented by the links.



This study aims to examine the unstable relationship between European countries and banks and to stress the particularities of each period for sensing what causes the increase or decrease of the links between the studied entities.

The chapter is structured in the following way: Section 3 presents the chosen methodology to measure the connectedness, in section 4 we introduce the data and the modelling. The results and the discussion are given in Section 5, while



Section 6 contains the main conclusions.

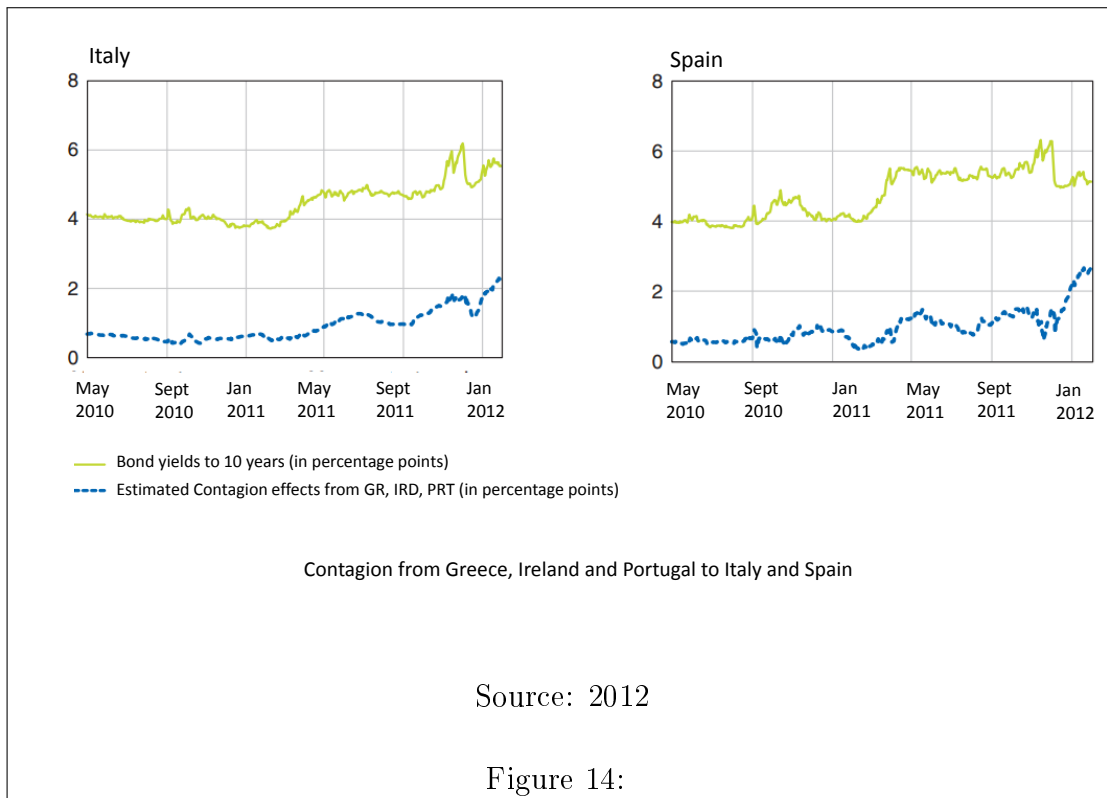
## Contagion and Systemic Risk

Financial systemic risk is the risk of collapse of an entire financial system or entire market, in contrast to risk associated with any one individual entity, group or component of a system. It concerns the risks inflicted by interlinkages and interdependencies in a system or market, where the breakdown of a sole distinct entity or a group of entities can generate a cascading failure, which could potentially bankrupt or depress the entire system or market. Contagion is one of the mechanisms by which financial instability spreads to the point that crisis reaches systemic proportions. Generally we evoke contagion when turmoil in a market or institution propagates to one or more other markets or institutions.

The European sovereign debt crisis has raised requests for more general and co-

ordinated policy interventions to refrain the crisis from expanding contagiously over countries, areas and the financial system. Indeed, during the recent financial crises that developed economies experienced and above all Europe, a succession of bank bankruptcies would have endangered the entire economy as the financial system contains a systemic component. Consequently, saving this latter became a priority for governments, that worked in concert with central banks to introduce wide-ranging financial rescue packages, involving substantial guarantees for bank liabilities. This generated pronounced contagion and risk transfer from banks to governments that can be perceived through the going up of the sovereign CDS. Remarkably, when the crisis of sovereign debt is amplified again, Moody's downgraded the rating of Portugal invoking, among other things, the situation in Greece. This is because Moody's believed that the contagion of a Greek default increased the probability that Portugal may need a second financial assistance plan. As the graph 14 shows, Castro 2013 found that the contagion from Greece, Ireland and Portugal, explains a significant proportion of the Italian and Spanish governments' bond yields. The author also noticed that changes in CDS spreads of Greece, Ireland, Portugal, Italy and France accounts for a growing proportion of the variability in CDS spreads of Société Générale and Crédit Agricole. Hence he suggested that the sovereign debt crisis has a clear impact on the availability and cost of funding for banks in the Euro area. Goria and Radev 2014, studying individual CDS contracts, found that financial linkages are an active contagion transmission channel only in the case of the troubled periphery Euro area economies.

This chapter aims to contribute to the techniques of measurement of what leads to systemic credit risk, ie, what are the movements in the credit market that may conduct to the risk transfer between the market agents. To do so, we will try to inspect connectivity between the studied entities.





## Measuring connectivity

Connectivity measures are (typically bivariate) statistical measures that may be used to estimate interactions between potentially related entities. Connectivity is one of the basic concepts of graph theory.

To schematize the connectivity between the studied banks and countries we will use "entity-relationship diagram" in order to develop networks. A network is defined by the set of  $N$  nodes (or vertices) and the set of  $E$  edges (or links). The edge  $ij$  is the link that emanates from vertex  $i$  and ends in vertex  $j$ . Among a given network, two entities are considered to be connected if there is a path that binds them. We expect to obtain Many-to-Many Relationship diagram where:

Entities: Sovereigns and Banking groups

Relationship between entities: Which Entity CDS affect the other?

Attribute of entities: Changes in the Credit default swaps

For each network, it is possible to measure the level of connectivity. To do so, we use the Beta Index that it is expressed by the relationship between the number of edges ( $E$ ) over the number of nodes( $N$ ) ( $\beta = \frac{E}{N}$ ). In a network with a fixed number of nodes, the higher the number of links, the higher the number of paths possible in the network. Complex networks have a high value of Beta. More complex networks have a  $\beta$  value greater than 1.

A first way to define relationships between entities is to use the pairwise correlations to determine the nodes whose movements are interrelated. Or correlation may be due to the dependence of firms and sovereigns on common economic factors. Yet, the contagion concept is associated with the local interactions between the entities themselves. R. Masson 1998 defines contagion as the effect of the residual in one market on the after, after controlling for all other forms of shock. Hence the author restricts this notion to the relationships specific to the two counterparties,

eliminating external factors that can affect both of them.

## Granger Causality

Two correlated economic time series, are not necessarily linked by a causal relationship. They may have correlated tendencies changes without an economically significant link. Correlation does not evince causality. Indeed, having two correlated events  $E_1$  and  $E_2$ , they can be caused by common factors, without causing each other, There is no connection between  $E_1$  and  $E_2$ ; the correlation is fortuitous and misleading.

Granger Causality (1969), as initially formalized by Clive Granger<sup>40</sup>, is a statistical concept based on prediction that is used to determine whether time series  $X_t$  is helpful in the foreseeing of another one  $Y_t$ . As defined in Liu and Taha Bahadori 2005 "X Granger causes Y if its past value can help to predict the future value of Y beyond what could have been done with the past value of Y only".

The Granger causality test is for two scalar-valued, stationary and ergodic time series  $X_t$  and  $Y_t$ . The question we try to answer is : Does integrating the information contained in the past observations of  $X_t$  improve our  $Y_t$  forecasting?

Two main Granger test assumptions have to be mentioned:

- The past causes the present and/or the future but not vice versa.
- The informations about the impacts of a variable on the other, are unique and untraceable elsewhere, which allow us to identify it as a causality relationship.

The first assumption is intuitive, but it makes it impossible to take expectations into consideration. In the CDS market the risk perceptions are essentially forward

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40. British economist, he taught at the University of Nottingham and at the University of California. In 2003, Granger was awarded the Nobel Memorial Prize in Economic Sciences, in recognition that he and his co-winner, Robert F. Engle, had made discoveries in the analysis of time series data that had changed fundamentally the way in which economists analyse financial and macroeconomic data.

looking which is inconsistent with this hypothesis. To use this method, we believe that although the past causes the present and future and that the opposite is not correct it makes sense to consider that past information already contain future expectations.

The second one is to say, that including the lagged observations of  $X_t$  should give us informations that we cannot find in another variables' observations and that ameliorate the explanation of  $Y_t$ .

To answer: Does  $X_t$  Granger cause  $Y_t$ ? We assume:

- $X_t$  and  $Y_t$  two scalarValued, stationary and ergodic time series.
- $I(t)$ : The set of all the informations in the universe up to time t.
- $I(t)_X$ : The set of all the informations in the universe except  $X_t$  up to time t.
- $F(Y_t/I(t))$  : The conditional probability distribution of  $Y_t$  given the set of information  $I(t)$ .

$X_t$  is said not to Granger cause  $Y_t$ , if for all  $h > 0$  we have :

$$F(Y_{t+h}/I(t)) = F(Y_{t+h}/I(t)_X) \quad (62)$$

So, if the equality (62) is not accepted, then, there is a part of  $Y_t$  that can be explained by  $X_t$ . In other words, taking into account  $X_t$  improves our  $Y_t$  power of prediction.

The statement that  $X_t$  does Granger Cause  $Y_t$  does not mean that  $Y_t$  is the result of  $X_t$ , indeed, the Granger causality mostly measures the antecedence and the informative content.

## Modelling time series in Granger Causality test

According to Granger, the bivariate causality between two time series  $X_t$  and  $Y_t$  is tested through a vector autoregression model VAR. To do so, the variables have to be integrated of order 0, ie stationary, which explain the necessary condition of stationarity for the Granger test.

To test if  $X_t$  Granger cause  $Y_t$ , we compare two models :

$$Y_t = \sum_{l=1}^L \alpha_l Y_{t-l} + \epsilon_t \quad (63)$$

$$Y_t = \sum_{l=1}^L \alpha_l Y_{t-l} + \sum_{l=1}^L \beta_l X_{t-l} + \epsilon_t \quad (64)$$

To choose the lag lengths, we have to resort to criteria for finding best model:

- LR: Likelihood ratio test criterion
- AIC: Akaike information criterion
- SIC: Schwarz information criterion

If the model (63) is better than the model (64), then  $X_t$  does not Granger cause  $Y_t$ . If not, taking into account the information contained in  $X_t$  improves  $Y_t$  modelling, we conclude that there is a causal link in the Granger sense from  $X_t$  to  $Y_t$ .

To choose between these two models, we use t-statistics (single coefficient), or F-test, Log-likelihood ratio-test, Wald-test (multiple coefficients).

As mentioned above, Granger is a bivariate test, that is to say, we test the causality between two variables in both directions.

$$X_t = \sum_{l=1}^L \sigma_l X_{t-l} + \sum_{l=1}^L \gamma_l Y_{t-l} + \epsilon_{1t} \quad (65)$$

$$Y_t = \sum_{l=1}^L \alpha_l Y_{t-l} + \sum_{l=1}^L \beta_l X_{t-l} + \epsilon_{2t} \quad (66)$$

Where we test both null hypothesis

- $H_0$  : Y does not Granger cause X where we test  $\sum_{l=1}^L \gamma_l = 0$
- $H_0$  : X does not Granger cause Y where we test  $\sum_{l=1}^L \beta_l = 0$

Hiemstra and D.Jones 1994 used Granger Causality test in the financial sector to examine the dynamic relation between daily Dow Jones stock return and percentage changes in New York stock exchange trading Volume and they concluded that bidirectional relationships exist.

## Data and Modelling

### Data

The data we used in our investigation are collected through Thomson Reuters Datastream database. We worked with weekly corporate and Sovereign CDS over the 11/28/2008 - 10/31/2013. As we have already mentioned, the period is divided into three sub-periods: (11/28/2008 - 12/25/2009), (1/01/2010 - 12/23/2011) and (1/06/2012 - 10/25/2013).

Our sample consists of two types of CDS contracts. CDS whose underlying entity is a Sovereign and CDS whose underlying entity is a Corporate precisely bank. For Sovereigns, considering data representativeness and availability, six European countries have been chosen, namely Belgium, France, Germany, Italy, Spain and Portugal. We then attempted to integrate in our sample the largest and most active European banks from different countries. Appendix C.1 summarizes the data.

## Modeling

For the empirical section of this paper, we used time series data in order to analyse the bivariate causality between Some European Sovereign and corporate CDS. In unreported results, we conducted Augmented Dickey-Fuller test (ADF) and Phillips-Perron (PP) unit root tests<sup>41</sup> to check the stationarity of all series. Outcomes show that the null hypothesis of CDS non-stationarity can't be rejected and that these series are first order integrated.

To make it possible to compute Granger causality tests, we worked with the first differentiated series which are I(0).

Note that the VAR lag length L is always unknown and therefore has to be estimated via various lag length selection criteria such as the Aikaike's information criterion (AIC). Here the best lag length to work with is 2. We can now conduct Granger causality tests with two lags.

For any CDS series we test the causality with all the others CDS series.

We present now some Granger causality test implementations and results<sup>42</sup>.

Working for instance, on France causality with both Spain and Portugal over the (1/06/2012 - 10/25/2013) period. We'll have to estimate 4 Var models, 2 for each bilateral relationship.

### France Spain CDS Relationships :

The two VAR models corresponding to this test are:

$$France_t = \sum_{l=1}^L \sigma_l France_{t-l} + \sum_{l=1}^L \gamma_l Spain_{t-l} + \epsilon_{1t} \quad (67)$$

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41. The unit root tests are available upon request

42. All Granger causality tests are available upon request

$$Spain_t = \sum_{l=1}^L \alpha_l Spain_{t-l} + \sum_{l=1}^L \beta_l France_{t-l} + \epsilon_{2t} \quad (68)$$

Where  $L = 2$  and we test both null hypothesis

- $H_0$  : Spain does not Granger cause France where we test  $\sum_{l=1}^L \gamma_l = 0$
- $H_0$  : France does not Granger cause Spain where we test  $\sum_{l=1}^L \beta_l = 0$

			2009 Causality		2011 Causality		2013 Causality	
			F-Stat	Prob	F-Stat	Prob	F-Stat	Prob
Null Hypothesis								
Spain	does not	Granger Cause France	3.01346	0.0581	3.09600	0.0497	7.52653	0.0010
France	does not	Granger Cause Spain	0.50677	0.6055	4.03090	0.0208	0.26922	0.7646

Table 6: France - Spain Causality test

At the 95% confidence level, we confirm that an Entity-CDS Granger cause another Entity-CDS when the Pvalues are less than 0.05, then we reject the null hypothesis. For the first period we affirm that with a 5% risk, Spain-CDS do not affect France-CDS and vice versa. However, during the Eurozone debt crisis triggering period, the CDS of both countries affect each other since the Pvalues are less than 0.05. Yet, after establishing rescue plans, the relation between France-CDS and Spain CDS became asymmetrical since we validate the causality link from Spain-CDS to France-CDS but we reject it in the other direction.

#### France Portugal CDS Relationships :

The two VAR models corresponding to this test are:

$$France_t = \sum_{l=1}^L \sigma_l France_{t-l} + \sum_{l=1}^L \gamma_l Portugal_{t-l} + \epsilon_{1t} \quad (69)$$

$$Portugal_t = \sum_{l=1}^L \alpha_l Portugal_{t-l} + \sum_{l=1}^L \beta_l France_{t-l} + \epsilon_{2t} \quad (70)$$

Where  $L = 2$  and we test both null hypothesis

- $H_0$  : Portugal does not Granger cause France where we test  $\sum_{l=1}^L \gamma_l = 0$
- $H_0$  : France does not Granger cause Portugal where we test  $\sum_{l=1}^L \beta_l = 0$

			2009 Causality		2011 Causality		2013 Causality	
			F-Stat	Prob	F-Stat	Prob	F-Stat	Prob
Null Hypothesis								
Portugal	does not	Granger Cause France	5.70070	0.0038	5.46726	0.0056	0.70206	0.4983
France	does not	Granger Cause Portugal	5.25359	0.0058	1.06673	0.3481	1.54315	0.2194

Table 7: France - Portugal causality test

For the first model (69) where we test the causality from Portugal to France the P-value is less than 0.05 for the two first periods, then we reject the first null hypothesis and we confirm at the 95% confidence level that Portugal-CDS Granger cause (ie affect) France-CDS. However, this relationship can't be validated during the last period.

The null hypothesis of non-causality from France to Portugal corresponds to the second model (70). It is rejected during the first period with a P-value less than 0.05. For the two other periods we can affirm that France-CDS do not Granger cause (do not affect) Portugal-CDS.



## Results

As aforesaid, the Granger causality has been tested on European sovereign and banks CDS over three consecutive periods. If we refer to figures (12) and (13), we note that the first period, which directly followed the Subprime crisis, is where the pricing of the CDS market has calmed down. In fact, prices are low for all studied entities. During this first period, comforted by the influx of public money and the stock exchanges rising, stimulated by near-zero interest rates, banks and investment funds resume their ordinary business.

During the second period, States have saved the banks without requiring counterparty. Banks turn their newfound strength against the States. Goldman Sachs has helped Greece to borrow billions of euros in secret. Then, to circumvent EU rules limiting the level of public debt, the Wall Street firm advised Athens to use clever accounting and financial tricks. The bill for these innovations then rounded the huge Greek debt. Considering support to Greece became unavoidable when the European Union governments have been already hit by their own banks bail out. The different government interventions aiming at rescuing governments and financial institutions by capital injections and guarantees increased considerably the costs of public debts. This financial turmoil has plunged the Euro-Zone in a deep debt crisis.

in the late 2011, Countries in the Euro area managed to buckle the main lines of an anti-crisis plan through a significant reduction of Greece's debt and the mobilization of 1 trillion, not to mention the international rescue plans during the same period for Ireland and Portugal in order to prevent contagion. During the following period, all these measures began to pay. As the graphs 12 and 13 show, CDS started to decline significantly for both countries and financial institutions. Countries can be divided into two groups: countries with a stable financial posi-

tion, ie Germany, France and Belgium, and others whose credit risk is much more important, namely, Italy, Spain and Portugal. The second are part of GIIPS which are considered to be the most problematical and uncertain members in the Euro area.

As summarized in the table below (8), countries with low risk are not affected by the others during the phases of financial turmoil. These are countries whose financial and economic health is safer. The second group of countries that is more touched by the European debt crisis, is more affected during these times of hardship. It is more vulnerable and sensitive to changes occurring for other entities. Banks, however, have kept the same proportion of participation before and during the outbreak of the crisis. Their role has made a considerable jump during the later period (from 46% to 70%). Indeed, banks are more concerned by the agreements made to overcome the crisis, it is about the facilities they need to grant to entities facing problems.

Causality From <sup>a</sup>	Period 1	Period 2	Period 3
Germany, France, Belgium	31 (33%)	11 (16%)	24 (22%)
Italy, Spain, Portugal	19 (20%)	26 (38%)	9 (8%)
Banks	44 (47%)	32 (46%)	75 (70%)
Total	94 (100%)	69 (100%)	108 (100%)

Source: Author calculation.

Percentage of the total causality relationships in parentheses

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*a.* To all Network Counterparties

Table 8: Results Summary

We worked on the three above-mentioned periods. The results are presented

in the form of directed networks<sup>43</sup>. Each node is the CDS of an entity and each link is a causal relationship. Arrows are directed from the CDS-origin to the CDS affected. Full results of the causality tests between the studied entities are shown in Appendices C.2.

$$X \rightarrow Y \quad \text{Means X Granger causes Y} \quad \text{Means X Affects Y}$$

## The Pre-Eurozone debt crisis period

Figure (15) shows the connections between the entities of the studied sample for the first period. The 2008-2009 period is characterized by large responsibilities from states to save the banking sector following the Subprime crisis. These commitments include insurance, guarantees and particularly loans.

We found 94 causality links in the Granger sense between the 22 countries and banks.

**The network topology:** The measured level of connectivity  $\beta_1$  :

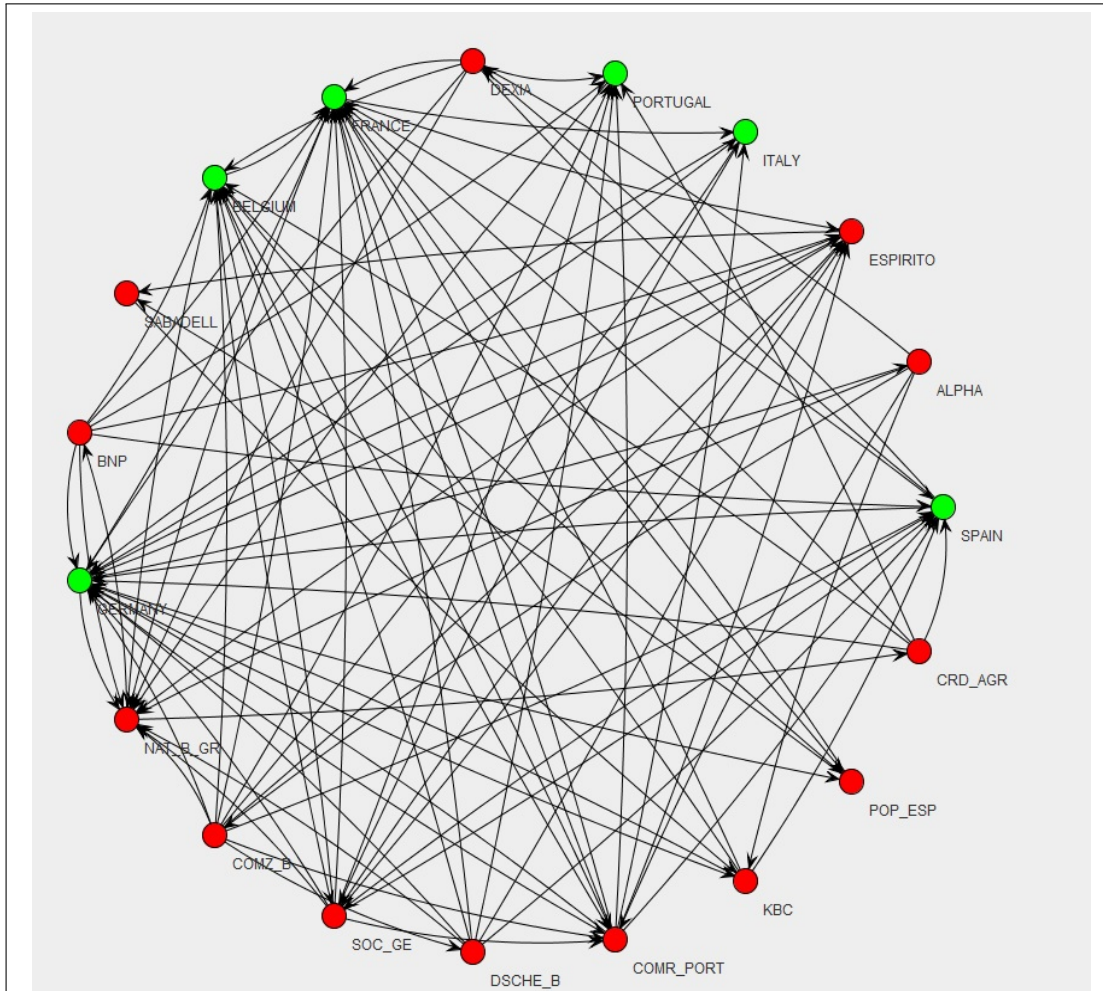
$$\beta_1 = \frac{E_1}{N} = \frac{94}{22} = 4,27 \quad (71)$$

A connected network with one cycle has a  $\beta$  value of 1. With this fairly large  $\beta$ , the resulting network is quite dense. Here the impact of an entity over another arises not only from the direct link between them but also via many paths through the impact of the former on other entities to which it is connected as well as the affected one.

The first thing to note is that the relationships are not symmetrical. However, just before the European debt crisis, countries on average are more responsive to CDS changes than banks. At this point, the financial system was pointed and intensively monitored. As argues Lane 2012 "Through 2008 and 2009, there was

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43. JAVA programming code is available upon request



Source: Author calculation.

Network diagram of linear Granger-causality relationships that are statistically significant at, at least the 95% level among the weekly changes of the CDS of the different entities (Banks and Sovereigns) over 11/28/2008 to 12/25/2009. The type of entities is indicated by colour: red for banks, and green for Sovereigns.

Figure 15: 2009 CDS Network

relatively little concern about European sovereign debt. Instead, the focus was on the actions of the European Central Bank to address the global financial shock".

## The Eurozone debt crisis triggering period

Figure (16) depicts the connectivities between the CDS of the same set of European sovereigns and banks during the European debt crisis triggering. Following the measures taken by the state governments of the Euro area in conjunction with central banks, financial weaknesses are propagated between the different network entities. The danger of credit risk transfer is strongly felt. The resulting network is much less dense.

The number of causal relationships goes from 94 to 69, representing a decrease of over 25%. We found 69 causality links in the Granger sense between the 22 countries and banks.

**The network topology:** The measured level of connectivity  $\beta_2$  :

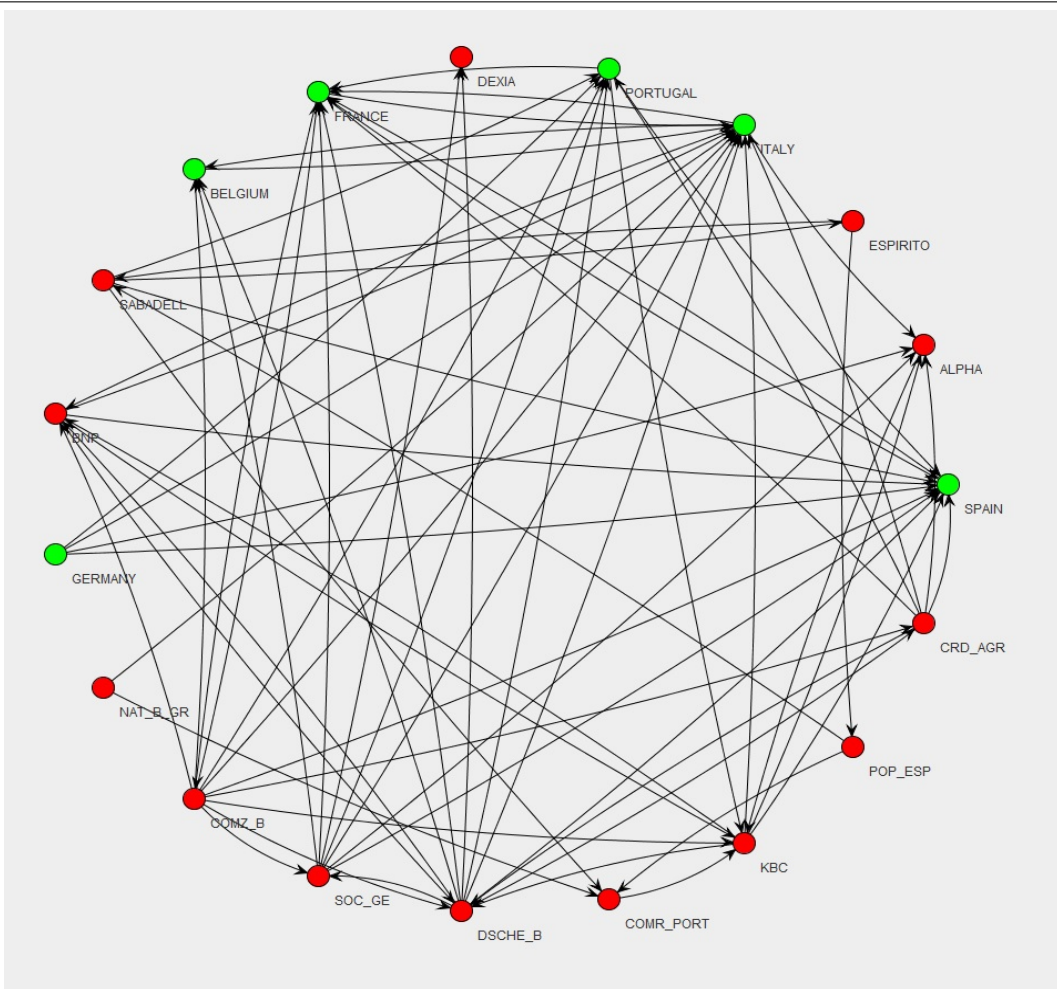
$$\beta_2 = \frac{E_2}{N} = \frac{69}{22} = 3,13 \quad (72)$$

The  $\beta$  dropped considerably from 4,27 to 3,13. Direct links between the entities as well as the number of cycles decreased significantly. The obtained network is less developed which reduces the contagion risk and hence the systemic risk.

After the outbreak of the Greek crisis, the countries that are part of the GIIPS<sup>44</sup>, Italy, Spain and Portugal here, are fiscally vulnerable and became more sensitive to variations of the other entities CDS. Indeed, the financial crisis provoked a review of asset prices, growth expectations and risk levels particularly for countries manifesting macroeconomic imbalances. The other entities got less connected to the network which allows to avoid or reduce contagion.

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44. Greece, Italy, Ireland, Portugal, Spain



Source: Author calculation.

Network diagram of linear Granger-causality relationships that are statistically significant at, at least the 95% level among the weekly changes of the CDS of the different entities (Banks and Sovereigns) over 1/01/2010 to 12/23/2011. The type of entities is indicated by colour: red for banks, and green for Sovereigns.

Figure 16: 2011 CDS Network

During this critical period, every transaction is uncertain and can be very risky. Combined to the fact that agents become risk averse, it is not surprising that the transactions on the financial market and thereafter CDS links drop considerably. Here, the authorities' objective is to restore trust to prevent the spread of the crisis and the collapse of the entire system.

### The Post agreements and rescue plans period

Figure (17) illustrates the connectedness among the CDS of the same set of European sovereigns and banks for the 2012-2013 period. This phase was marked by an early return of trust between agents on the financial market following agreements and rescue plans period. They cooperate to prevent the bankruptcy of entities that may eventually cause the failure of others.

Causal links moved from 69 to 108, representing a more than 56% increase.

**The network topology:** The measured level of connectivity  $\beta_3$  :

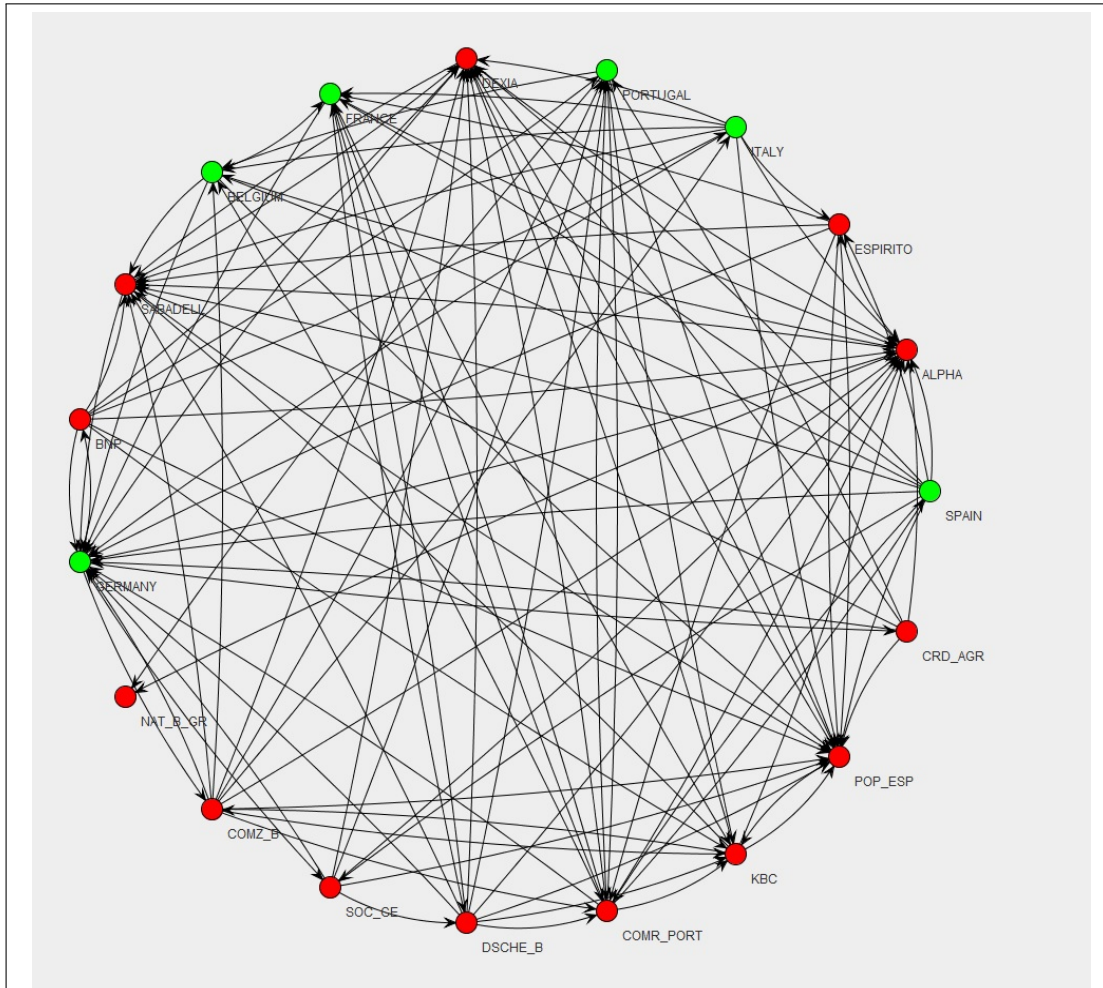
$$\beta_3 = \frac{E_3}{N} = \frac{108}{22} = 4,9 \quad (73)$$

We notice a return to the increase in  $\beta$ . This generates a more developed and connected network with more both direct and indirect links.

The obtained network is the densest one. It seems that the measures taken jointly by the European Union and the International Monetary Fund<sup>45</sup> aiming to stabilize the financial system in the Euro area after the bankruptcy of Greece succeeded to restore confidence between the studied entities. The aids and relief programs implemented to avoid failure of several entities has led to the reduction of distrust and made the CDS market more energetic. This was the last and the

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45. The IMF is a specialized agency of the United Nations. Through its economic surveillance, it keeps track of the economic health of its member countries, alerting them to risks on the horizon and providing policy advice. It also lends to countries in difficulty, and provides technical assistance and training.



Source: Author calculation.

Network diagram of linear Granger-causality relationships that are statistically significant at, at least the 95% level among the weekly changes of the CDS of the different entities (Banks and Sovereigns) over 1/06/2012 to 10/25/2013. The type of entities is indicated by colour: red for banks, and green for Sovereigns.

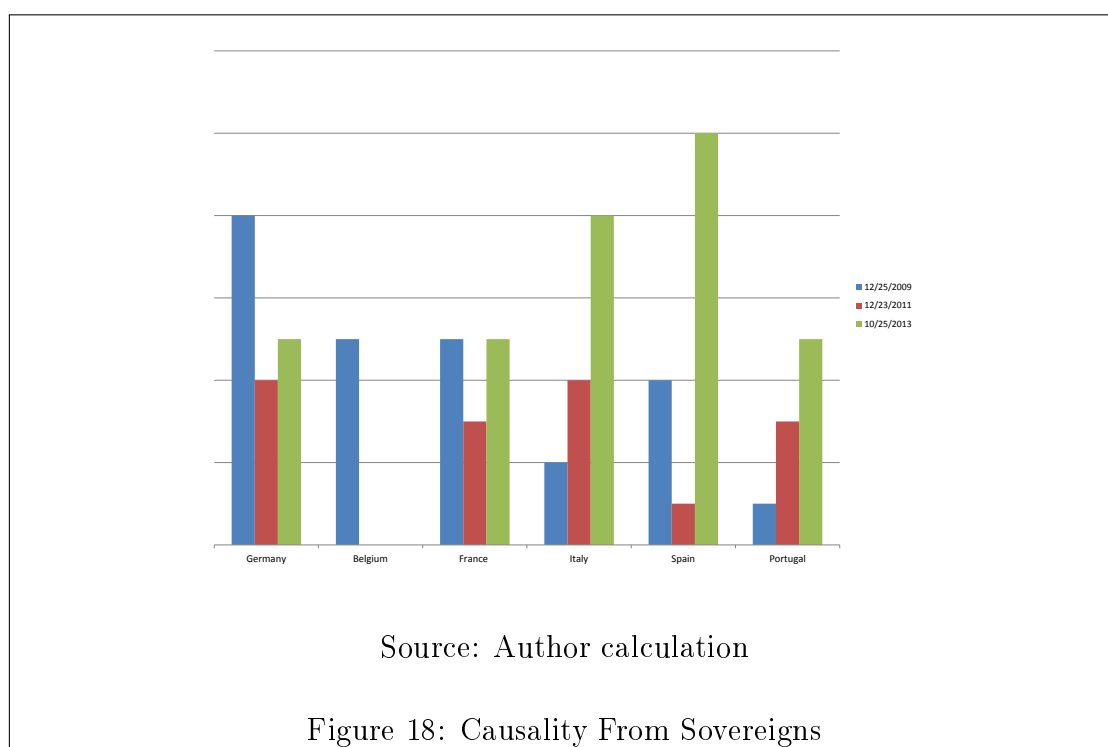
Figure 17: 2013 CDS Network



only solution because if banks and countries refuse to lend each other and to cooperate in the market, the system dries and agents would lack cash. If this would happen, the remaining question would be who is next to file for bankruptcy. This means the collapse of the entire system.

## Contagion from and to Sovereigns

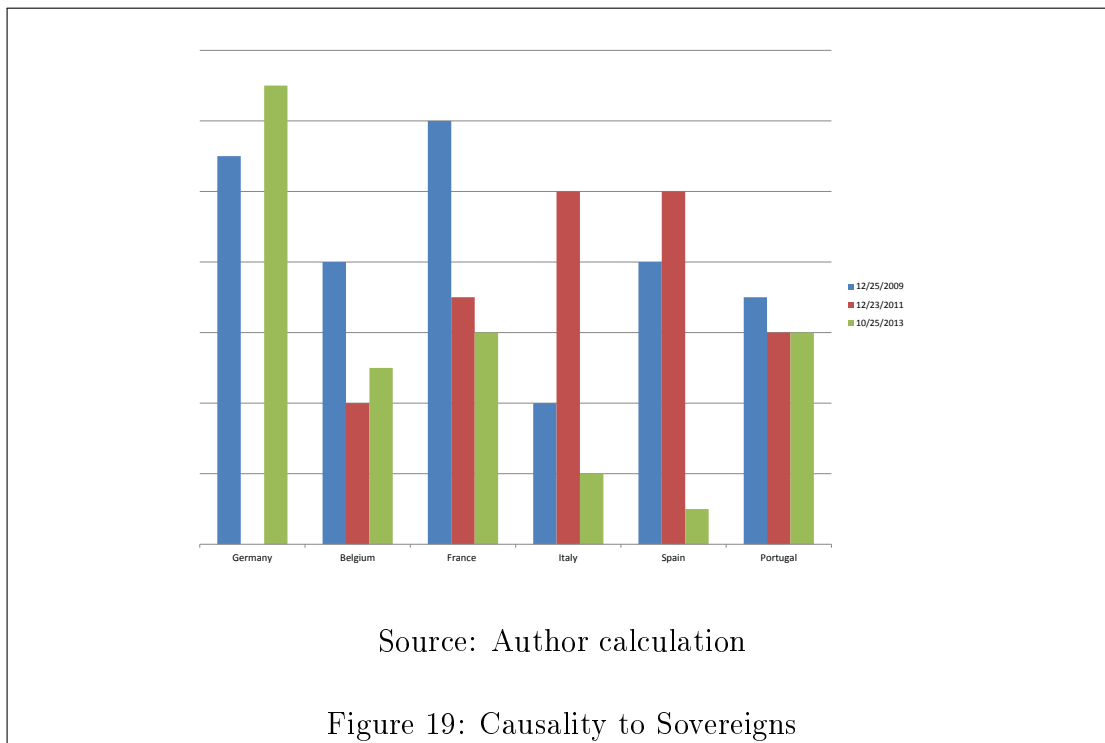
Countries are the most influential part of the studied network, they have greater weight and make decisions that affect the entire system. However, their impacts that differ according to their economic situations vary over time with the overall financial and economic condition of the monetary union. Figure 18 shows the evolution of the affected countries during the three considered periods.



For strong economies, causal relationships whose source is a sovereign fall considerably during the second period; Phase of the outbreak of the European debt

crisis and vice versa for other economies (except Spain). During bad patches, economies facing problems are more vulnerable. This is why stakeholders try to help them out of their problems, otherwise the losses spread and become huge and unsustainable.

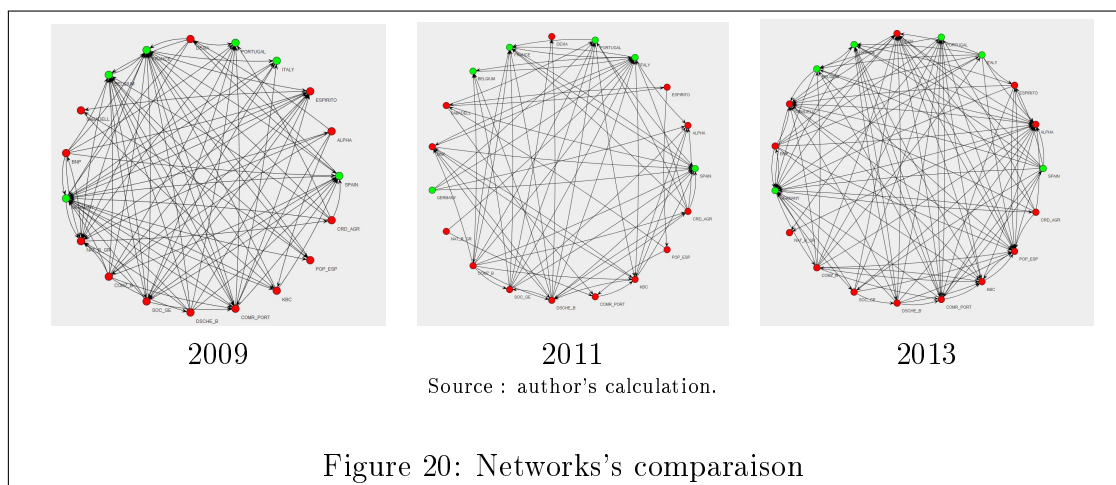
Figure 19 highlights the effects undergone by countries' CDS from the set of the network components from period to period.



Causal relationships to the sovereigns decline in a remarkable way for countries with healthier economies for the (1/01/2010 - 12/23/2011) period. This is a mean of protection against the propagation of adverse effects of the debt crisis. Nevertheless, the causalities to the less powerful countries, make a major leap attesting to the vulnerability and the fragility of these economies to shocks.

## Conclusion

Using pairwise Granger causality tools and the Graph theory (see Bondy and Murty 1976), we tried to model a network of European Sovereigns and banks Credit Default Swaps. The group of the studied entities is dynamically interrelated in the sense that relationships are constantly changing from period to period. The roles of affecting and affected can be reversed. Entities can be disconnected throughout a period then they become linked.



During calm periods, when the system is monitored, some level of trust is established between the agents, allowing them to exchange in the financial market which increases the transfer of risk and subsequently the causal links between entities. However, during crisis, and more generally periods of financial turmoil, lack of confidence pushes agents to become more risk averse and makes everyone operate in his corner in his own interest to avoid potential contagion by less efficient agents. The mistrust makes the network sparse and agents scattered. This can be seen as beneficial in the sense that This leads to braking systemic risk.

Questions about the basics and the economic legitimacy of the establishment of the European Union with a common currency were recently raised. Joining the EU,

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heterogeneous countries waive their specific adjustment mechanisms including the exchange rate and they are forced to adopt the same monetary policy. However, these policies are decided at the whole union level while European aggregate data conceal significant differences at the individual country level. In addition, there is a moral hazard problem since members are able to borrow in the common currency and this raises free-rider problems as shows Buiter et al. 1993 and Lane 2012.

In forthcoming works it would be interesting to find other methods to measure entities' connectivities, since one of the principal hypothesis of Granger causality parawaise test is that the future doesn't impact the present or the past which is not realistic since the credit default swap market is not as backward looking that it is forward looking.



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## Conclusion Générale

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La plupart des travaux sur le risque de crédit aboutissent à une évaluation de la vraisemblance de survenance d'un évènement de crédit à savoir la non honoration des engagements de la part de l'emprunteur envers son prêteur.

Après la présentation des différentes approches du risque de crédit ainsi que des modèles fondateurs de chacune d'elles. Les principaux objectifs de cette thèse ont été de trois ordres: D'abord, nous avons cherché à étudier empiriquement le lien entre les fondamentaux macroéconomiques et le risque de crédit souverain pour certains pays de la zone euro afin de définir les déterminants de celui-ci. Ensuite, en utilisant l'approche des Bounds testing to cointegration (ARDL-ECM), nous avons examiné les relations de long terme entre les spreads des Credit Default Swap d'un échantillon de groupes bancaires Européens avec les facteurs contextuels des banques, des pays et de la zone Euro. Enfin, à travers les outils de tests de causalité au sens de Granger, nous avons construit un réseau de Credit Default Swaps reliant les entités bancaires et souveraines. Nous avons ainsi pu étudier l'évolution et l'expansion de ce réseau pour la période de l'explosion des problèmes d risque de crédit.

## Les conclusions principales

D'après la première partie proposée, trois contributions principales ont été apportées. D'abord, nous avons réussi à établir des modèles économétriques permettant de définir les déterminants macroéconomiques du risque de crédit d'un échantillon de souverains Européens. Les modèles estimés nous permettent de conclure que, le risque de crédit des pays étudiés à savoir l'Autriche, la Belgique, la France, l'Allemagne, le Luxembourg, les Pays-Bas, l'Italie, l'Espagne et le Portugal est largement dépendant des fondamentaux macroéconomiques. Le taux du chômage qui paraît être la variable macroéconomique la plus influente, a d'autant plus d'effet lorsque le pays en question traverse des conditions économiques difficiles. Les relations de long terme entre les rendements des bonds de trésors des souverains Européens avec les déterminants macroéconomiques sont plus important et plus significatifs que ceux du court terme. Les relations définies sont globalement stable à long terme (pour 7 pays sur 9).

Dans la deuxième partie, nous nous sommes proposés de modéliser le risque de crédit d'un échantillon de groupes bancaires Européens en essayant de déterminer les relations de long terme entre le risque de crédit de ces derniers, en le mesurant par les spreads des contrats des Credit Default Swaps CDS, avec les facteurs propres aux banques, à leurs pays d'origine ainsi qu'à la zone Euro. Les résultats révèlent que dans le long terme, une augmentation de l'inflation et / ou le risque de crédit des pays d'origine amplifient le risque de crédit des Banques Européennes. Les estimations semblent indiquer que la dévaluation de l'euro, rend la dette libellée en euros moins coûteuse, ce qui diminue le risque de crédit des entités Européennes. Cependant, contrairement à ce qui est attendu, notre analyse montre que la valeur de marché de l'entité ainsi que l'indice boursier dans lequel la firme est inscrite deviennent insignifiants pour expliquer son risque de crédit.

Le dernier chapitre traite les liens entre le risque de crédit des entités souveraines et bancaires étudiées dans les chapitres précédents. Nous avons cherché à mettre en évidence les relations de causalité entre les Credit Default Swap des uns et des autres afin de déterminer quelles sont les entités qui affectent et quelles sont les entités affectées et ce à travers les techniques du test de causalité au sens de Granger. Nous avons constaté que les liens obtenus ne sont pas symétriques et qu'ils varient considérablement en fonction de l'état de l'économie de la région. Nous montrons aussi que juste avant les importantes phases de turbulences financières, le transfert du risque de crédit est très notable augmentant ainsi la contagion et le risque systémique, alors qu'il diminue significativement pendant les périodes d'incertitude marquées par la propagation de la méfiance. Ceci est d'autant plus important, que dans l'Union Européenne, les pays adoptent les mêmes politiques monétaires voire fiscales tout en étant hétérogènes.

## Travaux à venir

Quand bien même, les déterminants identifiés du risque de crédit sont significatifs aussi bien pour les souverains que pour les banques, il serait judicieux d'étudier d'autres facteurs susceptibles d'affecter leurs solvabilités. Des facteurs microéconomiques propres à chaque entité sont à intégrer dans des travaux futurs afin d'améliorer l'explication des probabilités de défaut. Empiriquement, il serait aussi intéressant d'essayer de trouver un autre moyen de mesure de connectivité entre les entités étudiées. Un outil qui pourrait remédier aux problèmes du test de causalité de Granger notamment la non prise en compte des prévisions sur le risque de crédit, comme ce test est plutôt forward looking.





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## Appendix A

**A.1- Data Summary & Description of the variables**

Variables	Description	Source	Expected sign
Sovereign Long Run Bond Yield (the dependent variable)	Long-Term Government Bond Yields, 10-Year, Main benchmark), Yield 10-year government bonds	Main Economic Indicators, copyright OECD	
Exports Growth rate	Exports to World: the quarterly growth rate	IMF - Direction of Trade Statistics	-
Unemployment rate	Unemployment to population rate, All Persons, Unemployment/population rate, all persons ratio, SA	Main Economic Indicators, copyright OECD	+
Gross domestic product	GDP by Expenditure, Gross domestic product, Volume index, SA,	Quarterly National Accounts, copyright OECD	-
Long Run government debt	Government Debt, Long-term, General government, % of GDP	Eurostat	+

## A.2- Augmented Dickey-Fuller test statistic I

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	Austria	France	Belgium	Germany	Italy
LTBY	-1,131 (0,698)	-1,449 (0,552)	-1,470 (0,541)	-1,154 (0,688)	-2,602 (0,099)
D(LTBY)	-7,644 (0,000)	-7,517 (0,000)	-8,099 (0,000)	-7,428 (0,000)	-9,147 (0,000)
GDPVOL	-1,248 (0,646)	-1,394 (0,579)	-1,199 (0,669)	-0,781 (0,816)	-1,874 (0,342)
D(GDPVOL)	-4,000 (0,003)	-4,343 (0,001)	-4,522 (0,001)	-4,645 (0,000)	-3,897 (0,004)
DEBT_GDP	-1,373 (0,589)	-0,961 (0,760)	-0,862 (0,793)	-3,420 (0,014)	-0,806 (0,810)

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D(DEBT_GDP)	-4,996 (0,000)	-5,656 (0,000)	-5,251 (0,000)		-7,273 (0,000)
Unemplo	-1,703 (0,424)	-1,559 (0,496)	-3,123 (0,031)	-0,545 (0,874)	-0,388 (0,904)
D(Unemplo)	-8,285 (0,000)	-5,963 (0,000)		-4,960 (0,000)	-4,149 (0,002)
Export_growth	-3,363 (0,017)	-4,045 (0,003)	-6,964 (0,000)	-5,411 (0,000)	-3,716 (0,007)

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Null Hypothesis: Variable has a unit root.

p-value in the parentheses

## Augmented Dickey-Fuller test statistic II

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	Luxembourg	Netherlands	Portugal	Spain
LTBY	-1,274 (0,636)	-1,206 (0,666)	-2,255 (0,190)	-2,218 (0,203)
D(LTBY)	-6,556 (0,000)	-7,640 (0,000)	-4,119 (0,002)	-8,698 (0,000)
GDPVOL	-1,157 (0,687)	-1,566 (0,493)	-2,002 (0,285)	-2,002 (0,285)
D(GDPVOL)	-7,286 (0,000)	-3,972 (0,003)	-5,150 (0,000)	-2,022 (0,042)
DEBT_GDP	-0,612 (0,859)	-1,697 (0,427)	1,441 (0,999)	0,423 (0,982)

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D(DEBT_GDP)	-6,950 (0,000)	-5,234 (0,000)	-4,441 (0,001)	-7,082 (0,000)
Unemplo	-2,651 (0,090)	-0,940 (0,768)	-1,124 (0,700)	-0,599 (0,862)
D(Unemplo)	-7,480 (0,000)	-3,959 (0,003)	-4,030 (0,003)	-3,254 (0,022)
Export_growth	-9,636 (0,000)	-5,970 (0,000)	-6,610 (0,000)	-3,877 (0,004)

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Null Hypothesis: Variable has a unit root.

p-value in the parentheses



### A.3- Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
Austria						
0	-18.71452	NA	0.148486	0.929981	1.119376	1.002354
1	-18.55007	0.290195	0.153503	0.962748	1.190022	1.049596
2	-14.76233	6.535717*	0.137696*	0.853425*	1.118577*	0.954747*
3	-14.60834	0.259666	0.142464	0.886602	1.189633	1.002399
4	-14.54885	0.097983	0.147983	0.923484	1.264395	1.053756
5	-12.47557	3.333505	0.142084	0.881395	1.260184	1.026142
France						
0	-17.52273	NA	0.149767	0.938447	1.133364	1.012106
1	-16.55329	1.696509	0.150042	0.939721	1.173621	1.028112
2	-11.33496	8.914661*	0.125956*	0.763957*	1.036840*	0.867080*
3	-11.06812	0.444734	0.129998	0.794505	1.106372	0.912360
4	-10.32917	1.200781	0.131598	0.805382	1.156232	0.937969
5	-8.812244	2.401806	0.129013	0.783843	1.173677	0.931162
Belgium						



0	-19.40255	NA	0.161970	1.016773	1.250987	1.090432
1	-17.91990	2.594643	0.158833	0.996662	1.230563	1.085054
2	-16.47448	5.484366*	0.156034	0.952650*	1.211690*	1.081226*
3	-16.45245	0.036712	0.162694	1.018852	1.330719	1.136707
4	-16.32741	0.203190	0.168962	1.055309	1.406159	1.187896
5	-12.86360	2.469259	0.152737*	0.978103	1.342484	1.099969
Germany						
0	-22.77757	NA	0.174134	1.089316	1.278711	1.161690
1	-22.35767	0.740992	0.178224	1.112066	1.339339	1.198913
2	-17.27311	8.773352*	0.151943*	0.951887*	1.217039*	1.053209*
3	-17.20790	0.109973	0.157754	0.988545	1.291576	1.104342
4	-16.47873	1.200987	0.159617	0.999166	1.340076	1.129438
5	-15.82583	1.049749	0.162033	1.012778	1.391567	1.157524
Italy						
0	-32.68546	NA	0.256819	1.477861	1.667256	1.550234
1	-30.24445	4.307656*	0.242821	1.421351	1.648625*	1.508199*
2	-28.94576	2.240880	0.240149	1.409638	1.674790	1.510960
3	-27.88087	1.795697	0.239747*	1.407093*	1.710124	1.522890
4	-27.85508	0.042484	0.249363	1.445297	1.786208	1.575569
5	-27.30566	0.883373	0.254167	1.462967	1.841756	1.607714
Luxembourg						
0	-23.53549	NA	0.192407	1.188979	1.383896	1.262638
1	-23.52942	0.010626	0.200655	1.230392	1.464293	1.318784
2	-19.46676	6.940370*	0.176753*	1.102782*	1.375665*	1.205905*
3	-19.45953	0.012060	0.184410	1.144147	1.456014	1.262002
4	-18.29188	1.897426	0.183374	1.137162	1.488012	1.269748
5	-17.89184	0.633402	0.188336	1.162160	1.551993	1.309478
Netherlands						
0	-19.58198	NA	0.156621	0.983279	1.174481*	1.056090*

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1	-19.41229	0.298648	0.161990	1.016492	1.245934	1.103865
2	-16.87749	4.359853*	0.152449*	0.955100*	1.222783	1.057035
3	-16.84237	0.059001	0.158594	0.993695	1.299619	1.110192
4	-16.58940	0.414869	0.163599	1.023576	1.367740	1.154636
5	-15.46179	1.804175	0.163011	1.018472	1.400876	1.164094

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Portugal						
0	-58.02458	NA	0.693716	2.471552	2.660947	2.543926
1	-54.09969	6.005658*	0.618825	2.325586*	2.584124*	2.443698*
2	-54.01026	0.154303	0.641739	2.392559	2.657712	2.493882
3	-53.94873	0.103751	0.666375	2.429362	2.732394	2.545159
4	-50.30244	6.926291	0.601362*	2.356850	2.666496	2.455858
5	-50.03589	0.428568	0.619785	2.354349	2.733138	2.499095

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Spain						
0	-29.24892	NA*	0.224439	1.343095	1.532490	1.415468
1	-27.22498	3.571661	0.215705*	1.302940*	1.530214*	1.389788*
2	-27.19464	0.052348	0.224211	1.340966	1.606119	1.442289
3	-27.09736	0.164042	0.232492	1.376367	1.679399	1.492164
4	-26.91368	0.302539	0.240325	1.408379	1.749290	1.538651
5	-26.39692	0.830867	0.245268	1.427330	1.806119	1.572077

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#### A.4- Serial correlation test

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Austria			
F-statistic	0.183870	Prob. F(2,36)	0.8328
Obs*R-squared	0.546033	Prob. Chi-Square(2)	0.7611

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Belgium			
F-statistic	0.841891	Prob. F(2,34)	0.4397
Obs*R-squared	2.453681	Prob. Chi-Square(2)	0.2932

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France			
F-statistic	0.198483	Prob. F(2,35)	0.8209
Obs*R-squared	0.581966	Prob. Chi-Square(2)	0.7475

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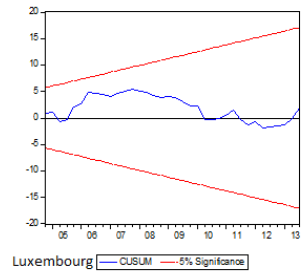
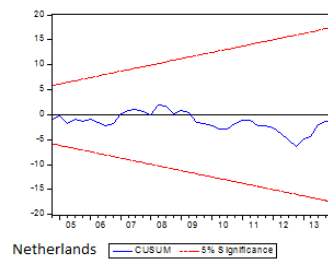
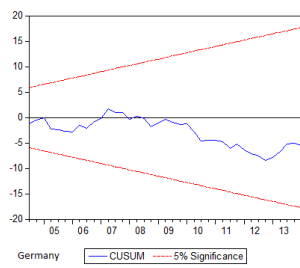
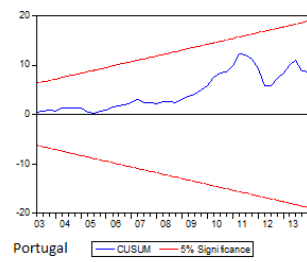
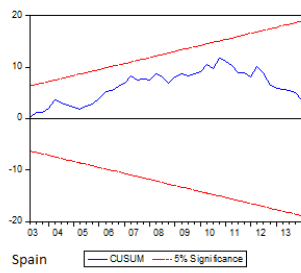
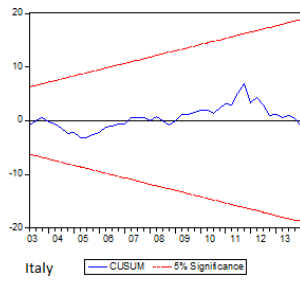
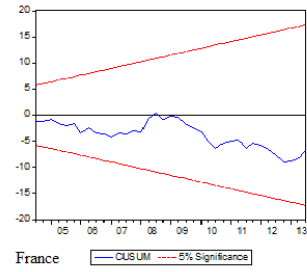
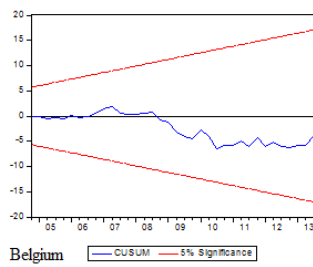
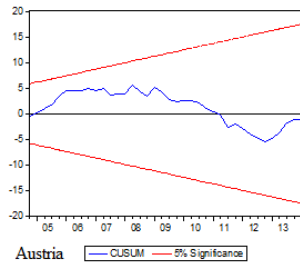
Netherlands			
F-statistic	0.389249	Prob. F(2,36)	0.6804
Obs*R-squared	1.143029	Prob. Chi-Square(2)	0.5647

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Spain			
F-statistic	1.572452	Prob. F(2,42)	0.2195
Obs*R-squared	3.831434	Prob. Chi-Square(2)	0.1472
<hr/>			
Germany			
F-statistic	0.061971	Prob. F(2,36)	0.9400
Obs*R-squared	0.185276	Prob. Chi-Square(2)	0.9115
<hr/>			
Italy			
F-statistic	0.459163	Prob. F(2,42)	0.6349
Obs*R-squared	1.176839	Prob. Chi-Square(2)	0.5552
<hr/>			
Luxembourg			
F-statistic	0.972779	Prob. F(2,34)	0.3883
Obs*R-squared	2.814508	Prob. Chi-Square(2)	0.2448
<hr/>			
Portugal			
F-statistic	0.758435	Prob. F(2,42)	0.4747
Obs*R-square	1.917138	Prob. Chi-Square(2)	0.3834
<hr/>			

## Stability test



Source : author's calculation.







## Appendix A

**A.5- Long run Relationships Evidence**

	F-statistic	Evidence for long term relationship
Austria	3.582091	Yes at 95%
France	3.40313	Yes at 90%
Germany	4.235459	Yes at 97.5%
Italy	1.158257	NO
Luxembourg	1.554256	NO
Netherlands	4.976910	Yes at 99%
Spain	3.136248	Yes at 90%
Portugal	3.200856	Yes at 90%
Belgium	5.654713	Yes at 99%

Source : author's calculation.

Upper-Lower bounds [2.20-3.09 (0.1)] [2.56-3.49(0.05)] [2.88-3.87 (0.025)] [3.29-4.37 (0.01)]



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## Appendix A

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## A.6- Short Run relationships

		Austria		France		Germany	
		(-1)	(-2)	(-1)	(-2)	(-1)	(-2)
Real GDP	Coefficient	0,094	-0,175	0,112	-0,073	-0,079	-0,085
	t-Statistic	0,789	-2,133	0,899	-2,586	-1,104	-1,101
	P-value	(0,43)	(0,04)	(0,37)	(0,036)	(0,27)	(0,27)
Exports variation	Coefficient	-0,023	-0,021	0,01	0,014	0,014	-0,02
	t-Statistic	1,936	2,97	0,776	1,719	1,175	-2,302
	P-value	(0,06)	(0,005)	(0,44)	(0,09)	(0,24)	(0,0)
LR Debt%GDP	Coefficient	-0,057	0,329	-0,098	-0,064	0,062	0,064
	t-Statistic	-0,346	2,077	-0,548	-0,376	0,276	0,275
	P-value	(0,73)	(0,04)	(0,58)	(0,7)	(0,78)	(0,78)
Unemployment rate	Coefficient	0,37	0,294	0,192	-0,125	1,297	-0,147
	t-Statistic	2,22	0,77	1,996	-0,289	3,373	-0,367
	P-value	(0,039)	(0,44)	(0,064)	(0,77)	(0,001)	(0,71)
		Italy		Luxembourg		Netherlands	
		(-1)	(-2)	(-1)	(-2)	(-1)	(-2)
Real GDP	Coefficient	0,012		-0,001	0,017	-0,192	0,135
	t-Statistic	0,101		-0,033	0,444	2,023	1,276
	P-value	(0,92)		(0,97)	(0,66)	(0,05)	(0,21)
Exports variation	Coefficient	-0,011		0,003	0,007	0,025	-0,027
	t-Statistic	-2,048		0,301	1,370	1,922	-3,173
	P-value	(0,50)		(0,76)	(0,18)	(0,06)	(0,00)
LR Debt%GDP	Coefficient	-0,057	0,329	-0,098	-0,064	0,062	0,064
	t-Statistic	-0,346	2,077	-0,548	-0,376	0,276	0,275
	P-value	(0,73)	(0,04)	(0,58)	(0,7)	(0,78)	(0,78)
Unemployment rate	Coefficient	0,37	0,294	0,192	-0,125	1,297	-0,147
	t-Statistic	2,22	0,77	1,996	-0,289	3,373	-0,367
	P-value	(0,039)	(0,44)	(0,064)	(0,77)	(0,001)	(0,71)
		Spain		Portugal		Belgium	
		(-1)	(-2)	(-1)	(-2)	(-1)	(-2)
Real GDP	Coefficient	0,083		-0,175		-0,047	-0,183
	t-Statistic	0,447		-1,142		-0,430	-0,804
	P-value	(0,66)		(0,26)		(0,67)	(0,43)
Exports variation	Coefficient	-0,006		-0,024		-0,005	0,009
	t-Statistic	-0,990		-1,798		-0,398	1,041
	P-value	(0,33)		(0,08)		(0,69)	(0,30)
LR Debt%GDP	Coefficient	0,051		0,008		0,329	0,183
	t-Statistic	0,588		0,121		1,466	0,804
	P-value	(0,56)		(0,90)		(0,15)	(0,43)
Unemployment rate	Coefficient	-0,085		0,999		1,265	0,433
	t-Statistic	-0,294		2,542		3,389	1,333
	P-value	(0,77)		(0,04)		(0,00)	(0,19)

Source : author's calculation.

## B.1- Unit Root tests for Banks' variables

ADF t-statistic	CDSs		Entity Equity	
	I(0) test	I(1) test	I(0) test	I(1) test
Entity				
BNP PARIBAS	-1.771435 (0.3907)	-7.842260 (0.0000)	-2.053765 (0.2638)	-7.124459 (0.0000)
CREDIT AGRICOLE	-1.871333 (0.3432)	-7.757161 (0.0000)	-1.410958 (0.5703)	-3.337068 (0.0185)
SOCIETE GENERALE	-1.668389 (0.4415)	-6.052854 (0.0000)	-1.845042 (0.3554)	-6.639293 (0.0000)
DEUTSCHE BANK AG	-2.799070 (0.0647)	-9.391924 (0.0000)	-2.593211 (0.1003)	-6.448680 (0.0000)
COMZBANK AG	-1.811670 (0.3713)	-7.189137 (0.0000)	-0.329944 (0.9131)	-3.650863 (0.0081)
BANCO DE SABADELL SA	-2.078607 (0.2539)	-4.623113 (0.0004)	-1.181306 (0.6751)	-5.101297 (0.0001)
BANCO POP ESPANOL SA	-2.029385 (0.2738)	-4.745137 (0.0003)	-0.320933 (0.9146)	-9.101765 (0.0000)
DEXIA CREDIT LOCAL	-1.447317 (0.5528)	-7.255005 (0.0000)	-2.119214 (0.2383)	-5.224437 (0.0001)
KBC BANK	-1.864817 (0.3462)	-5.527409 (0.0000)	-2.204599 (0.2074)	-7.465465 (0.0000)
BANCO COMR PORTUGUES	-1.670949 (0.4402)	-5.552460 (0.0000)	-0.976125 (0.7560)	-6.983254 (0.0000)
BANCO ESPIRITO SANTO SA	-1.624618	-6.971220	-1.029023	-6.517854

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	(0.4636)	(0.0000)	( 0.7371)	( 0.0000)
ALPHA BANK A,E	-1.342905	-6.640258	-1.260728	-3.821025
	(0.6036)	(0.0000)	(0.6418)	(0.0052)

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Source: Author calculation.

P-value are between parentheses.

## B.2- Unit Root tests for Countries' variables

ADF t-statistic	CDSs		Stock Index		Inflation	
Entity	I(0) test	I(1) test	I(0) test	I(1) test	I(0) test	I(1) test
France	-1.786479 ( 0.3833)	-5.397507 ( 0.0000)	-2.302100 ( 0.1749)	-6.467632 ( 0.0000)	-0.725455 ( 0.8316)	-6.159238 (0.0000)
Belgium	-1.445187 (0.5539)	-6.819215 (0.0000)	-1.632563 (0.4596)	-6.258344 (0.0000)	-0.296150 (0.9185)	-5.468373 (0.0000)
Germany	-2.630906 ( 0.0929)	-7.131960 (0.0000)	-1.315451 ( 0.6164)	-6.836697 ( 0.0000)	0.396676 ( 0.9811)	-7.359776 ( 0.0000)
Spain	-1.888084 ( 0.3355)	-7.847726 ( 0.0000)	-2.731321 ( 0.0750)	-8.791901 ( 0.0000)	-0.368201 (0.9062)	-5.887593 (0.0000)
Portugal	-2.196809 ( 0.2099)	-4.579327 ( 0.0005)	-1.230155 ( 0.6553)	-5.329766 ( 0.0000)	-0.831667 ( 0.8021)	-6.447530 ( 0.0000)

Source: Author calculation.

P-value are between parentheses.





### B.3- Unit Root tests for Eurozone variables

ADF t-statistic	EUR INDEX		EUR INFL		USD/EUR	
Entity	I(0) test	I(1) test	I(0) test	I(1) test	I(0) test	I(1) test
Eurozone	-2.104199 ( 0.2439)	-6.957278 ( 0.0000)	-0.734212 ( 0.8286)	-4.740887 ( 0.0000)	-2.731321 ( 0.0750)	-8.791901 ( 0.0000)

Source: Author calculation.

P-value are between parentheses.





## Annexe C

## C.1-Data

## Summary

Number	Entity	Abreviation
1	FRENCH REPUBLIC	FRANCE
2	FEDERAL REP GERMANY	GERMANY
3	KINGDOM OF SPAIN	SPAIN
4	REPUBLIC OF ITALY	ITALY
5	KINGDOM OF BELGIUM	BELGIUM
6	REPUBLIC OF PORTUGAL	PORTUGAL
7	BNP PARIBAS, France	BNP
10	CREDIT AGRICOLE, France	CRD_AGR
11	SOCIETE GENERALE, France	SOC_GE
12	DEUTSCHE BANK AG, Germany	DSCHE_B
13	COMMERZBANK AG, Germany	COMZ_B
14	BANCO DE SABADELL SA, Spain	SABADELL
15	BANCO POP ESPANOL SA, Spain	POP_ESP
17	DEXIA CREDIT LOCAL, Belgium	DEXIA
18	KBC BANK, Belgium	KBC
19	BANCO COMR PORTUGUES, Portugal	COMR_PORT
20	BANCO ESPIRITO SANTO SA, Portugal	ESPIRITO
21	NATIONAL B OF GREECE SA, Greece	NAT_B_GR
22	ALPHA BANK A,E, Greece	ALPHA

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Annexe C

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**C.2-**

**2009**

**Causalities**

Pairwise Granger Causality Tests		F-Statistic	Prob.
Null Hypothesis:			
KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF PORTUGAL		1.98325	0.1290
REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF BELGIUM		4.86673	0.0049
REPUBLIC OF ITALY does not Granger Cause REPUBLIC OF PORTUGAL		0.57161	0.6364
REPUBLIC OF PORTUGAL does not Granger Cause REPUBLIC OF ITALY		1.02029	0.3920
KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF PORTUGAL		0.56396	0.6414
REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF SPAIN		0.93167	0.4327
FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF PORTUGAL		5.25181	0.0032
REPUBLIC OF PORTUGAL does not Granger Cause FEDERAL REP GERMANY		5.84045	0.0017
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL		2.38439	0.0808
REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA		4.00914	0.0126
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL		0.62468	0.6025
REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA		0.95589	0.4212
BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF PORTUGAL		11.4696	9.E-06
REPUBLIC OF PORTUGAL does not Granger Cause BANCA MDP DI SIENA SPA		9.44163	5.E-05
DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF PORTUGAL		6.46211	0.0009
REPUBLIC OF PORTUGAL does not Granger Cause DEXIA CREDIT LOCAL		5.54033	0.0024
KBC BANK does not Granger Cause REPUBLIC OF PORTUGAL		3.95457	0.0134
REPUBLIC OF PORTUGAL does not Granger Cause KBC BANK		3.30147	0.0280
BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF PORTUGAL		9.64100	4.E-05
REPUBLIC OF PORTUGAL does not Granger Cause BANCO COMR PORTUGUES		4.63013	0.0064
BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF PORTUGAL		6.29595	0.0011
REPUBLIC OF PORTUGAL does not Granger Cause BANCO ESPIRITO SANTO SA		1.99592	0.1271
NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF PORTUGAL		2.50074	0.0706
REPUBLIC OF PORTUGAL does not Granger Cause NAT BK OF GREECE SA		8.78241	0.0001
ALPHA BANK A.E. does not Granger Cause REPUBLIC OF PORTUGAL		1.67667	0.1845
REPUBLIC OF PORTUGAL does not Granger Cause ALPHA BANK A.E.		6.71379	0.0007
FRENCH REPUBLIC does not Granger Cause REPUBLIC OF PORTUGAL		4.39858	0.0082
REPUBLIC OF PORTUGAL does not Granger Cause FRENCH REPUBLIC		6.51356	0.0009
BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF PORTUGAL		2.24651	0.0949

REPUBLIC OF PORTUGAL does not Granger Cause BANCO DE SABADELL SA	4.08187	0.0116
COMMERZBANK AG does not Granger Cause REPUBLIC OF PORTUGAL	11.0804	1.E-05
REPUBLIC OF PORTUGAL does not Granger Cause COMMERZBANK AG	2.74856	0.0529
DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF PORTUGAL	5.96837	0.0015
REPUBLIC OF PORTUGAL does not Granger Cause DEUTSCHE BANK AG	4.66619	0.0061
SOCIETE GENERALE does not Granger Cause REPUBLIC OF PORTUGAL	10.4174	2.E-05
REPUBLIC OF PORTUGAL does not Granger Cause SOCIETE GENERALE	3.87692	0.0146
CREDIT AGRICOLE does not Granger Cause REPUBLIC OF PORTUGAL	6.42230	0.0010
REPUBLIC OF PORTUGAL does not Granger Cause CREDIT AGRICOLE	2.41495	0.0780
BNP PARIBAS does not Granger Cause REPUBLIC OF PORTUGAL	9.12647	7.E-05
REPUBLIC OF PORTUGAL does not Granger Cause BNP PARIBAS	4.96450	0.0044
REPUBLIC OF ITALY does not Granger Cause KINGDOM OF BELGIUM	2.35519	0.0836
KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF ITALY	1.52193	0.2208
KINGDOM OF SPAIN does not Granger Cause KINGDOM OF BELGIUM	2.37846	0.0814
KINGDOM OF BELGIUM does not Granger Cause KINGDOM OF SPAIN	1.03129	0.3872
FEDERAL REP GERMANY does not Granger Cause KINGDOM OF BELGIUM	4.18475	0.0104
KINGDOM OF BELGIUM does not Granger Cause FEDERAL REP GERMANY	8.53804	0.0001
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM	1.99228	0.1277
KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA	4.60689	0.0065
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM	0.62110	0.6048
KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA	0.85763	0.4695
BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF BELGIUM	6.07886	0.0014
KINGDOM OF BELGIUM does not Granger Cause BANCA MDP DI SIENA SPA	9.16475	7.E-05
DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF BELGIUM	6.92508	0.0006
KINGDOM OF BELGIUM does not Granger Cause DEXIA CREDIT LOCAL	7.92556	0.0002
KBC BANK does not Granger Cause KINGDOM OF BELGIUM	7.00635	0.0005
KINGDOM OF BELGIUM does not Granger Cause KBC BANK	4.11785	0.0112
BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF BELGIUM	11.0366	1.E-05
KINGDOM OF BELGIUM does not Granger Cause BANCO COMR PORTUGUES	4.48396	0.0075
BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF BELGIUM	5.81874	0.0018
KINGDOM OF BELGIUM does not Granger Cause BANCO ESPIRITO SANTO SA	1.02595	0.3895



NAT BK OF GREECE SA does not Granger Cause KINGDOM OF BELGIUM	0.92666	0.4351
KINGDOM OF BELGIUM does not Granger Cause NAT BK OF GREECE SA	10.3136	2.E-05
ALPHA BANK A.E. does not Granger Cause KINGDOM OF BELGIUM	0.82582	0.4861
KINGDOM OF BELGIUM does not Granger Cause ALPHA BANK A.E.	4.84890	0.0050
FRENCH REPUBLIC does not Granger Cause KINGDOM OF BELGIUM	3.29329	0.0283
KINGDOM OF BELGIUM does not Granger Cause FRENCH REPUBLIC	8.21632	0.0002
BANCO DE SABADELL SA does not Granger Cause KINGDOM OF BELGIUM	1.32614	0.2768
KINGDOM OF BELGIUM does not Granger Cause BANCO DE SABADELL SA	4.16901	0.0106
COMMERZBANK AG does not Granger Cause KINGDOM OF BELGIUM	15.7885	3.E-07
KINGDOM OF BELGIUM does not Granger Cause COMMERZBANK AG	3.32741	0.0272
DEUTSCHE BANK AG does not Granger Cause KINGDOM OF BELGIUM	7.71251	0.0003
KINGDOM OF BELGIUM does not Granger Cause DEUTSCHE BANK AG	4.98643	0.0043
SOCIETE GENERALE does not Granger Cause KINGDOM OF BELGIUM	6.15822	0.0013
KINGDOM OF BELGIUM does not Granger Cause SOCIETE GENERALE	5.81129	0.0018
CREDIT AGRICOLE does not Granger Cause KINGDOM OF BELGIUM	6.52681	0.0009
KINGDOM OF BELGIUM does not Granger Cause CREDIT AGRICOLE	2.34209	0.0849
BNP PARIBAS does not Granger Cause KINGDOM OF BELGIUM	8.61322	0.0001
KINGDOM OF BELGIUM does not Granger Cause BNP PARIBAS	4.54625	0.0070
KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF ITALY	0.29234	0.8307
REPUBLIC OF ITALY does not Granger Cause KINGDOM OF SPAIN	1.11648	0.3517
FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF ITALY	5.53823	0.0024
REPUBLIC OF ITALY does not Granger Cause FEDERAL REP GERMANY	6.19582	0.0012
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY	2.58654	0.0639
REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA	2.52312	0.0688
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY	0.45782	0.7130
REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA	1.92834	0.1376
BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF ITALY	4.37639	0.0084
REPUBLIC OF ITALY does not Granger Cause BANCA MDP DI SIENA SPA	4.61686	0.0064
DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF ITALY	5.78304	0.0019
REPUBLIC OF ITALY does not Granger Cause DEXIA CREDIT LOCAL	4.56001	0.0069
KBC BANK does not Granger Cause REPUBLIC OF ITALY	5.54202	0.0024

REPUBLIC OF ITALY does not Granger Cause KBC BANK	1.97311	0.1306
BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF ITALY	5.21887	0.0034
REPUBLIC OF ITALY does not Granger Cause BANCO COMR PORTUGUES	1.94875	0.1343
BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF ITALY	3.41152	0.0247
REPUBLIC OF ITALY does not Granger Cause BANCO ESPIRITO SANTO SA	0.82353	0.4874
NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF ITALY	3.27671	0.0288
REPUBLIC OF ITALY does not Granger Cause NAT BK OF GREECE SA	5.31584	0.0030
ALPHA BANK A.E. does not Granger Cause REPUBLIC OF ITALY	3.11787	0.0346
REPUBLIC OF ITALY does not Granger Cause ALPHA BANK A.E.	3.15327	0.0332
FRENCH REPUBLIC does not Granger Cause REPUBLIC OF ITALY	3.84542	0.0152
REPUBLIC OF ITALY does not Granger Cause FRENCH REPUBLIC	4.34841	0.0087
BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF ITALY	2.43664	0.0760
REPUBLIC OF ITALY does not Granger Cause BANCO DE SABADELL SA	2.32973	0.0861
COMMERZBANK AG does not Granger Cause REPUBLIC OF ITALY	8.53811	0.0001
REPUBLIC OF ITALY does not Granger Cause COMMERZBANK AG	1.89425	0.1432
DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF ITALY	7.34636	0.0004
REPUBLIC OF ITALY does not Granger Cause DEUTSCHE BANK AG	3.76151	0.0166
SOCIETE GENERALE does not Granger Cause REPUBLIC OF ITALY	3.64265	0.0190
REPUBLIC OF ITALY does not Granger Cause SOCIETE GENERALE	3.43648	0.0240
CREDIT AGRICOLE does not Granger Cause REPUBLIC OF ITALY	4.15531	0.0107
REPUBLIC OF ITALY does not Granger Cause CREDIT AGRICOLE	1.42851	0.2460
BNP PARIBAS does not Granger Cause REPUBLIC OF ITALY	4.35126	0.0086
REPUBLIC OF ITALY does not Granger Cause BNP PARIBAS	2.21962	0.0979
FEDERAL REP GERMANY does not Granger Cause KINGDOM OF SPAIN	2.50454	0.0703
KINGDOM OF SPAIN does not Granger Cause FEDERAL REP GERMANY	6.61438	0.0008
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN	3.15707	0.0331
KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA	5.70637	0.0020
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN	0.40248	0.7519
KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA	0.41743	0.7413
BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF SPAIN	7.88268	0.0002
KINGDOM OF SPAIN does not Granger Cause BANCA MDP DI SIENA SPA	7.58100	0.0003

DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause DEXIA CREDIT LOCAL	5.75667 7.77807	0.0019 0.0002
KBC BANK does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause KBC BANK	5.98379 4.37988	0.0015 0.0084
BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause BANCO COMR PORTUGUES	11.8943 5.00067	6.E-06 0.0043
BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause BANCO ESPIRITO SANTO SA	5.97375 1.89066	0.0015 0.1438
NAT BK OF GREECE SA does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause NAT BK OF GREECE SA	1.21955 8.25258	0.3128 0.0002
ALPHA BANK A.E. does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause ALPHA BANK A.E.	1.71180 4.21882	0.1771 0.0100
FRENCH REPUBLIC does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause FRENCH REPUBLIC	2.17545 6.31715	0.1031 0.0011
BANCO DE SABADELL SA does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause BANCO DE SABADELL SA	2.97814 4.88691	0.0406 0.0048
COMMERZBANK AG does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause COMMERZBANK AG	12.7060 4.13321	3.E-06 0.0110
DEUTSCHE BANK AG does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause DEUTSCHE BANK AG	6.24915 5.42547	0.0011 0.0027
SOCIETE GENERALE does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause SOCIETE GENERALE	6.94523 6.95190	0.0006 0.0006
CREDIT AGRICOLE does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause CREDIT AGRICOLE	6.66613 2.73489	0.0007 0.0538
BNP PARIBAS does not Granger Cause KINGDOM OF SPAIN KINGDOM OF SPAIN does not Granger Cause BNP PARIBAS	7.21104 6.04447	0.0004 0.0014
BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA	0.58106 4.38372	0.6303 0.0083
BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA	1.79559 1.43946	0.1606 0.2429
BANCA MDP DI SIENA SPA does not Granger Cause FEDERAL REP GERMANY	3.22520	0.0306

FEDERAL REP GERMANY does not Granger Cause BANCA MDP DI SIENA SPA	7.48517	0.0003
DEXIA CREDIT LOCAL does not Granger Cause FEDERAL REP GERMANY	6.08010	0.0014
FEDERAL REP GERMANY does not Granger Cause DEXIA CREDIT LOCAL	5.23995	0.0033
KBC BANK does not Granger Cause FEDERAL REP GERMANY	6.34912	0.0010
FEDERAL REP GERMANY does not Granger Cause KBC BANK	5.89419	0.0016
BANCO COMR PORTUGUES does not Granger Cause FEDERAL REP GERMANY	6.33824	0.0010
FEDERAL REP GERMANY does not Granger Cause BANCO COMR PORTUGUES	6.31368	0.0011
BANCO ESPIRITO SANTO SA does not Granger Cause FEDERAL REP GERMANY	4.62145	0.0064
FEDERAL REP GERMANY does not Granger Cause BANCO ESPIRITO SANTO SA	2.68352	0.0571
NAT BK OF GREECE SA does not Granger Cause FEDERAL REP GERMANY	0.15851	0.9237
FEDERAL REP GERMANY does not Granger Cause NAT BK OF GREECE SA	16.7736	1.E-07
ALPHA BANK A.E. does not Granger Cause FEDERAL REP GERMANY	1.42796	0.2462
FEDERAL REP GERMANY does not Granger Cause ALPHA BANK A.E.	3.23179	0.0304
FRENCH REPUBLIC does not Granger Cause FEDERAL REP GERMANY	2.10655	0.1117
FEDERAL REP GERMANY does not Granger Cause FRENCH REPUBLIC	3.27842	0.0288
BANCO DE SABADELL SA does not Granger Cause FEDERAL REP GERMANY	0.15690	0.9247
FEDERAL REP GERMANY does not Granger Cause BANCO DE SABADELL SA	3.02472	0.0385
COMMERZBANK AG does not Granger Cause FEDERAL REP GERMANY	11.4984	8.E-06
FEDERAL REP GERMANY does not Granger Cause COMMERZBANK AG	3.80752	0.0158
DEUTSCHE BANK AG does not Granger Cause FEDERAL REP GERMANY	4.51624	0.0072
FEDERAL REP GERMANY does not Granger Cause DEUTSCHE BANK AG	3.36420	0.0261
SOCIETE GENERALE does not Granger Cause FEDERAL REP GERMANY	4.92329	0.0046
FEDERAL REP GERMANY does not Granger Cause SOCIETE GENERALE	3.08373	0.0360
CREDIT AGRICOLE does not Granger Cause FEDERAL REP GERMANY	5.28998	0.0031
FEDERAL REP GERMANY does not Granger Cause CREDIT AGRICOLE	2.38486	0.0808
BNP PARIBAS does not Granger Cause FEDERAL REP GERMANY	6.26208	0.0011
FEDERAL REP GERMANY does not Granger Cause BNP PARIBAS	5.86792	0.0017
BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA	2.30724	0.0884
BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA	1.33360	0.2745
BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA	1.09398	0.3608
BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA	1.09698	0.3595

DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA	0.15497	0.9260
BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL	2.26395	0.0930
KBC BANK does not Granger Cause BANCO POP ESPANOL SA	0.84209	0.4776
BANCO POP ESPANOL SA does not Granger Cause KBC BANK	4.60754	0.0065
BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA	0.24687	0.8632
BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES	0.23173	0.8738
BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA	0.75902	0.5226
BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA	0.81567	0.4915
NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA	0.94601	0.4259
BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA	0.40679	0.7488
ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA	2.41232	0.0782
BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E.	0.40086	0.7530
FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA	4.40835	0.0081
BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC	0.95496	0.4217
BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA	2.55313	0.0664
BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA	2.66862	0.0581
COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA	1.57970	0.2065
BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG	3.42720	0.0243
DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA	0.17636	0.9119
BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG	4.73515	0.0057
SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA	1.43574	0.2440
BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE	1.38694	0.2581
CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA	1.12421	0.3486
BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE	2.14778	0.1065
BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA	0.03831	0.3899
BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS	0.94233	0.4276
BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA	0.09765	0.9609
BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA	1.29061	0.2884
DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA	2.54984	0.0667
BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL	2.20209	0.0999
KBC BANK does not Granger Cause BANCO POP ESPANOL SA	3.03350	0.0381

BANCO POP ESPANOL SA does not Granger Cause KBC BANK	1.61725	0.1977
BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA	1.25092	0.3018
BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES	1.17918	0.3275
BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA	1.06047	0.3747
BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA	0.20362	0.8934
NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA	10.3057	2.E-05
BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA	1.45015	0.2399
ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA	1.41691	0.2493
BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E.	2.15875	0.1051
FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA	0.81695	0.4909
BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC	1.66144	0.1878
BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA	3.76361	0.0166
BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA	1.79084	0.1615
COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA	3.75997	0.0167
BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG	1.02814	0.3885
DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA	3.91542	0.0140
BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG	2.22226	0.0976
SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA	2.57983	0.0644
BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE	1.20586	0.3177
CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA	4.66243	0.0061
BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE	0.57687	0.6330
BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA	3.81603	0.0157
BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS	1.48984	0.2292
DEXIA CREDIT LOCAL does not Granger Cause BANCA MDP DI SIENA SPA	3.81857	0.0156
BANCA MDP DI SIENA SPA does not Granger Cause DEXIA CREDIT LOCAL	4.46723	0.0076
KBC BANK does not Granger Cause BANCA MDP DI SIENA SPA	3.14307	0.0336
BANCA MDP DI SIENA SPA does not Granger Cause KBC BANK	2.40684	0.0787
BANCO COMR PORTUGUES does not Granger Cause BANCA MDP DI SIENA SPA	2.94003	0.0424
BANCA MDP DI SIENA SPA does not Granger Cause BANCO COMR PORTUGUES	3.38777	0.0254
BANCO ESPIRITO SANTO SA does not Granger Cause BANCA MDP DI SIENA SPA	2.12851	0.1089
BANCA MDP DI SIENA SPA does not Granger Cause BANCO ESPIRITO SANTO SA	3.50813	0.0222

NAT BK OF GREECE SA does not Granger Cause BANCA MDP DI SIENA SPA	0.32078	0.8103
BANCA MDP DI SIENA SPA does not Granger Cause NAT BK OF GREECE SA	5.45144	0.0026
ALPHA BANK A.E. does not Granger Cause BANCA MDP DI SIENA SPA	5.64366	0.0021
BANCA MDP DI SIENA SPA does not Granger Cause ALPHA BANK A.E.	0.95969	0.4194
FRENCH REPUBLIC does not Granger Cause BANCA MDP DI SIENA SPA	6.30288	0.0011
BANCA MDP DI SIENA SPA does not Granger Cause FRENCH REPUBLIC	1.98967	0.1281
BANCO DE SABADELL SA does not Granger Cause BANCA MDP DI SIENA SPA	1.67037	0.1858
BANCA MDP DI SIENA SPA does not Granger Cause BANCO DE SABADELL SA	1.60793	0.1998
COMMERZBANK AG does not Granger Cause BANCA MDP DI SIENA SPA	9.34443	6.E-05
BANCA MDP DI SIENA SPA does not Granger Cause COMMERZBANK AG	2.37470	0.0817
DEUTSCHE BANK AG does not Granger Cause BANCA MDP DI SIENA SPA	5.70978	0.0020
BANCA MDP DI SIENA SPA does not Granger Cause DEUTSCHE BANK AG	4.81703	0.0052
SOCIETE GENERALE does not Granger Cause BANCA MDP DI SIENA SPA	5.54200	0.0024
BANCA MDP DI SIENA SPA does not Granger Cause SOCIETE GENERALE	3.16136	0.0329
CREDIT AGRICOLE does not Granger Cause BANCA MDP DI SIENA SPA	4.71812	0.0058
BANCA MDP DI SIENA SPA does not Granger Cause CREDIT AGRICOLE	2.40441	0.0789
BNP PARIBAS does not Granger Cause BANCA MDP DI SIENA SPA	6.66834	0.0007
BANCA MDP DI SIENA SPA does not Granger Cause BNP PARIBAS	4.35697	0.0086
KBC BANK does not Granger Cause DEXIA CREDIT LOCAL	0.65014	0.5867
DEXIA CREDIT LOCAL does not Granger Cause KBC BANK	2.58933	0.0637
BANCO COMR PORTUGUES does not Granger Cause DEXIA CREDIT LOCAL	0.67469	0.5718
DEXIA CREDIT LOCAL does not Granger Cause BANCO COMR PORTUGUES	0.95110	0.4235
BANCO ESPIRITO SANTO SA does not Granger Cause DEXIA CREDIT LOCAL	0.60529	0.6148
DEXIA CREDIT LOCAL does not Granger Cause BANCO ESPIRITO SANTO SA	0.91130	0.4426
NAT BK OF GREECE SA does not Granger Cause DEXIA CREDIT LOCAL	3.33882	0.0269
DEXIA CREDIT LOCAL does not Granger Cause NAT BK OF GREECE SA	7.52955	0.0003
ALPHA BANK A.E. does not Granger Cause DEXIA CREDIT LOCAL	4.84863	0.0050
DEXIA CREDIT LOCAL does not Granger Cause ALPHA BANK A.E.	3.80015	0.0159
FRENCH REPUBLIC does not Granger Cause DEXIA CREDIT LOCAL	6.10658	0.0013
DEXIA CREDIT LOCAL does not Granger Cause FRENCH REPUBLIC	6.01999	0.0014
BANCO DE SABADELL SA does not Granger Cause DEXIA CREDIT LOCAL	2.74453	0.0532

DEXIA CREDIT LOCAL does not Granger Cause BANCO DE SABADELL SA	0.07749	0.9719
COMMERZBANK AG does not Granger Cause DEXIA CREDIT LOCAL	2.29006	0.0902
DEXIA CREDIT LOCAL does not Granger Cause COMMERZBANK AG	2.73317	0.0539
DEUTSCHE BANK AG does not Granger Cause DEXIA CREDIT LOCAL	0.96994	0.4147
DEXIA CREDIT LOCAL does not Granger Cause DEUTSCHE BANK AG	4.82516	0.0051
SOCIETE GENERALE does not Granger Cause DEXIA CREDIT LOCAL	0.69847	0.5576
DEXIA CREDIT LOCAL does not Granger Cause SOCIETE GENERALE	0.67665	0.5706
CREDIT AGRICOLE does not Granger Cause DEXIA CREDIT LOCAL	0.27158	0.8456
DEXIA CREDIT LOCAL does not Granger Cause CREDIT AGRICOLE	0.84833	0.4743
BNP PARIBAS does not Granger Cause DEXIA CREDIT LOCAL	0.12819	0.9429
DEXIA CREDIT LOCAL does not Granger Cause BNP PARIBAS	1.23576	0.3071
BANCO COMR PORTUGUES does not Granger Cause KBC BANK	1.45027	0.2399
KBC BANK does not Granger Cause BANCO COMR PORTUGUES	0.48470	0.6945
BANCO ESPIRITO SANTO SA does not Granger Cause KBC BANK	0.60324	0.6161
KBC BANK does not Granger Cause BANCO ESPIRITO SANTO SA	0.60841	0.6128
NAT BK OF GREECE SA does not Granger Cause KBC BANK	2.59596	0.0632
KBC BANK does not Granger Cause NAT BK OF GREECE SA	5.56127	0.0023
ALPHA BANK A.E. does not Granger Cause KBC BANK	3.26629	0.0292
KBC BANK does not Granger Cause ALPHA BANK A.E.	3.89342	0.0144
FRENCH REPUBLIC does not Granger Cause KBC BANK	4.73515	0.0057
KBC BANK does not Granger Cause FRENCH REPUBLIC	5.71825	0.0020
BANCO DE SABADELL SA does not Granger Cause KBC BANK	6.46863	0.0009
KBC BANK does not Granger Cause BANCO DE SABADELL SA	2.01587	0.1242
COMMERZBANK AG does not Granger Cause KBC BANK	2.74436	0.0532
KBC BANK does not Granger Cause COMMERZBANK AG	3.65870	0.0187
DEUTSCHE BANK AG does not Granger Cause KBC BANK	0.85050	0.4732
KBC BANK does not Granger Cause DEUTSCHE BANK AG	1.46042	0.2371
SOCIETE GENERALE does not Granger Cause KBC BANK	5.42009	0.0027
KBC BANK does not Granger Cause SOCIETE GENERALE	0.27652	0.8420
CREDIT AGRICOLE does not Granger Cause KBC BANK	0.09769	0.9609
KBC BANK does not Granger Cause CREDIT AGRICOLE	0.16746	0.9178



BNP PARIBAS does not Granger Cause KBC BANK	0.94043	0.4285
KBC BANK does not Granger Cause BNP PARIBAS	0.77018	0.5164
BANCO ESPIRITO SANTO SA does not Granger Cause BANCO COMR PORTUGUES	1.25324	0.3010
BANCO COMR PORTUGUES does not Granger Cause BANCO ESPIRITO SANTO SA	1.79851	0.1601
NAT BK OF GREECE SA does not Granger Cause BANCO COMR PORTUGUES	1.25533	0.3003
BANCO COMR PORTUGUES does not Granger Cause NAT BK OF GREECE SA	1.93809	0.1360
ALPHA BANK A.E. does not Granger Cause BANCO COMR PORTUGUES	3.97158	0.0132
BANCO COMR PORTUGUES does not Granger Cause ALPHA BANK A.E.	1.26195	0.2980
FRENCH REPUBLIC does not Granger Cause BANCO COMR PORTUGUES	4.46822	0.0076
BANCO COMR PORTUGUES does not Granger Cause FRENCH REPUBLIC	5.50114	0.0025
BANCO DE SABADELL SA does not Granger Cause BANCO COMR PORTUGUES	0.63145	0.5983
BANCO COMR PORTUGUES does not Granger Cause BANCO DE SABADELL SA	0.66467	0.5779
COMMERZBANK AG does not Granger Cause BANCO COMR PORTUGUES	4.73452	0.0057
BANCO COMR PORTUGUES does not Granger Cause COMMERZBANK AG	4.89894	0.0047
DEUTSCHE BANK AG does not Granger Cause BANCO COMR PORTUGUES	1.83189	0.1540
BANCO COMR PORTUGUES does not Granger Cause DEUTSCHE BANK AG	1.35261	0.2685
SOCIETE GENERALE does not Granger Cause BANCO COMR PORTUGUES	2.03506	0.1215
BANCO COMR PORTUGUES does not Granger Cause SOCIETE GENERALE	2.16006	0.1050
CREDIT AGRICOLE does not Granger Cause BANCO COMR PORTUGUES	1.93026	0.1373
BANCO COMR PORTUGUES does not Granger Cause CREDIT AGRICOLE	1.75386	0.1686
BNP PARIBAS does not Granger Cause BANCO COMR PORTUGUES	2.02028	0.1236
BANCO COMR PORTUGUES does not Granger Cause BNP PARIBAS	4.24679	0.0097
NAT BK OF GREECE SA does not Granger Cause BANCO ESPIRITO SANTO SA	0.48062	0.6973
BANCO ESPIRITO SANTO SA does not Granger Cause NAT BK OF GREECE SA	3.21322	0.0310
ALPHA BANK A.E. does not Granger Cause BANCO ESPIRITO SANTO SA	2.20905	0.0991
BANCO ESPIRITO SANTO SA does not Granger Cause ALPHA BANK A.E.	0.82980	0.4840
FRENCH REPUBLIC does not Granger Cause BANCO ESPIRITO SANTO SA	1.80902	0.1581
BANCO ESPIRITO SANTO SA does not Granger Cause FRENCH REPUBLIC	3.64918	0.0189
BANCO DE SABADELL SA does not Granger Cause BANCO ESPIRITO SANTO SA	0.67337	0.5726
BANCO ESPIRITO SANTO SA does not Granger Cause BANCO DE SABADELL SA	1.71603	0.1762
COMMERZBANK AG does not Granger Cause BANCO ESPIRITO SANTO SA	3.71230	0.0176

BANCO ESPIRITO SANTO SA does not Granger Cause COMMERZBANK AG	4.68227	0.0060
DEUTSCHE BANK AG does not Granger Cause BANCO ESPIRITO SANTO SA	2.17451	0.1032
BANCO ESPIRITO SANTO SA does not Granger Cause DEUTSCHE BANK AG	0.74422	0.5310
SOCIETE GENERALE does not Granger Cause BANCO ESPIRITO SANTO SA	2.50865	0.0699
BANCO ESPIRITO SANTO SA does not Granger Cause SOCIETE GENERALE	2.43959	0.0758
CREDIT AGRICOLE does not Granger Cause BANCO ESPIRITO SANTO SA	1.45448	0.2387
BANCO ESPIRITO SANTO SA does not Granger Cause CREDIT AGRICOLE	2.42623	0.0770
BNP PARIBAS does not Granger Cause BANCO ESPIRITO SANTO SA	1.78151	0.1633
BANCO ESPIRITO SANTO SA does not Granger Cause BNP PARIBAS	2.24239	0.0954
ALPHA BANK A.E. does not Granger Cause NAT BK OF GREECE SA	12.8278	3.E-06
NAT BK OF GREECE SA does not Granger Cause ALPHA BANK A.E.	0.90450	0.4459
FRENCH REPUBLIC does not Granger Cause NAT BK OF GREECE SA	14.3732	8.E-07
NAT BK OF GREECE SA does not Granger Cause FRENCH REPUBLIC	0.28710	0.8345
BANCO DE SABADELL SA does not Granger Cause NAT BK OF GREECE SA	1.36764	0.2639
NAT BK OF GREECE SA does not Granger Cause BANCO DE SABADELL SA	2.53111	0.0681
COMMERZBANK AG does not Granger Cause NAT BK OF GREECE SA	9.51128	5.E-05
NAT BK OF GREECE SA does not Granger Cause COMMERZBANK AG	3.10946	0.0349
DEUTSCHE BANK AG does not Granger Cause NAT BK OF GREECE SA	7.12182	0.0005
NAT BK OF GREECE SA does not Granger Cause DEUTSCHE BANK AG	4.23473	0.0098
SOCIETE GENERALE does not Granger Cause NAT BK OF GREECE SA	9.16731	7.E-05
NAT BK OF GREECE SA does not Granger Cause SOCIETE GENERALE	1.55736	0.2119
CREDIT AGRICOLE does not Granger Cause NAT BK OF GREECE SA	3.04821	0.0375
NAT BK OF GREECE SA does not Granger Cause CREDIT AGRICOLE	3.34345	0.0267
BNP PARIBAS does not Granger Cause NAT BK OF GREECE SA	2.97979	0.0405
NAT BK OF GREECE SA does not Granger Cause BNP PARIBAS	5.31738	0.0030
FRENCH REPUBLIC does not Granger Cause ALPHA BANK A.E.	2.91362	0.0438
ALPHA BANK A.E. does not Granger Cause FRENCH REPUBLIC	0.56557	0.6404
BANCO DE SABADELL SA does not Granger Cause ALPHA BANK A.E.	1.00307	0.3996
ALPHA BANK A.E. does not Granger Cause BANCO DE SABADELL SA	1.72788	0.1738
COMMERZBANK AG does not Granger Cause ALPHA BANK A.E.	6.36488	0.0010
ALPHA BANK A.E. does not Granger Cause COMMERZBANK AG	2.85085	0.0470

DEUTSCHE BANK AG does not Granger Cause ALPHA BANK A.E.	3.21310	0.0310
ALPHA BANK A.E. does not Granger Cause DEUTSCHE BANK AG	3.19776	0.0316
SOCIETE GENERALE does not Granger Cause ALPHA BANK A.E.	0.65622	0.5830
ALPHA BANK A.E. does not Granger Cause SOCIETE GENERALE	1.91503	0.1397
CREDIT AGRICOLE does not Granger Cause ALPHA BANK A.E.	2.40548	0.0788
ALPHA BANK A.E. does not Granger Cause CREDIT AGRICOLE	2.05246	0.1190
BNP PARIBAS does not Granger Cause ALPHA BANK A.E.	1.63362	0.1940
ALPHA BANK A.E. does not Granger Cause BNP PARIBAS	3.79702	0.0160
BANCO DE SABADELL SA does not Granger Cause FRENCH REPUBLIC	0.28611	0.8352
FRENCH REPUBLIC does not Granger Cause BANCO DE SABADELL SA	3.08608	0.0359
COMMERZBANK AG does not Granger Cause FRENCH REPUBLIC	11.4650	9.E-06
FRENCH REPUBLIC does not Granger Cause COMMERZBANK AG	3.00568	0.0394
DEUTSCHE BANK AG does not Granger Cause FRENCH REPUBLIC	4.72130	0.0058
FRENCH REPUBLIC does not Granger Cause DEUTSCHE BANK AG	4.29168	0.0092
SOCIETE GENERALE does not Granger Cause FRENCH REPUBLIC	4.72183	0.0057
FRENCH REPUBLIC does not Granger Cause SOCIETE GENERALE	2.81604	0.0490
CREDIT AGRICOLE does not Granger Cause FRENCH REPUBLIC	5.15955	0.0036
FRENCH REPUBLIC does not Granger Cause CREDIT AGRICOLE	1.71561	0.1763
BNP PARIBAS does not Granger Cause FRENCH REPUBLIC	6.39874	0.0010
FRENCH REPUBLIC does not Granger Cause BNP PARIBAS	4.24630	0.0097
COMMERZBANK AG does not Granger Cause BANCO DE SABADELL SA	2.71984	0.0547
BANCO DE SABADELL SA does not Granger Cause COMMERZBANK AG	2.66710	0.0582
DEUTSCHE BANK AG does not Granger Cause BANCO DE SABADELL SA	0.94583	0.4260
BANCO DE SABADELL SA does not Granger Cause DEUTSCHE BANK AG	7.62697	0.0003
SOCIETE GENERALE does not Granger Cause BANCO DE SABADELL SA	0.50710	0.6792
BANCO DE SABADELL SA does not Granger Cause SOCIETE GENERALE	1.47694	0.2326
CREDIT AGRICOLE does not Granger Cause BANCO DE SABADELL SA	1.00230	0.4000
BANCO DE SABADELL SA does not Granger Cause CREDIT AGRICOLE	0.80689	0.4963
BNP PARIBAS does not Granger Cause BANCO DE SABADELL SA	0.92133	0.4377
BANCO DE SABADELL SA does not Granger Cause BNP PARIBAS	0.54981	0.6507
DEUTSCHE BANK AG does not Granger Cause COMMERZBANK AG	1.58618	0.2049

COMMERZBANK AG does not Granger Cause DEUTSCHE BANK AG	1.38782	0.2579
SOCIETE GENERALE does not Granger Cause COMMERZBANK AG	2.82296	0.0486
COMMERZBANK AG does not Granger Cause SOCIETE GENERALE	2.78528	0.0507
CREDIT AGRICOLE does not Granger Cause COMMERZBANK AG	3.06224	0.0369
COMMERZBANK AG does not Granger Cause CREDIT AGRICOLE	0.76754	0.5179
BNP PARIBAS does not Granger Cause COMMERZBANK AG	3.70896	0.0177
COMMERZBANK AG does not Granger Cause BNP PARIBAS	3.45645	0.0235
SOCIETE GENERALE does not Granger Cause DEUTSCHE BANK AG	2.36746	0.0824
DEUTSCHE BANK AG does not Granger Cause SOCIETE GENERALE	0.78413	0.5087
CREDIT AGRICOLE does not Granger Cause DEUTSCHE BANK AG	1.09663	0.3597
DEUTSCHE BANK AG does not Granger Cause CREDIT AGRICOLE	0.29490	0.8289
BNP PARIBAS does not Granger Cause DEUTSCHE BANK AG	1.32799	0.2762
DEUTSCHE BANK AG does not Granger Cause BNP PARIBAS	1.72308	0.1748
CREDIT AGRICOLE does not Granger Cause SOCIETE GENERALE	0.85391	0.4714
SOCIETE GENERALE does not Granger Cause CREDIT AGRICOLE	0.96438	0.4173
BNP PARIBAS does not Granger Cause SOCIETE GENERALE	0.45952	0.7118
SOCIETE GENERALE does not Granger Cause BNP PARIBAS	2.16885	0.1039
BNP PARIBAS does not Granger Cause CREDIT AGRICOLE	0.69034	0.5624
CREDIT AGRICOLE does not Granger Cause BNP PARIBAS	1.02665	0.3892

2011

Causalities

Pairwise Granger Causality Tests	F-Statistic	Prob.
Null Hypothesis:		
CREDIT AGRICOLE does not Granger Cause BNP PARIBAS	1.77603	0.1541
BNP PARIBAS does not Granger Cause CREDIT AGRICOLE	1.90364	0.1313
SOCIETE GENERALE does not Granger Cause BNP PARIBAS	2.05855	0.1081
BNP PARIBAS does not Granger Cause SOCIETE GENERALE	1.61675	0.1878
DEUTSCHE BANK AG does not Granger Cause BNP PARIBAS	6.88615	0.0002
BNP PARIBAS does not Granger Cause DEUTSCHE BANK AG	4.13870	0.0075
COMMERZBANK AG does not Granger Cause BNP PARIBAS	9.32782	1.E-05
BNP PARIBAS does not Granger Cause COMMERZBANK AG	1.80555	0.1485
BANCO DE SABADELL SA does not Granger Cause BNP PARIBAS	3.92227	0.0099
BNP PARIBAS does not Granger Cause BANCO DE SABADELL SA	0.81266	0.4887
BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS	4.80419	0.0032
BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA	0.45995	0.7107
BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS	0.79867	0.4964
BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA	1.60884	0.1896
BANCA MDP DI SIENA SPA does not Granger Cause BNP PARIBAS	1.70378	0.1686
BNP PARIBAS does not Granger Cause BANCA MDP DI SIENA SPA	0.38125	0.7667
DEXIA CREDIT LOCAL does not Granger Cause BNP PARIBAS	0.69254	0.5579
BNP PARIBAS does not Granger Cause DEXIA CREDIT LOCAL	4.61105	0.0041
KBC BANK does not Granger Cause BNP PARIBAS	2.08122	0.1050
BNP PARIBAS does not Granger Cause KBC BANK	2.89794	0.0370
BANCO COMR PORTUGUES does not Granger Cause BNP PARIBAS	4.58108	0.0042
BNP PARIBAS does not Granger Cause BANCO COMR PORTUGUES	1.64754	0.1808
BANCO ESPIRITO SANTO SA does not Granger Cause BNP PARIBAS	1.40085	0.2448
BNP PARIBAS does not Granger Cause BANCO ESPIRITO SANTO SA	0.15357	0.9273
NAT BK OF GREECE SA does not Granger Cause BNP PARIBAS	7.88505	6.E-05
BNP PARIBAS does not Granger Cause NAT BK OF GREECE SA	2.06529	0.1072
ALPHA BANK A.E. does not Granger Cause BNP PARIBAS	4.60581	0.0041
BNP PARIBAS does not Granger Cause ALPHA BANK A.E.	1.63957	0.1826
FRENCH REPUBLIC does not Granger Cause BNP PARIBAS	2.33397	0.0762

BNP PARIBAS does not Granger Cause FRENCH REPUBLIC	2.01632	0.1140
FEDERAL REP GERMANY does not Granger Cause BNP PARIBAS	1.30177	0.2760
BNP PARIBAS does not Granger Cause FEDERAL REP GERMANY	0.65178	0.5830
KINGDOM OF SPAIN does not Granger Cause BNP PARIBAS	2.30117	0.0795
BNP PARIBAS does not Granger Cause KINGDOM OF SPAIN	3.54155	0.0161
REPUBLIC OF ITALY does not Granger Cause BNP PARIBAS	5.66811	0.0010
BNP PARIBAS does not Granger Cause REPUBLIC OF ITALY	5.80676	0.0009
KINGDOM OF BELGIUM does not Granger Cause BNP PARIBAS	0.89136	0.4471
BNP PARIBAS does not Granger Cause KINGDOM OF BELGIUM	2.28950	0.0806
REPUBLIC OF PORTUGAL does not Granger Cause BNP PARIBAS	6.81938	0.0002
BNP PARIBAS does not Granger Cause REPUBLIC OF PORTUGAL	3.56068	0.0157
SOCIETE GENERALE does not Granger Cause CREDIT AGRICOLE	0.59848	0.6169
CREDIT AGRICOLE does not Granger Cause SOCIETE GENERALE	0.08217	0.9696
DEUTSCHE BANK AG does not Granger Cause CREDIT AGRICOLE	3.32027	0.0215
CREDIT AGRICOLE does not Granger Cause DEUTSCHE BANK AG	1.91491	0.1295
COMMERZBANK AG does not Granger Cause CREDIT AGRICOLE	5.95380	0.0007
CREDIT AGRICOLE does not Granger Cause COMMERZBANK AG	1.76324	0.1566
BANCO DE SABADELL SA does not Granger Cause CREDIT AGRICOLE	3.96381	0.0094
CREDIT AGRICOLE does not Granger Cause BANCO DE SABADELL SA	0.48106	0.6959
BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE	5.07848	0.0022
CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA	0.52171	0.6680
BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE	0.31624	0.8136
CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA	1.02136	0.3849
BANCA MDP DI SIENA SPA does not Granger Cause CREDIT AGRICOLE	1.12499	0.3409
CREDIT AGRICOLE does not Granger Cause BANCA MDP DI SIENA SPA	0.00696	0.9992
DEXIA CREDIT LOCAL does not Granger Cause CREDIT AGRICOLE	0.21951	0.8827
CREDIT AGRICOLE does not Granger Cause DEXIA CREDIT LOCAL	3.25852	0.0233
KBC BANK does not Granger Cause CREDIT AGRICOLE	1.47422	0.2238
CREDIT AGRICOLE does not Granger Cause KBC BANK	2.98212	0.0332
BANCO COMR PORTUGUES does not Granger Cause CREDIT AGRICOLE	6.46362	0.0004
CREDIT AGRICOLE does not Granger Cause BANCO COMR PORTUGUES	0.91921	0.4331

BANCO ESPIRITO SANTO SA does not Granger Cause CREDIT AGRICOLE	2.59199	0.0548
CREDIT AGRICOLE does not Granger Cause BANCO ESPIRITO SANTO SA	0.43099	0.7311
NAT BK OF GRECE SA does not Granger Cause CREDIT AGRICOLE	8.54509	3.E-05
CREDIT AGRICOLE does not Granger Cause NAT BK OF GRECE SA	0.73107	0.5350
ALPHA BANK A.E. does not Granger Cause CREDIT AGRICOLE	5.70429	0.0010
CREDIT AGRICOLE does not Granger Cause ALPHA BANK A.E.	1.81010	0.1477
FRENCH REPUBLIC does not Granger Cause CREDIT AGRICOLE	3.84647	0.0109
CREDIT AGRICOLE does not Granger Cause FRENCH REPUBLIC	3.20212	0.0250
FEDERAL REP GERMANY does not Granger Cause CREDIT AGRICOLE	0.71751	0.5430
CREDIT AGRICOLE does not Granger Cause FEDERAL REP GERMANY	0.72569	0.5381
KINGDOM OF SPAIN does not Granger Cause CREDIT AGRICOLE	4.43137	0.0051
CREDIT AGRICOLE does not Granger Cause KINGDOM OF SPAIN	5.32483	0.0016
REPUBLIC OF ITALY does not Granger Cause CREDIT AGRICOLE	3.61687	0.0146
CREDIT AGRICOLE does not Granger Cause REPUBLIC OF ITALY	6.44451	0.0004
KINGDOM OF BELGIUM does not Granger Cause CREDIT AGRICOLE	2.03139	0.1118
CREDIT AGRICOLE does not Granger Cause KINGDOM OF BELGIUM	2.21796	0.0883
REPUBLIC OF PORTUGAL does not Granger Cause CREDIT AGRICOLE	6.33445	0.0004
CREDIT AGRICOLE does not Granger Cause REPUBLIC OF PORTUGAL	5.95722	0.0007
DEUTSCHE BANK AG does not Granger Cause SOCIETE GENERALE	7.53145	0.0001
SOCIETE GENERALE does not Granger Cause DEUTSCHE BANK AG	3.09827	0.0286
COMMERZBANK AG does not Granger Cause SOCIETE GENERALE	5.95061	0.0007
SOCIETE GENERALE does not Granger Cause COMMERZBANK AG	0.78588	0.5035
BANCO DE SABADELL SA does not Granger Cause SOCIETE GENERALE	5.04692	0.0023
SOCIETE GENERALE does not Granger Cause BANCO DE SABADELL SA	0.60204	0.6146
BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE	6.01131	0.0007
SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA	0.54197	0.6543
BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE	0.33557	0.7996
SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA	1.96011	0.1223
BANCA MDP DI SIENA SPA does not Granger Cause SOCIETE GENERALE	0.70300	0.5516
SOCIETE GENERALE does not Granger Cause BANCA MDP DI SIENA SPA	0.28085	0.8392
DEXIA CREDIT LOCAL does not Granger Cause SOCIETE GENERALE	0.34611	0.7920



SOCIETE GENERALE does not Granger Cause DEXIA CREDIT LOCAL	5.30945	0.0017
KBC BANK does not Granger Cause SOCIETE GENERALE	1.41394	0.2409
SOCIETE GENERALE does not Granger Cause KBC BANK	4.00517	0.0089
BANCO COMR PORTUGUES does not Granger Cause SOCIETE GENERALE	4.04197	0.0085
SOCIETE GENERALE does not Granger Cause BANCO COMR PORTUGUES	0.94760	0.4193
BANCO ESPIRITO SANTO SA does not Granger Cause SOCIETE GENERALE	1.51421	0.2131
SOCIETE GENERALE does not Granger Cause BANCO ESPIRITO SANTO SA	0.68767	0.5609
NAT BK OF GREECE SA does not Granger Cause SOCIETE GENERALE	6.07137	0.0006
SOCIETE GENERALE does not Granger Cause NAT BK OF GREECE SA	2.12368	0.0995
ALPHA BANK A.E. does not Granger Cause SOCIETE GENERALE	3.36131	0.0204
SOCIETE GENERALE does not Granger Cause ALPHA BANK A.E.	3.14643	0.0269
FRENCH REPUBLIC does not Granger Cause SOCIETE GENERALE	2.50447	0.0613
SOCIETE GENERALE does not Granger Cause FRENCH REPUBLIC	4.31525	0.0059
FEDERAL REP GERMANY does not Granger Cause SOCIETE GENERALE	1.05721	0.3692
SOCIETE GENERALE does not Granger Cause FEDERAL REP GERMANY	1.80814	0.1480
KINGDOM OF SPAIN does not Granger Cause SOCIETE GENERALE	2.60632	0.0538
SOCIETE GENERALE does not Granger Cause KINGDOM OF SPAIN	3.70157	0.0131
REPUBLIC OF ITALY does not Granger Cause SOCIETE GENERALE	4.59584	0.0041
SOCIETE GENERALE does not Granger Cause REPUBLIC OF ITALY	4.63224	0.0039
KINGDOM OF BELGIUM does not Granger Cause SOCIETE GENERALE	1.22806	0.3015
SOCIETE GENERALE does not Granger Cause KINGDOM OF BELGIUM	3.24628	0.0236
REPUBLIC OF PORTUGAL does not Granger Cause SOCIETE GENERALE	5.27278	0.0017
SOCIETE GENERALE does not Granger Cause REPUBLIC OF PORTUGAL	5.77732	0.0009
COMMERZBANK AG does not Granger Cause DEUTSCHE BANK AG	4.11556	0.0077
DEUTSCHE BANK AG does not Granger Cause COMMERZBANK AG	0.97121	0.4080
BANCO DE SABADELL SA does not Granger Cause DEUTSCHE BANK AG	4.23998	0.0065
DEUTSCHE BANK AG does not Granger Cause BANCO DE SABADELL SA	1.62387	0.1862
BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG	3.61662	0.0147
DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA	1.57909	0.1967
BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG	0.90511	0.4402
DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA	0.62396	0.6006

BANCA MDP DI SIENA SPA does not Granger Cause DEUTSCHE BANK AG	1.78484	0.1524
DEUTSCHE BANK AG does not Granger Cause BANCA MDP DI SIENA SPA	0.93798	0.4239
DEXIA CREDIT LOCAL does not Granger Cause DEUTSCHE BANK AG	2.99677	0.0326
DEUTSCHE BANK AG does not Granger Cause DEXIA CREDIT LOCAL	1.94301	0.1250
KBC BANK does not Granger Cause DEUTSCHE BANK AG	1.73592	0.1620
DEUTSCHE BANK AG does not Granger Cause KBC BANK	2.63617	0.0518
BANCO COMR PORTUGUES does not Granger Cause DEUTSCHE BANK AG	2.36956	0.0728
DEUTSCHE BANK AG does not Granger Cause BANCO COMR PORTUGUES	1.36977	0.2542
BANCO ESPIRITO SANTO SA does not Granger Cause DEUTSCHE BANK AG	1.20287	0.3107
DEUTSCHE BANK AG does not Granger Cause BANCO ESPIRITO SANTO SA	0.68547	0.5622
NAT BK OF GREECE SA does not Granger Cause DEUTSCHE BANK AG	3.32846	0.0213
DEUTSCHE BANK AG does not Granger Cause NAT BK OF GREECE SA	2.01630	0.1140
ALPHA BANK A.E. does not Granger Cause DEUTSCHE BANK AG	3.59896	0.0150
DEUTSCHE BANK AG does not Granger Cause ALPHA BANK A.E.	1.27059	0.2865
FRENCH REPUBLIC does not Granger Cause DEUTSCHE BANK AG	7.38121	0.0001
DEUTSCHE BANK AG does not Granger Cause FRENCH REPUBLIC	8.70157	2.E-05
FEDERAL REP GERMANY does not Granger Cause DEUTSCHE BANK AG	1.57714	0.1972
DEUTSCHE BANK AG does not Granger Cause FEDERAL REP GERMANY	1.04332	0.3752
KINGDOM OF SPAIN does not Granger Cause DEUTSCHE BANK AG	2.36705	0.0731
DEUTSCHE BANK AG does not Granger Cause KINGDOM OF SPAIN	5.59487	0.0011
REPUBLIC OF ITALY does not Granger Cause DEUTSCHE BANK AG	5.98540	0.0007
DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF ITALY	7.62522	9.E-05
KINGDOM OF BELGIUM does not Granger Cause DEUTSCHE BANK AG	2.82532	0.0406
DEUTSCHE BANK AG does not Granger Cause KINGDOM OF BELGIUM	6.57447	0.0003
REPUBLIC OF PORTUGAL does not Granger Cause DEUTSCHE BANK AG	4.67364	0.0037
DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF PORTUGAL	5.04790	0.0023
BANCO DE SABADELL SA does not Granger Cause COMMERZBANK AG	4.57228	0.0043
COMMERZBANK AG does not Granger Cause BANCO DE SABADELL SA	1.26777	0.2875
BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG	5.90726	0.0008
COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA	1.35188	0.2598
BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG	0.54562	0.6518

COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA	1.20806	0.3088
BANCA MDP DI SIENA SPA does not Granger Cause COMMERZBANK AG	1.93216	0.1267
COMMERZBANK AG does not Granger Cause BANCA MDP DI SIENA SPA	2.41425	0.0688
DEXIA CREDIT LOCAL does not Granger Cause COMMERZBANK AG	1.98288	0.1189
COMMERZBANK AG does not Granger Cause DEXIA CREDIT LOCAL	2.12691	0.0991
KBC BANK does not Granger Cause COMMERZBANK AG	2.35818	0.0739
COMMERZBANK AG does not Granger Cause KBC BANK	3.27693	0.0227
BANCO COMR PORTUGUES does not Granger Cause COMMERZBANK AG	4.34701	0.0057
COMMERZBANK AG does not Granger Cause BANCO COMR PORTUGUES	1.43987	0.2334
BANCO ESPIRITO SANTO SA does not Granger Cause COMMERZBANK AG	3.86363	0.0106
COMMERZBANK AG does not Granger Cause BANCO ESPIRITO SANTO SA	1.74704	0.1598
NAT BK OF GRECE SA does not Granger Cause COMMERZBANK AG	4.60871	0.0041
COMMERZBANK AG does not Granger Cause NAT BK OF GRECE SA	0.18330	0.9076
ALPHA BANK A.E. does not Granger Cause COMMERZBANK AG	4.44901	0.0050
COMMERZBANK AG does not Granger Cause ALPHA BANK A.E.	1.33815	0.2641
FRENCH REPUBLIC does not Granger Cause COMMERZBANK AG	6.13600	0.0006
COMMERZBANK AG does not Granger Cause FRENCH REPUBLIC	11.6883	6.E-07
FEDERAL REP GERMANY does not Granger Cause COMMERZBANK AG	0.32874	0.8046
COMMERZBANK AG does not Granger Cause FEDERAL REP GERMANY	2.37030	0.0728
KINGDOM OF SPAIN does not Granger Cause COMMERZBANK AG	5.66413	0.0010
COMMERZBANK AG does not Granger Cause KINGDOM OF SPAIN	9.46188	9.E-06
REPUBLIC OF ITALY does not Granger Cause COMMERZBANK AG	1.96383	0.1218
COMMERZBANK AG does not Granger Cause REPUBLIC OF ITALY	8.56209	3.E-05
KINGDOM OF BELGIUM does not Granger Cause COMMERZBANK AG	4.81095	0.0031
COMMERZBANK AG does not Granger Cause KINGDOM OF BELGIUM	14.9256	1.E-08
REPUBLIC OF PORTUGAL does not Granger Cause COMMERZBANK AG	6.48636	0.0004
COMMERZBANK AG does not Granger Cause REPUBLIC OF PORTUGAL	4.50223	0.0047
BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA	6.71119	0.0003
BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA	0.01939	0.9963
BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA	0.40030	0.7530
BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA	1.57258	0.1983

BANCA MDP DI SIENA SPA does not Granger Cause BANCO DE SABADELL SA	1.61740	0.1876
BANCO DE SABADELL SA does not Granger Cause BANCA MDP DI SIENA SPA	2.11861	0.1002
DEXIA CREDIT LOCAL does not Granger Cause BANCO DE SABADELL SA	0.91414	0.4357
BANCO DE SABADELL SA does not Granger Cause DEXIA CREDIT LOCAL	5.46311	0.0014
KBC BANK does not Granger Cause BANCO DE SABADELL SA	2.99455	0.0327
BANCO DE SABADELL SA does not Granger Cause KBC BANK	4.22337	0.0067
BANCO COMR PORTUGUES does not Granger Cause BANCO DE SABADELL SA	3.32479	0.0214
BANCO DE SABADELL SA does not Granger Cause BANCO COMR PORTUGUES	3.85658	0.0107
BANCO ESPIRITO SANTO SA does not Granger Cause BANCO DE SABADELL SA	5.89379	0.0008
BANCO DE SABADELL SA does not Granger Cause BANCO ESPIRITO SANTO SA	3.58655	0.0152
NAT BK OF GREECE SA does not Granger Cause BANCO DE SABADELL SA	2.15546	0.0956
BANCO DE SABADELL SA does not Granger Cause NAT BK OF GREECE SA	1.21324	0.3069
ALPHA BANK A.E. does not Granger Cause BANCO DE SABADELL SA	1.83800	0.1426
BANCO DE SABADELL SA does not Granger Cause ALPHA BANK A.E.	2.19761	0.0906
FRENCH REPUBLIC does not Granger Cause BANCO DE SABADELL SA	2.55773	0.0573
BANCO DE SABADELL SA does not Granger Cause FRENCH REPUBLIC	2.17700	0.0930
FEDERAL REP GERMANY does not Granger Cause BANCO DE SABADELL SA	0.44021	0.7246
BANCO DE SABADELL SA does not Granger Cause FEDERAL REP GERMANY	1.72265	0.1647
KINGDOM OF SPAIN does not Granger Cause BANCO DE SABADELL SA	4.96914	0.0026
BANCO DE SABADELL SA does not Granger Cause KINGDOM OF SPAIN	4.12678	0.0076
REPUBLIC OF ITALY does not Granger Cause BANCO DE SABADELL SA	1.89272	0.1332
BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF ITALY	3.31401	0.0217
KINGDOM OF BELGIUM does not Granger Cause BANCO DE SABADELL SA	2.60350	0.0540
BANCO DE SABADELL SA does not Granger Cause KINGDOM OF BELGIUM	1.72561	0.1641
REPUBLIC OF PORTUGAL does not Granger Cause BANCO DE SABADELL SA	7.88236	6.E-05
BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF PORTUGAL	5.83456	0.0008
BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA	0.33419	0.8006
BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA	0.67019	0.5716
BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA	0.44823	0.7189
BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA	3.67575	0.0136
DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA	0.80670	0.4920

BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL	4.95248	0.0026
KBC BANK does not Granger Cause BANCO POP ESPANOL SA	3.82275	0.0112
BANCO POP ESPANOL SA does not Granger Cause KBC BANK	3.45876	0.0180
BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA	3.13873	0.0271
BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES	3.49668	0.0171
BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA	5.33562	0.0016
BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA	2.02902	0.1122
NAT BK OF GRECE SA does not Granger Cause BANCO POP ESPANOL SA	2.12139	0.0998
BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GRECE SA	1.09165	0.3545
ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA	2.38420	0.0715
BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E.	1.92684	0.1276
FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA	0.73409	0.5332
BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC	1.88820	0.1339
FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA	0.95505	0.4157
BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY	1.22511	0.3026
KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA	4.80694	0.0032
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN	1.06728	0.3648
REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA	1.05238	0.3713
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY	2.05677	0.1083
KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA	1.38411	0.2498
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM	1.67074	0.1757
REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA	8.86528	2.E-05
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL	2.50672	0.0611
BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA	1.08566	0.3570
BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA	0.48488	0.6933
DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA	1.11753	0.3439
BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL	0.44228	0.7231
KBC BANK does not Granger Cause BANCO POP ESPANOL SA	0.34889	0.7900
BANCO POP ESPANOL SA does not Granger Cause KBC BANK	0.33542	0.7997
BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA	1.52976	0.2091
BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES	0.50772	0.6775

BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA	0.93120	0.4272
BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA	0.60798	0.6108
NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA	2.51282	0.0607
BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA	0.71679	0.5434
ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA	1.14483	0.3330
BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E.	0.78196	0.5057
FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA	1.54726	0.2046
BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC	1.08447	0.3575
FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA	2.25287	0.0845
BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY	0.19015	0.9030
KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA	1.63645	0.1833
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN	0.83992	0.4740
REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA	1.52388	0.2106
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY	1.52437	0.2104
KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA	1.57575	0.1976
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM	0.90599	0.4397
REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA	1.18329	0.3181
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL	0.80542	0.4927
DEXIA CREDIT LOCAL does not Granger Cause BANCA MDP DI SIENA SPA	0.86080	0.4629
BANCA MDP DI SIENA SPA does not Granger Cause DEXIA CREDIT LOCAL	3.85177	0.0108
KBC BANK does not Granger Cause BANCA MDP DI SIENA SPA	2.82511	0.0406
BANCA MDP DI SIENA SPA does not Granger Cause KBC BANK	5.23253	0.0018
BANCO COMR PORTUGUES does not Granger Cause BANCA MDP DI SIENA SPA	8.34181	4.E-05
BANCA MDP DI SIENA SPA does not Granger Cause BANCO COMR PORTUGUES	0.89567	0.4449
BANCO ESPIRITO SANTO SA does not Granger Cause BANCA MDP DI SIENA SPA	3.05565	0.0302
BANCA MDP DI SIENA SPA does not Granger Cause BANCO ESPIRITO SANTO SA	0.39091	0.7597
NAT BK OF GREECE SA does not Granger Cause BANCA MDP DI SIENA SPA	8.93358	2.E-05
BANCA MDP DI SIENA SPA does not Granger Cause NAT BK OF GREECE SA	0.16736	0.9183
ALPHA BANK A.E. does not Granger Cause BANCA MDP DI SIENA SPA	5.98657	0.0007
BANCA MDP DI SIENA SPA does not Granger Cause ALPHA BANK A.E.	2.84313	0.0397
FRENCH REPUBLIC does not Granger Cause BANCA MDP DI SIENA SPA	2.94771	0.0347

BANCA MDP DI SIENA SPA does not Granger Cause FRENCH REPUBLIC	2.30619	0.0789
FEDERAL REP GERMANY does not Granger Cause BANCA MDP DI SIENA SPA	0.51285	0.6740
BANCA MDP DI SIENA SPA does not Granger Cause FEDERAL REP GERMANY	0.86984	0.4582
KINGDOM OF SPAIN does not Granger Cause BANCA MDP DI SIENA SPA	5.18725	0.0019
BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF SPAIN	4.12517	0.0076
REPUBLIC OF ITALY does not Granger Cause BANCA MDP DI SIENA SPA	2.44058	0.0665
BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF ITALY	6.53408	0.0003
KINGDOM OF BELGIUM does not Granger Cause BANCA MDP DI SIENA SPA	2.19826	0.0906
BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF BELGIUM	3.85478	0.0108
REPUBLIC OF PORTUGAL does not Granger Cause BANCA MDP DI SIENA SPA	6.17126	0.0005
BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF PORTUGAL	4.13713	0.0075
KBC BANK does not Granger Cause DEXIA CREDIT LOCAL	0.66642	0.5739
DEXIA CREDIT LOCAL does not Granger Cause KBC BANK	5.40093	0.0015
BANCO COMR PORTUGUES does not Granger Cause DEXIA CREDIT LOCAL	3.39801	0.0194
DEXIA CREDIT LOCAL does not Granger Cause BANCO COMR PORTUGUES	1.26986	0.2868
BANCO ESPIRITO SANTO SA does not Granger Cause DEXIA CREDIT LOCAL	2.87289	0.0382
DEXIA CREDIT LOCAL does not Granger Cause BANCO ESPIRITO SANTO SA	0.80177	0.4947
NAT BK OF GREECE SA does not Granger Cause DEXIA CREDIT LOCAL	3.71882	0.0128
DEXIA CREDIT LOCAL does not Granger Cause NAT BK OF GREECE SA	0.71043	0.5472
ALPHA BANK A.E. does not Granger Cause DEXIA CREDIT LOCAL	3.96138	0.0094
DEXIA CREDIT LOCAL does not Granger Cause ALPHA BANK A.E.	0.89864	0.4434
FRENCH REPUBLIC does not Granger Cause DEXIA CREDIT LOCAL	4.04181	0.0085
DEXIA CREDIT LOCAL does not Granger Cause FRENCH REPUBLIC	0.08096	0.9703
FEDERAL REP GERMANY does not Granger Cause DEXIA CREDIT LOCAL	0.82602	0.4814
DEXIA CREDIT LOCAL does not Granger Cause FEDERAL REP GERMANY	0.65387	0.5817
KINGDOM OF SPAIN does not Granger Cause DEXIA CREDIT LOCAL	4.73678	0.0035
DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF SPAIN	1.84419	0.1415
REPUBLIC OF ITALY does not Granger Cause DEXIA CREDIT LOCAL	6.98079	0.0002
DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF ITALY	0.85098	0.4681
KINGDOM OF BELGIUM does not Granger Cause DEXIA CREDIT LOCAL	5.25606	0.0018
DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF BELGIUM	0.67659	0.5676

REPUBLIC OF PORTUGAL does not Granger Cause DEXIA CREDIT LOCAL	4.83913	0.0030
DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF PORTUGAL	2.24375	0.0855
BANCO COMR PORTUGUES does not Granger Cause KBC BANK	4.46569	0.0049
KBC BANK does not Granger Cause BANCO COMR PORTUGUES	1.94339	0.1249
BANCO ESPIRITO SANTO SA does not Granger Cause KBC BANK	2.26323	0.0834
KBC BANK does not Granger Cause BANCO ESPIRITO SANTO SA	1.65800	0.1784
NAT BK OF GREECE SA does not Granger Cause KBC BANK	2.96257	0.0341
KBC BANK does not Granger Cause NAT BK OF GREECE SA	1.28890	0.2803
ALPHA BANK A.E. does not Granger Cause KBC BANK	4.99328	0.0025
KBC BANK does not Granger Cause ALPHA BANK A.E.	1.50142	0.2165
FRENCH REPUBLIC does not Granger Cause KBC BANK	3.96700	0.0093
KBC BANK does not Granger Cause FRENCH REPUBLIC	2.38117	0.0718
FEDERAL REP GERMANY does not Granger Cause KBC BANK	3.50802	0.0169
KBC BANK does not Granger Cause FEDERAL REP GERMANY	0.51595	0.6719
KINGDOM OF SPAIN does not Granger Cause KBC BANK	3.80884	0.0114
KBC BANK does not Granger Cause KINGDOM OF SPAIN	5.20443	0.0019
REPUBLIC OF ITALY does not Granger Cause KBC BANK	5.16782	0.0020
KBC BANK does not Granger Cause REPUBLIC OF ITALY	3.76829	0.0120
KINGDOM OF BELGIUM does not Granger Cause KBC BANK	5.35177	0.0016
KBC BANK does not Granger Cause KINGDOM OF BELGIUM	4.03212	0.0086
REPUBLIC OF PORTUGAL does not Granger Cause KBC BANK	4.02027	0.0087
KBC BANK does not Granger Cause REPUBLIC OF PORTUGAL	1.35963	0.2573
BANCO ESPIRITO SANTO SA does not Granger Cause BANCO COMR PORTUGUES	0.07552	0.9731
BANCO COMR PORTUGUES does not Granger Cause BANCO ESPIRITO SANTO SA	0.59612	0.6185
NAT BK OF GREECE SA does not Granger Cause BANCO COMR PORTUGUES	3.39457	0.0195
BANCO COMR PORTUGUES does not Granger Cause NAT BK OF GREECE SA	2.47270	0.0638
ALPHA BANK A.E. does not Granger Cause BANCO COMR PORTUGUES	0.30693	0.8204
BANCO COMR PORTUGUES does not Granger Cause ALPHA BANK A.E.	1.68873	0.1718
FRENCH REPUBLIC does not Granger Cause BANCO COMR PORTUGUES	2.44771	0.0659
BANCO COMR PORTUGUES does not Granger Cause FRENCH REPUBLIC	3.82089	0.0113
FEDERAL REP GERMANY does not Granger Cause BANCO COMR PORTUGUES	0.92760	0.4290



BANCO COMR PORTUGUES does not Granger Cause FEDERAL REP GERMANY	1.05316	0.3709
KINGDOM OF SPAIN does not Granger Cause BANCO COMR PORTUGUES	0.43020	0.7317
BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF SPAIN	2.27547	0.0821
REPUBLIC OF ITALY does not Granger Cause BANCO COMR PORTUGUES	0.13169	0.9411
BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF ITALY	4.28754	0.0062
KINGDOM OF BELGIUM does not Granger Cause BANCO COMR PORTUGUES	0.91549	0.4350
BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF BELGIUM	5.15442	0.0020
REPUBLIC OF PORTUGAL does not Granger Cause BANCO COMR PORTUGUES	4.53341	0.0045
BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF PORTUGAL	0.80215	0.4945
NAT BK OF GREECE SA does not Granger Cause BANCO ESPIRITO SANTO SA	2.09292	0.1035
BANCO ESPIRITO SANTO SA does not Granger Cause NAT BK OF GREECE SA	0.77703	0.5085
ALPHA BANK A.E. does not Granger Cause BANCO ESPIRITO SANTO SA	0.63560	0.5932
BANCO ESPIRITO SANTO SA does not Granger Cause ALPHA BANK A.E.	0.44232	0.7231
FRENCH REPUBLIC does not Granger Cause BANCO ESPIRITO SANTO SA	0.31628	0.8136
BANCO ESPIRITO SANTO SA does not Granger Cause FRENCH REPUBLIC	1.68809	0.1719
FEDERAL REP GERMANY does not Granger Cause BANCO ESPIRITO SANTO SA	1.94858	0.1241
BANCO ESPIRITO SANTO SA does not Granger Cause FEDERAL REP GERMANY	0.73507	0.5326
KINGDOM OF SPAIN does not Granger Cause BANCO ESPIRITO SANTO SA	0.62452	0.6002
BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF SPAIN	1.00285	0.3933
REPUBLIC OF ITALY does not Granger Cause BANCO ESPIRITO SANTO SA	0.05544	0.9828
BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF ITALY	1.49704	0.2176
KINGDOM OF BELGIUM does not Granger Cause BANCO ESPIRITO SANTO SA	0.27151	0.8459
BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF BELGIUM	2.06050	0.1078
REPUBLIC OF PORTUGAL does not Granger Cause BANCO ESPIRITO SANTO SA	3.27782	0.0227
BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF PORTUGAL	0.47405	0.7008
ALPHA BANK A.E. does not Granger Cause NAT BK OF GREECE SA	4.74654	0.0034
NAT BK OF GREECE SA does not Granger Cause ALPHA BANK A.E.	4.04107	0.0085
FRENCH REPUBLIC does not Granger Cause NAT BK OF GREECE SA	4.40499	0.0053
NAT BK OF GREECE SA does not Granger Cause FRENCH REPUBLIC	4.57380	0.0043
FEDERAL REP GERMANY does not Granger Cause NAT BK OF GREECE SA	3.21881	0.0245
NAT BK OF GREECE SA does not Granger Cause FEDERAL REP GERMANY	2.23835	0.0861

KINGDOM OF SPAIN does not Granger Cause NAT BK OF GREECE SA	1.58783	0.1946
NAT BK OF GREECE SA does not Granger Cause KINGDOM OF SPAIN	2.07656	0.1056
REPUBLIC OF ITALY does not Granger Cause NAT BK OF GREECE SA	0.94111	0.4224
NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF ITALY	5.62506	0.0011
KINGDOM OF BELGIUM does not Granger Cause NAT BK OF GREECE SA	2.46117	0.0648
NAT BK OF GREECE SA does not Granger Cause KINGDOM OF BELGIUM	4.76046	0.0033
REPUBLIC OF PORTUGAL does not Granger Cause NAT BK OF GREECE SA	5.26589	0.0017
NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF PORTUGAL	2.40327	0.0698
FRENCH REPUBLIC does not Granger Cause ALPHA BANK A.E.	1.14799	0.3317
ALPHA BANK A.E. does not Granger Cause FRENCH REPUBLIC	2.73418	0.0457
FEDERAL REP GERMANY does not Granger Cause ALPHA BANK A.E.	3.53360	0.0163
ALPHA BANK A.E. does not Granger Cause FEDERAL REP GERMANY	2.36671	0.0731
KINGDOM OF SPAIN does not Granger Cause ALPHA BANK A.E.	1.69414	0.1706
ALPHA BANK A.E. does not Granger Cause KINGDOM OF SPAIN	1.04358	0.3751
REPUBLIC OF ITALY does not Granger Cause ALPHA BANK A.E.	1.69705	0.1700
ALPHA BANK A.E. does not Granger Cause REPUBLIC OF ITALY	2.86880	0.0384
KINGDOM OF BELGIUM does not Granger Cause ALPHA BANK A.E.	0.97059	0.4083
ALPHA BANK A.E. does not Granger Cause KINGDOM OF BELGIUM	3.97131	0.0093
REPUBLIC OF PORTUGAL does not Granger Cause ALPHA BANK A.E.	4.75179	0.0034
ALPHA BANK A.E. does not Granger Cause REPUBLIC OF PORTUGAL	1.19884	0.3122
FEDERAL REP GERMANY does not Granger Cause FRENCH REPUBLIC	4.08211	0.0080
FRENCH REPUBLIC does not Granger Cause FEDERAL REP GERMANY	1.34997	0.2604
KINGDOM OF SPAIN does not Granger Cause FRENCH REPUBLIC	4.43411	0.0051
FRENCH REPUBLIC does not Granger Cause KINGDOM OF SPAIN	3.87354	0.0105
REPUBLIC OF ITALY does not Granger Cause FRENCH REPUBLIC	5.48454	0.0013
FRENCH REPUBLIC does not Granger Cause REPUBLIC OF ITALY	3.18958	0.0254
KINGDOM OF BELGIUM does not Granger Cause FRENCH REPUBLIC	0.43265	0.7299
FRENCH REPUBLIC does not Granger Cause KINGDOM OF BELGIUM	1.06873	0.3642
REPUBLIC OF PORTUGAL does not Granger Cause FRENCH REPUBLIC	8.83676	2.E-05
FRENCH REPUBLIC does not Granger Cause REPUBLIC OF PORTUGAL	1.91808	0.1290
KINGDOM OF SPAIN does not Granger Cause FEDERAL REP GERMANY	1.82393	0.1451

FEDERAL REP GERMANY does not Granger Cause KINGDOM OF SPAIN	4.09354	0.0079
REPUBLIC OF ITALY does not Granger Cause FEDERAL REP GERMANY	1.98570	0.1185
FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF ITALY	4.66926	0.0038
KINGDOM OF BELGIUM does not Granger Cause FEDERAL REP GERMANY	1.46995	0.2250
FEDERAL REP GERMANY does not Granger Cause KINGDOM OF BELGIUM	3.07392	0.0295
REPUBLIC OF PORTUGAL does not Granger Cause FEDERAL REP GERMANY	3.33480	0.0211
FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF PORTUGAL	3.22853	0.0242
REPUBLIC OF ITALY does not Granger Cause KINGDOM OF SPAIN	0.15178	0.9284
KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF ITALY	2.18228	0.0924
KINGDOM OF BELGIUM does not Granger Cause KINGDOM OF SPAIN	3.29822	0.0221
KINGDOM OF SPAIN does not Granger Cause KINGDOM OF BELGIUM	5.41894	0.0014
REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF SPAIN	5.43510	0.0014
KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF PORTUGAL	1.61275	0.1887
KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF ITALY	4.64513	0.0039
REPUBLIC OF ITALY does not Granger Cause KINGDOM OF BELGIUM	3.94625	0.0096
REPUBLIC OF PORTUGAL does not Granger Cause REPUBLIC OF ITALY	7.33022	0.0001
REPUBLIC OF ITALY does not Granger Cause REPUBLIC OF PORTUGAL	2.97507	0.0335
REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF BELGIUM	6.70750	0.0003
KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF PORTUGAL	2.73905	0.0454

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Causalities

Pairwise Granger Causality Tests	F-Statistic	Prob.
Null Hypothesis:		
CREDIT AGRICOLE does not Granger Cause BNP PARIBAS	0.83785	0.4742
BNP PARIBAS does not Granger Cause CREDIT AGRICOLE	0.97237	0.4064
SOCIETE GENERALE does not Granger Cause BNP PARIBAS	1.52639	0.2082
BNP PARIBAS does not Granger Cause SOCIETE GENERALE	0.60756	0.6107
DEUTSCHE BANK AG does not Granger Cause BNP PARIBAS	5.02884	0.0021
BNP PARIBAS does not Granger Cause DEUTSCHE BANK AG	2.88749	0.0362
COMMERZBANK AG does not Granger Cause BNP PARIBAS	5.29032	0.0015
BNP PARIBAS does not Granger Cause COMMERZBANK AG	1.96952	0.1191
BANCO DE SABADELL SA does not Granger Cause BNP PARIBAS	3.12080	0.0266
BNP PARIBAS does not Granger Cause BANCO DE SABADELL SA	2.55914	0.0556
BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS	2.85322	0.0379
BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA	2.47605	0.0620
BANCO POP ESPANOL SA does not Granger Cause BNP PARIBAS	0.78290	0.5045
BNP PARIBAS does not Granger Cause BANCO POP ESPANOL SA	1.24299	0.2947
BANCA MDP DI SIENA SPA does not Granger Cause BNP PARIBAS	1.27300	0.2842
BNP PARIBAS does not Granger Cause BANCA MDP DI SIENA SPA	0.99381	0.3963
DEXIA CREDIT LOCAL does not Granger Cause BNP PARIBAS	1.71716	0.1640
BNP PARIBAS does not Granger Cause DEXIA CREDIT LOCAL	13.3371	4.E-08
KBC BANK does not Granger Cause BNP PARIBAS	1.78116	0.1513
BNP PARIBAS does not Granger Cause KBC BANK	1.78307	0.1509
BANCO COMR PORTUGUES does not Granger Cause BNP PARIBAS	5.12460	0.0019
BNP PARIBAS does not Granger Cause BANCO COMR PORTUGUES	2.37252	0.0709
BANCO ESPIRITO SANTO SA does not Granger Cause BNP PARIBAS	2.12493	0.0976
BNP PARIBAS does not Granger Cause BANCO ESPIRITO SANTO SA	1.00574	0.3908
NAT BK OF GREECE SA does not Granger Cause BNP PARIBAS	5.50168	0.0011
BNP PARIBAS does not Granger Cause NAT BK OF GREECE SA	2.76339	0.0426
ALPHA BANK A.E. does not Granger Cause BNP PARIBAS	0.79120	0.4998
BNP PARIBAS does not Granger Cause ALPHA BANK A.E.	11.6931	3.E-07
FRENCH REPUBLIC does not Granger Cause BNP PARIBAS	2.77521	0.0420

BNP PARIBAS does not Granger Cause FRENCH REPUBLIC	1.45506	0.2274
FEDERAL REP GERMANY does not Granger Cause BNP PARIBAS	1.14847	0.3301
BNP PARIBAS does not Granger Cause FEDERAL REP GERMANY	0.59185	0.6209
KINGDOM OF SPAIN does not Granger Cause BNP PARIBAS	1.81581	0.1448
BNP PARIBAS does not Granger Cause KINGDOM OF SPAIN	1.62457	0.1842
REPUBLIC OF ITALY does not Granger Cause BNP PARIBAS	1.65745	0.1768
BNP PARIBAS does not Granger Cause REPUBLIC OF ITALY	4.02740	0.0080
KINGDOM OF BELGIUM does not Granger Cause BNP PARIBAS	1.98811	0.1163
BNP PARIBAS does not Granger Cause KINGDOM OF BELGIUM	2.51638	0.0588
REPUBLIC OF PORTUGAL does not Granger Cause BNP PARIBAS	7.17614	0.0001
BNP PARIBAS does not Granger Cause REPUBLIC OF PORTUGAL	7.32237	0.0001
SOCIETE GENERALE does not Granger Cause CREDIT AGRICOLE	0.96230	0.4111
CREDIT AGRICOLE does not Granger Cause SOCIETE GENERALE	0.84119	0.4724
DEUTSCHE BANK AG does not Granger Cause CREDIT AGRICOLE	3.48689	0.0164
CREDIT AGRICOLE does not Granger Cause DEUTSCHE BANK AG	1.09048	0.3537
COMMERZBANK AG does not Granger Cause CREDIT AGRICOLE	3.78000	0.0111
CREDIT AGRICOLE does not Granger Cause COMMERZBANK AG	1.76603	0.1542
BANCO DE SABADELL SA does not Granger Cause CREDIT AGRICOLE	2.02570	0.1108
CREDIT AGRICOLE does not Granger Cause BANCO DE SABADELL SA	2.14191	0.0955
BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE	1.93203	0.1249
CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA	2.38767	0.0695
BANCO POP ESPANOL SA does not Granger Cause CREDIT AGRICOLE	0.35235	0.7875
CREDIT AGRICOLE does not Granger Cause BANCO POP ESPANOL SA	0.80437	0.4925
BANCA MDP DI SIENA SPA does not Granger Cause CREDIT AGRICOLE	0.55079	0.6481
CREDIT AGRICOLE does not Granger Cause BANCA MDP DI SIENA SPA	1.21786	0.3038
DEXIA CREDIT LOCAL does not Granger Cause CREDIT AGRICOLE	0.41419	0.7430
CREDIT AGRICOLE does not Granger Cause DEXIA CREDIT LOCAL	10.0209	3.E-06
KBC BANK does not Granger Cause CREDIT AGRICOLE	1.91317	0.1280
CREDIT AGRICOLE does not Granger Cause KBC BANK	1.33068	0.2649
BANCO COMR PORTUGUES does not Granger Cause CREDIT AGRICOLE	4.26395	0.0059
CREDIT AGRICOLE does not Granger Cause BANCO COMR PORTUGUES	1.18059	0.3177

BANCO ESPIRITO SANTO SA does not Granger Cause CREDIT AGRICOLE	2.21204	0.0872
CREDIT AGRICOLE does not Granger Cause BANCO ESPIRITO SANTO SA	0.90365	0.4399
NAT BK OF GRECE SA does not Granger Cause CREDIT AGRICOLE	3.94349	0.0090
CREDIT AGRICOLE does not Granger Cause NAT BK OF GRECE SA	0.61626	0.6051
ALPHA BANK A.E. does not Granger Cause CREDIT AGRICOLE	1.69010	0.1697
CREDIT AGRICOLE does not Granger Cause ALPHA BANK A.E.	7.54488	8.E-05
FRENCH REPUBLIC does not Granger Cause CREDIT AGRICOLE	2.54110	0.0570
CREDIT AGRICOLE does not Granger Cause FRENCH REPUBLIC	2.36990	0.0711
FEDERAL REP GERMANY does not Granger Cause CREDIT AGRICOLE	0.63753	0.5915
CREDIT AGRICOLE does not Granger Cause FEDERAL REP GERMANY	0.83087	0.4780
KINGDOM OF SPAIN does not Granger Cause CREDIT AGRICOLE	3.72551	0.0120
CREDIT AGRICOLE does not Granger Cause KINGDOM OF SPAIN	1.59515	0.1911
REPUBLIC OF ITALY does not Granger Cause CREDIT AGRICOLE	1.79353	0.1489
CREDIT AGRICOLE does not Granger Cause REPUBLIC OF ITALY	3.06694	0.0286
KINGDOM OF BELGIUM does not Granger Cause CREDIT AGRICOLE	2.29170	0.0787
CREDIT AGRICOLE does not Granger Cause KINGDOM OF BELGIUM	3.21168	0.0236
REPUBLIC OF PORTUGAL does not Granger Cause CREDIT AGRICOLE	6.49911	0.0003
CREDIT AGRICOLE does not Granger Cause REPUBLIC OF PORTUGAL	9.40851	7.E-06
DEUTSCHE BANK AG does not Granger Cause SOCIETE GENERALE	4.18133	0.0065
SOCIETE GENERALE does not Granger Cause DEUTSCHE BANK AG	1.76701	0.1540
COMMERZBANK AG does not Granger Cause SOCIETE GENERALE	2.32789	0.0751
SOCIETE GENERALE does not Granger Cause COMMERZBANK AG	0.93100	0.4263
BANCO DE SABADELL SA does not Granger Cause SOCIETE GENERALE	3.33104	0.0202
SOCIETE GENERALE does not Granger Cause BANCO DE SABADELL SA	1.24221	0.2950
BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE	2.62248	0.0512
SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA	1.53346	0.2064
BANCO POP ESPANOL SA does not Granger Cause SOCIETE GENERALE	0.46653	0.7059
SOCIETE GENERALE does not Granger Cause BANCO POP ESPANOL SA	1.76953	0.1535
BANCA MDP DI SIENA SPA does not Granger Cause SOCIETE GENERALE	0.53443	0.6591
SOCIETE GENERALE does not Granger Cause BANCA MDP DI SIENA SPA	1.29634	0.2762
DEXIA CREDIT LOCAL does not Granger Cause SOCIETE GENERALE	0.68524	0.5618

SOCIETE GENERALE does not Granger Cause DEXIA CREDIT LOCAL	10.2991	2.E-06
KBC BANK does not Granger Cause SOCIETE GENERALE	1.25933	0.2889
SOCIETE GENERALE does not Granger Cause KBC BANK	2.47393	0.0622
BANCO COMR PORTUGUES does not Granger Cause SOCIETE GENERALE	5.42336	0.0013
SOCIETE GENERALE does not Granger Cause BANCO COMR PORTUGUES	1.22422	0.3014
BANCO ESPIRITO SANTO SA does not Granger Cause SOCIETE GENERALE	2.50446	0.0597
SOCIETE GENERALE does not Granger Cause BANCO ESPIRITO SANTO SA	1.06619	0.3640
NAT BK OF GREECE SA does not Granger Cause SOCIETE GENERALE	4.95604	0.0023
SOCIETE GENERALE does not Granger Cause NAT BK OF GREECE SA	3.18347	0.0245
ALPHA BANK A.E. does not Granger Cause SOCIETE GENERALE	1.33508	0.2635
SOCIETE GENERALE does not Granger Cause ALPHA BANK A.E.	11.0398	8.E-07
FRENCH REPUBLIC does not Granger Cause SOCIETE GENERALE	2.12201	0.0980
SOCIETE GENERALE does not Granger Cause FRENCH REPUBLIC	3.37523	0.0190
FEDERAL REP GERMANY does not Granger Cause SOCIETE GENERALE	0.95155	0.4163
SOCIETE GENERALE does not Granger Cause FEDERAL REP GERMANY	1.75904	0.1556
KINGDOM OF SPAIN does not Granger Cause SOCIETE GENERALE	2.81569	0.0398
SOCIETE GENERALE does not Granger Cause KINGDOM OF SPAIN	2.11716	0.0986
REPUBLIC OF ITALY does not Granger Cause SOCIETE GENERALE	2.63705	0.0503
SOCIETE GENERALE does not Granger Cause REPUBLIC OF ITALY	4.36852	0.0051
KINGDOM OF BELGIUM does not Granger Cause SOCIETE GENERALE	1.80905	0.1460
SOCIETE GENERALE does not Granger Cause KINGDOM OF BELGIUM	3.78897	0.0110
REPUBLIC OF PORTUGAL does not Granger Cause SOCIETE GENERALE	5.89562	0.0007
SOCIETE GENERALE does not Granger Cause REPUBLIC OF PORTUGAL	8.59115	2.E-05
COMMERZBANK AG does not Granger Cause DEUTSCHE BANK AG	1.72903	0.1616
DEUTSCHE BANK AG does not Granger Cause COMMERZBANK AG	0.62181	0.6015
BANCO DE SABADELL SA does not Granger Cause DEUTSCHE BANK AG	3.61235	0.0139
DEUTSCHE BANK AG does not Granger Cause BANCO DE SABADELL SA	1.52276	0.2091
BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG	2.56951	0.0549
DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA	0.99518	0.3957
BANCO POP ESPANOL SA does not Granger Cause DEUTSCHE BANK AG	0.74698	0.5250
DEUTSCHE BANK AG does not Granger Cause BANCO POP ESPANOL SA	0.48387	0.6938



BANCA MDP DI SIENA SPA does not Granger Cause DEUTSCHE BANK AG	0.75672	0.5194
DEUTSCHE BANK AG does not Granger Cause BANCA MDP DI SIENA SPA	0.93566	0.4240
DEXIA CREDIT LOCAL does not Granger Cause DEUTSCHE BANK AG	1.61628	0.1861
DEUTSCHE BANK AG does not Granger Cause DEXIA CREDIT LOCAL	6.46456	0.0003
KBC BANK does not Granger Cause DEUTSCHE BANK AG	3.09866	0.0274
DEUTSCHE BANK AG does not Granger Cause KBC BANK	3.93846	0.0090
BANCO COMR PORTUGUES does not Granger Cause DEUTSCHE BANK AG	2.85604	0.0377
DEUTSCHE BANK AG does not Granger Cause BANCO COMR PORTUGUES	2.66607	0.0484
BANCO ESPIRITO SANTO SA does not Granger Cause DEUTSCHE BANK AG	1.82836	0.1425
DEUTSCHE BANK AG does not Granger Cause BANCO ESPIRITO SANTO SA	1.30178	0.2744
NAT BK OF GREECE SA does not Granger Cause DEUTSCHE BANK AG	2.91926	0.0347
DEUTSCHE BANK AG does not Granger Cause NAT BK OF GREECE SA	1.43733	0.2324
ALPHA BANK A.E. does not Granger Cause DEUTSCHE BANK AG	2.14333	0.0953
DEUTSCHE BANK AG does not Granger Cause ALPHA BANK A.E.	4.60765	0.0037
FRENCH REPUBLIC does not Granger Cause DEUTSCHE BANK AG	7.30656	0.0001
DEUTSCHE BANK AG does not Granger Cause FRENCH REPUBLIC	6.60133	0.0003
FEDERAL REP GERMANY does not Granger Cause DEUTSCHE BANK AG	1.96005	0.1205
DEUTSCHE BANK AG does not Granger Cause FEDERAL REP GERMANY	0.83348	0.4766
KINGDOM OF SPAIN does not Granger Cause DEUTSCHE BANK AG	2.93936	0.0338
DEUTSCHE BANK AG does not Granger Cause KINGDOM OF SPAIN	4.19127	0.0065
REPUBLIC OF ITALY does not Granger Cause DEUTSCHE BANK AG	3.47655	0.0167
DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF ITALY	5.56570	0.0010
KINGDOM OF BELGIUM does not Granger Cause DEUTSCHE BANK AG	3.45285	0.0172
DEUTSCHE BANK AG does not Granger Cause KINGDOM OF BELGIUM	7.30302	0.0001
REPUBLIC OF PORTUGAL does not Granger Cause DEUTSCHE BANK AG	6.01597	0.0006
DEUTSCHE BANK AG does not Granger Cause REPUBLIC OF PORTUGAL	9.84883	4.E-06
BANCO DE SABADELL SA does not Granger Cause COMMERZBANK AG	3.88191	0.0097
COMMERZBANK AG does not Granger Cause BANCO DE SABADELL SA	2.87570	0.0368
BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG	4.72115	0.0032
COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA	2.03366	0.1097
BANCO POP ESPANOL SA does not Granger Cause COMMERZBANK AG	0.34789	0.7907

COMMERZBANK AG does not Granger Cause BANCO POP ESPANOL SA	0.63461	0.5933
BANCA MDP DI SIENA SPA does not Granger Cause COMMERZBANK AG	0.39490	0.7568
COMMERZBANK AG does not Granger Cause BANCA MDP DI SIENA SPA	1.76469	0.1545
DEXIA CREDIT LOCAL does not Granger Cause COMMERZBANK AG	0.91814	0.4327
COMMERZBANK AG does not Granger Cause DEXIA CREDIT LOCAL	8.61558	2.E-05
KBC BANK does not Granger Cause COMMERZBANK AG	1.13924	0.3338
COMMERZBANK AG does not Granger Cause KBC BANK	3.49418	0.0163
BANCO COMR PORTUGUES does not Granger Cause COMMERZBANK AG	4.32174	0.0054
COMMERZBANK AG does not Granger Cause BANCO COMR PORTUGUES	2.38531	0.0697
BANCO ESPIRITO SANTO SA does not Granger Cause COMMERZBANK AG	5.04785	0.0021
COMMERZBANK AG does not Granger Cause BANCO ESPIRITO SANTO SA	2.37545	0.0706
NAT BK OF GRECE SA does not Granger Cause COMMERZBANK AG	3.65013	0.0132
COMMERZBANK AG does not Granger Cause NAT BK OF GRECE SA	1.28588	0.2798
ALPHA BANK A.E. does not Granger Cause COMMERZBANK AG	2.52172	0.0584
COMMERZBANK AG does not Granger Cause ALPHA BANK A.E.	8.82850	1.E-05
FRENCH REPUBLIC does not Granger Cause COMMERZBANK AG	4.04477	0.0078
COMMERZBANK AG does not Granger Cause FRENCH REPUBLIC	4.67587	0.0034
FEDERAL REP GERMANY does not Granger Cause COMMERZBANK AG	0.73386	0.5327
COMMERZBANK AG does not Granger Cause FEDERAL REP GERMANY	0.55218	0.6471
KINGDOM OF SPAIN does not Granger Cause COMMERZBANK AG	7.02702	0.0001
COMMERZBANK AG does not Granger Cause KINGDOM OF SPAIN	4.34767	0.0052
REPUBLIC OF ITALY does not Granger Cause COMMERZBANK AG	2.60141	0.0527
COMMERZBANK AG does not Granger Cause REPUBLIC OF ITALY	5.61070	0.0010
KINGDOM OF BELGIUM does not Granger Cause COMMERZBANK AG	2.80469	0.0404
COMMERZBANK AG does not Granger Cause KINGDOM OF BELGIUM	8.01899	4.E-05
REPUBLIC OF PORTUGAL does not Granger Cause COMMERZBANK AG	7.66471	6.E-05
COMMERZBANK AG does not Granger Cause REPUBLIC OF PORTUGAL	10.2500	2.E-06
BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA	2.81184	0.0400
BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA	2.10212	0.1005
BANCO POP ESPANOL SA does not Granger Cause BANCO DE SABADELL SA	0.58827	0.6232
BANCO DE SABADELL SA does not Granger Cause BANCO POP ESPANOL SA	1.88272	0.1330

BANCA MDP DI SIENA SPA does not Granger Cause BANCO DE SABADELL SA	5.63394	0.0009
BANCO DE SABADELL SA does not Granger Cause BANCA MDP DI SIENA SPA	1.27592	0.2832
DEXIA CREDIT LOCAL does not Granger Cause BANCO DE SABADELL SA	2.45877	0.0634
BANCO DE SABADELL SA does not Granger Cause DEXIA CREDIT LOCAL	9.45543	6.E-06
KBC BANK does not Granger Cause BANCO DE SABADELL SA	3.24784	0.0225
BANCO DE SABADELL SA does not Granger Cause KBC BANK	3.89494	0.0096
BANCO COMR PORTUGUES does not Granger Cause BANCO DE SABADELL SA	2.77718	0.0418
BANCO DE SABADELL SA does not Granger Cause BANCO COMR PORTUGUES	2.66138	0.0487
BANCO ESPIRITO SANTO SA does not Granger Cause BANCO DE SABADELL SA	8.26021	3.E-05
BANCO DE SABADELL SA does not Granger Cause BANCO ESPIRITO SANTO SA	4.69131	0.0033
NAT BK OF GREECE SA does not Granger Cause BANCO DE SABADELL SA	1.74369	0.1586
BANCO DE SABADELL SA does not Granger Cause NAT BK OF GREECE SA	2.98515	0.0319
ALPHA BANK A.E. does not Granger Cause BANCO DE SABADELL SA	1.90026	0.1301
BANCO DE SABADELL SA does not Granger Cause ALPHA BANK A.E.	5.49541	0.0011
FRENCH REPUBLIC does not Granger Cause BANCO DE SABADELL SA	3.38029	0.0189
BANCO DE SABADELL SA does not Granger Cause FRENCH REPUBLIC	1.39237	0.2457
FEDERAL REP GERMANY does not Granger Cause BANCO DE SABADELL SA	0.00691	0.3992
BANCO DE SABADELL SA does not Granger Cause FEDERAL REP GERMANY	1.56123	0.1994
KINGDOM OF SPAIN does not Granger Cause BANCO DE SABADELL SA	9.84652	4.E-06
BANCO DE SABADELL SA does not Granger Cause KINGDOM OF SPAIN	2.74319	0.0437
REPUBLIC OF ITALY does not Granger Cause BANCO DE SABADELL SA	5.03783	0.0021
BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF ITALY	3.19603	0.0241
KINGDOM OF BELGIUM does not Granger Cause BANCO DE SABADELL SA	3.72582	0.0120
BANCO DE SABADELL SA does not Granger Cause KINGDOM OF BELGIUM	1.27815	0.2824
REPUBLIC OF PORTUGAL does not Granger Cause BANCO DE SABADELL SA	7.92025	5.E-05
BANCO DE SABADELL SA does not Granger Cause REPUBLIC OF PORTUGAL	7.76071	6.E-05
BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA	0.46155	0.7094
BANCO POP ESPANOL SA does not Granger Cause BANCO POP ESPANOL SA	0.99476	0.3959
BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA	4.79238	0.0029
BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA	1.05429	0.3692
DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA	3.03767	0.0297

BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL	9.08040	1.E-05
KBC BANK does not Granger Cause BANCO POP ESPANOL SA	3.75914	0.0115
BANCO POP ESPANOL SA does not Granger Cause KBC BANK	2.73664	0.0441
BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA	2.85534	0.0378
BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES	1.56424	0.1986
BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA	9.41082	7.E-06
BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA	3.39908	0.0185
NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA	1.49848	0.2155
BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA	3.55490	0.0150
ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA	1.75877	0.1556
BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E.	6.08238	0.0005
FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA	2.20284	0.0883
BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC	0.62903	0.5969
FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA	0.36023	0.7818
BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY	0.84576	0.4700
KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA	12.0501	2.E-07
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN	1.22519	0.3011
REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA	5.32542	0.0014
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY	2.46840	0.0626
KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA	2.85254	0.0379
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM	0.71962	0.5411
REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA	7.61198	7.E-05
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL	2.97905	0.0321
BANCA MDP DI SIENA SPA does not Granger Cause BANCO POP ESPANOL SA	0.88392	0.4500
BANCO POP ESPANOL SA does not Granger Cause BANCA MDP DI SIENA SPA	0.55718	0.6438
DEXIA CREDIT LOCAL does not Granger Cause BANCO POP ESPANOL SA	1.38936	0.2466
BANCO POP ESPANOL SA does not Granger Cause DEXIA CREDIT LOCAL	0.19114	0.9024
KBC BANK does not Granger Cause BANCO POP ESPANOL SA	0.14553	0.9325
BANCO POP ESPANOL SA does not Granger Cause KBC BANK	0.38138	0.7665
BANCO COMR PORTUGUES does not Granger Cause BANCO POP ESPANOL SA	2.02144	0.1114
BANCO POP ESPANOL SA does not Granger Cause BANCO COMR PORTUGUES	0.85249	0.4664

BANCO ESPIRITO SANTO SA does not Granger Cause BANCO POP ESPANOL SA	1.38104	0.2491
BANCO POP ESPANOL SA does not Granger Cause BANCO ESPIRITO SANTO SA	1.03464	0.3778
NAT BK OF GREECE SA does not Granger Cause BANCO POP ESPANOL SA	1.37260	0.2517
BANCO POP ESPANOL SA does not Granger Cause NAT BK OF GREECE SA	0.94678	0.4186
ALPHA BANK A.E. does not Granger Cause BANCO POP ESPANOL SA	0.97467	0.4053
BANCO POP ESPANOL SA does not Granger Cause ALPHA BANK A.E.	2.04056	0.1088
FRENCH REPUBLIC does not Granger Cause BANCO POP ESPANOL SA	1.67788	0.1723
BANCO POP ESPANOL SA does not Granger Cause FRENCH REPUBLIC	0.90432	0.4396
FEDERAL REP GERMANY does not Granger Cause BANCO POP ESPANOL SA	2.25706	0.0823
BANCO POP ESPANOL SA does not Granger Cause FEDERAL REP GERMANY	0.37849	0.7686
KINGDOM OF SPAIN does not Granger Cause BANCO POP ESPANOL SA	1.67840	0.1722
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF SPAIN	0.81087	0.4889
REPUBLIC OF ITALY does not Granger Cause BANCO POP ESPANOL SA	1.65084	0.1782
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF ITALY	1.24389	0.2944
KINGDOM OF BELGIUM does not Granger Cause BANCO POP ESPANOL SA	1.41435	0.2391
BANCO POP ESPANOL SA does not Granger Cause KINGDOM OF BELGIUM	0.81716	0.4854
REPUBLIC OF PORTUGAL does not Granger Cause BANCO POP ESPANOL SA	1.15946	0.3258
BANCO POP ESPANOL SA does not Granger Cause REPUBLIC OF PORTUGAL	1.33764	0.2627
DEXIA CREDIT LOCAL does not Granger Cause BANCA MDP DI SIENA SPA	0.20311	0.8942
BANCA MDP DI SIENA SPA does not Granger Cause DEXIA CREDIT LOCAL	7.82142	5.E-05
KBC BANK does not Granger Cause BANCA MDP DI SIENA SPA	0.84321	0.4713
BANCA MDP DI SIENA SPA does not Granger Cause KBC BANK	1.93651	0.1242
BANCO COMR PORTUGUES does not Granger Cause BANCA MDP DI SIENA SPA	1.30930	0.2719
BANCA MDP DI SIENA SPA does not Granger Cause BANCO COMR PORTUGUES	1.43854	0.2321
BANCO ESPIRITO SANTO SA does not Granger Cause BANCA MDP DI SIENA SPA	1.24712	0.2932
BANCA MDP DI SIENA SPA does not Granger Cause BANCO ESPIRITO SANTO SA	1.77736	0.1520
NAT BK OF GREECE SA does not Granger Cause BANCA MDP DI SIENA SPA	1.46453	0.2248
BANCA MDP DI SIENA SPA does not Granger Cause NAT BK OF GREECE SA	0.74871	0.5240
ALPHA BANK A.E. does not Granger Cause BANCA MDP DI SIENA SPA	1.91779	0.1272
BANCA MDP DI SIENA SPA does not Granger Cause ALPHA BANK A.E.	6.45815	0.0003
FRENCH REPUBLIC does not Granger Cause BANCA MDP DI SIENA SPA	2.12159	0.0980

BANCA MDP DI SIENA SPA does not Granger Cause FRENCH REPUBLIC	1.42236	0.2368
FEDERAL REP GERMANY does not Granger Cause BANCA MDP DI SIENA SPA	1.44604	0.2299
BANCA MDP DI SIENA SPA does not Granger Cause FEDERAL REP GERMANY	1.18206	0.3171
KINGDOM OF SPAIN does not Granger Cause BANCA MDP DI SIENA SPA	3.11689	0.0268
BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF SPAIN	1.91273	0.1280
REPUBLIC OF ITALY does not Granger Cause BANCA MDP DI SIENA SPA	1.34195	0.2613
BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF ITALY	2.92322	0.0346
KINGDOM OF BELGIUM does not Granger Cause BANCA MDP DI SIENA SPA	2.38399	0.0699
BANCA MDP DI SIENA SPA does not Granger Cause KINGDOM OF BELGIUM	1.69899	0.1678
REPUBLIC OF PORTUGAL does not Granger Cause BANCA MDP DI SIENA SPA	2.79408	0.0409
BANCA MDP DI SIENA SPA does not Granger Cause REPUBLIC OF PORTUGAL	4.86146	0.0026
KBC BANK does not Granger Cause DEXIA CREDIT LOCAL	1.54001	0.2047
DEXIA CREDIT LOCAL does not Granger Cause KBC BANK	2.71343	0.0455
BANCO COMR PORTUGUES does not Granger Cause DEXIA CREDIT LOCAL	5.59420	0.0010
DEXIA CREDIT LOCAL does not Granger Cause BANCO COMR PORTUGUES	3.94194	0.0090
BANCO ESPIRITO SANTO SA does not Granger Cause DEXIA CREDIT LOCAL	4.63569	0.0036
DEXIA CREDIT LOCAL does not Granger Cause BANCO ESPIRITO SANTO SA	2.83079	0.0390
NAT BK OF GREECE SA does not Granger Cause DEXIA CREDIT LOCAL	4.77195	0.0030
DEXIA CREDIT LOCAL does not Granger Cause NAT BK OF GREECE SA	4.07882	0.0075
ALPHA BANK A.E. does not Granger Cause DEXIA CREDIT LOCAL	4.08342	0.0074
DEXIA CREDIT LOCAL does not Granger Cause ALPHA BANK A.E.	7.43452	9.E-05
FRENCH REPUBLIC does not Granger Cause DEXIA CREDIT LOCAL	6.43920	0.0003
DEXIA CREDIT LOCAL does not Granger Cause FRENCH REPUBLIC	1.10091	0.3494
FEDERAL REP GERMANY does not Granger Cause DEXIA CREDIT LOCAL	1.44304	0.2308
DEXIA CREDIT LOCAL does not Granger Cause FEDERAL REP GERMANY	0.70900	0.5474
KINGDOM OF SPAIN does not Granger Cause DEXIA CREDIT LOCAL	14.2638	1.E-08
DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF SPAIN	2.53714	0.0573
REPUBLIC OF ITALY does not Granger Cause DEXIA CREDIT LOCAL	16.8551	5.E-10
DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF ITALY	1.61414	0.1866
KINGDOM OF BELGIUM does not Granger Cause DEXIA CREDIT LOCAL	6.08091	0.0005
DEXIA CREDIT LOCAL does not Granger Cause KINGDOM OF BELGIUM	2.64280	0.0499

REPUBLIC OF PORTUGAL does not Granger Cause DEXIA CREDIT LOCAL	5.95641	0.0006
DEXIA CREDIT LOCAL does not Granger Cause REPUBLIC OF PORTUGAL	3.55040	0.0151
BANCO COMR PORTUGUES does not Granger Cause KBC BANK	4.70846	0.0032
KBC BANK does not Granger Cause BANCO COMR PORTUGUES	3.05464	0.0291
BANCO ESPIRITO SANTO SA does not Granger Cause KBC BANK	2.69310	0.0467
KBC BANK does not Granger Cause BANCO ESPIRITO SANTO SA	2.16619	0.0926
NAT BK OF GREECE SA does not Granger Cause KBC BANK	1.58991	0.1923
KBC BANK does not Granger Cause NAT BK OF GREECE SA	0.95001	0.4170
ALPHA BANK A.E. does not Granger Cause KBC BANK	1.23672	0.2969
KBC BANK does not Granger Cause ALPHA BANK A.E.	4.14001	0.0069
FRENCH REPUBLIC does not Granger Cause KBC BANK	6.01452	0.0006
KBC BANK does not Granger Cause FRENCH REPUBLIC	3.93884	0.0090
FEDERAL REP GERMANY does not Granger Cause KBC BANK	4.30625	0.0055
KBC BANK does not Granger Cause FEDERAL REP GERMANY	1.01820	0.3852
KINGDOM OF SPAIN does not Granger Cause KBC BANK	1.68721	0.1703
KBC BANK does not Granger Cause KINGDOM OF SPAIN	3.11471	0.0269
REPUBLIC OF ITALY does not Granger Cause KBC BANK	1.90665	0.1290
KBC BANK does not Granger Cause REPUBLIC OF ITALY	1.74093	0.1592
KINGDOM OF BELGIUM does not Granger Cause KBC BANK	6.86117	0.0002
KBC BANK does not Granger Cause KINGDOM OF BELGIUM	5.76469	0.0008
REPUBLIC OF PORTUGAL does not Granger Cause KBC BANK	5.27955	0.0015
KBC BANK does not Granger Cause REPUBLIC OF PORTUGAL	1.77269	0.1529
BANCO ESPIRITO SANTO SA does not Granger Cause BANCO COMR PORTUGUES	0.72948	0.5353
BANCO COMR PORTUGUES does not Granger Cause BANCO ESPIRITO SANTO SA	0.44727	0.7194
NAT BK OF GREECE SA does not Granger Cause BANCO COMR PORTUGUES	3.36689	0.0193
BANCO COMR PORTUGUES does not Granger Cause NAT BK OF GREECE SA	10.8775	1.E-06
ALPHA BANK A.E. does not Granger Cause BANCO COMR PORTUGUES	1.97936	0.1176
BANCO COMR PORTUGUES does not Granger Cause ALPHA BANK A.E.	13.0179	6.E-08
FRENCH REPUBLIC does not Granger Cause BANCO COMR PORTUGUES	1.94381	0.1231
BANCO COMR PORTUGUES does not Granger Cause FRENCH REPUBLIC	6.89773	0.0002
FEDERAL REP GERMANY does not Granger Cause BANCO COMR PORTUGUES	0.06907	0.9764

BANCO COMR PORTUGUES does not Granger Cause FEDERAL REP GERMANY	1.42120	0.2371
KINGDOM OF SPAIN does not Granger Cause BANCO COMR PORTUGUES	1.00947	0.3891
BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF SPAIN	2.52609	0.0581
REPUBLIC OF ITALY does not Granger Cause BANCO COMR PORTUGUES	1.17559	0.3196
BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF ITALY	6.92956	0.0002
KINGDOM OF BELGIUM does not Granger Cause BANCO COMR PORTUGUES	0.85322	0.4660
BANCO COMR PORTUGUES does not Granger Cause KINGDOM OF BELGIUM	7.42547	9.E-05
REPUBLIC OF PORTUGAL does not Granger Cause BANCO COMR PORTUGUES	0.79559	0.4973
BANCO COMR PORTUGUES does not Granger Cause REPUBLIC OF PORTUGAL	5.33149	0.0014
NAT BK OF GREECE SA does not Granger Cause BANCO ESPIRITO SANTO SA	0.80468	0.4923
BANCO ESPIRITO SANTO SA does not Granger Cause NAT BK OF GREECE SA	5.46179	0.0012
ALPHA BANK A.E. does not Granger Cause BANCO ESPIRITO SANTO SA	0.66686	0.5731
BANCO ESPIRITO SANTO SA does not Granger Cause ALPHA BANK A.E.	9.60810	5.E-06
FRENCH REPUBLIC does not Granger Cause BANCO ESPIRITO SANTO SA	0.01904	0.9964
BANCO ESPIRITO SANTO SA does not Granger Cause FRENCH REPUBLIC	3.07853	0.0282
FEDERAL REP GERMANY does not Granger Cause BANCO ESPIRITO SANTO SA	1.40670	0.2414
BANCO ESPIRITO SANTO SA does not Granger Cause FEDERAL REP GERMANY	0.84399	0.4709
KINGDOM OF SPAIN does not Granger Cause BANCO ESPIRITO SANTO SA	0.53090	0.6615
BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF SPAIN	1.51030	0.2124
REPUBLIC OF ITALY does not Granger Cause BANCO ESPIRITO SANTO SA	0.44838	0.7187
BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF ITALY	2.65950	0.0488
KINGDOM OF BELGIUM does not Granger Cause BANCO ESPIRITO SANTO SA	0.33546	0.7997
BANCO ESPIRITO SANTO SA does not Granger Cause KINGDOM OF BELGIUM	1.31859	0.2689
REPUBLIC OF PORTUGAL does not Granger Cause BANCO ESPIRITO SANTO SA	1.14460	0.3317
BANCO ESPIRITO SANTO SA does not Granger Cause REPUBLIC OF PORTUGAL	4.07639	0.0075
ALPHA BANK A.E. does not Granger Cause NAT BK OF GREECE SA	10.3430	2.E-06
NAT BK OF GREECE SA does not Granger Cause ALPHA BANK A.E.	14.5007	1.E-08
FRENCH REPUBLIC does not Granger Cause NAT BK OF GREECE SA	4.80005	0.0029
NAT BK OF GREECE SA does not Granger Cause FRENCH REPUBLIC	2.05543	0.1067
FEDERAL REP GERMANY does not Granger Cause NAT BK OF GREECE SA	3.04125	0.0296
NAT BK OF GREECE SA does not Granger Cause FEDERAL REP GERMANY	2.71773	0.0452



KINGDOM OF SPAIN does not Granger Cause NAT BK OF GREECE SA	1.09320	0.3526
NAT BK OF GREECE SA does not Granger Cause KINGDOM OF SPAIN	3.92373	0.0092
REPUBLIC OF ITALY does not Granger Cause NAT BK OF GREECE SA	1.02294	0.3831
NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF ITALY	6.55137	0.0003
KINGDOM OF BELGIUM does not Granger Cause NAT BK OF GREECE SA	6.58101	0.0003
NAT BK OF GREECE SA does not Granger Cause KINGDOM OF BELGIUM	1.92105	0.1267
REPUBLIC OF PORTUGAL does not Granger Cause NAT BK OF GREECE SA	11.2047	6.E-07
NAT BK OF GREECE SA does not Granger Cause REPUBLIC OF PORTUGAL	1.34237	0.2612
FRENCH REPUBLIC does not Granger Cause ALPHA BANK A.E.	5.80675	0.0008
ALPHA BANK A.E. does not Granger Cause FRENCH REPUBLIC	0.78514	0.5032
FEDERAL REP GERMANY does not Granger Cause ALPHA BANK A.E.	2.74608	0.0436
ALPHA BANK A.E. does not Granger Cause FEDERAL REP GERMANY	0.13208	0.9409
KINGDOM OF SPAIN does not Granger Cause ALPHA BANK A.E.	6.85213	0.0002
ALPHA BANK A.E. does not Granger Cause KINGDOM OF SPAIN	1.11701	0.3428
REPUBLIC OF ITALY does not Granger Cause ALPHA BANK A.E.	6.94310	0.0002
ALPHA BANK A.E. does not Granger Cause REPUBLIC OF ITALY	1.60137	0.1896
KINGDOM OF BELGIUM does not Granger Cause ALPHA BANK A.E.	6.00345	0.0006
ALPHA BANK A.E. does not Granger Cause KINGDOM OF BELGIUM	0.35190	0.7878
REPUBLIC OF PORTUGAL does not Granger Cause ALPHA BANK A.E.	7.00593	0.0002
ALPHA BANK A.E. does not Granger Cause REPUBLIC OF PORTUGAL	0.77735	0.5076
FEDERAL REP GERMANY does not Granger Cause FRENCH REPUBLIC	1.75293	0.1568
FRENCH REPUBLIC does not Granger Cause FEDERAL REP GERMANY	1.05117	0.3705
KINGDOM OF SPAIN does not Granger Cause FRENCH REPUBLIC	0.79939	0.4952
FRENCH REPUBLIC does not Granger Cause KINGDOM OF SPAIN	1.92604	0.1259
REPUBLIC OF ITALY does not Granger Cause FRENCH REPUBLIC	1.62308	0.1845
FRENCH REPUBLIC does not Granger Cause REPUBLIC OF ITALY	2.81289	0.0399
KINGDOM OF BELGIUM does not Granger Cause FRENCH REPUBLIC	1.20981	0.3067
FRENCH REPUBLIC does not Granger Cause KINGDOM OF BELGIUM	0.12621	0.9445
REPUBLIC OF PORTUGAL does not Granger Cause FRENCH REPUBLIC	5.22739	0.0016
FRENCH REPUBLIC does not Granger Cause REPUBLIC OF PORTUGAL	3.92211	0.0092
KINGDOM OF SPAIN does not Granger Cause FEDERAL REP GERMANY	0.67741	0.5666

FEDERAL REP GERMANY does not Granger Cause KINGDOM OF SPAIN	2.49307	0.0606
REPUBLIC OF ITALY does not Granger Cause FEDERAL REP GERMANY	0.33777	0.7980
FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF ITALY	3.13782	0.0261
KINGDOM OF BELGIUM does not Granger Cause FEDERAL REP GERMANY	1.13082	0.3372
FEDERAL REP GERMANY does not Granger Cause KINGDOM OF BELGIUM	2.86539	0.0373
REPUBLIC OF PORTUGAL does not Granger Cause FEDERAL REP GERMANY	0.90855	0.4375
FEDERAL REP GERMANY does not Granger Cause REPUBLIC OF PORTUGAL	3.87753	0.0098
REPUBLIC OF ITALY does not Granger Cause KINGDOM OF SPAIN	0.19914	0.8969
KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF ITALY	1.65352	0.1776
KINGDOM OF BELGIUM does not Granger Cause KINGDOM OF SPAIN	3.21849	0.0234
KINGDOM OF SPAIN does not Granger Cause KINGDOM OF BELGIUM	1.64506	0.1795
REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF SPAIN	6.73411	0.0002
KINGDOM OF SPAIN does not Granger Cause REPUBLIC OF PORTUGAL	5.15193	0.0018
KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF ITALY	5.79628	0.0008
REPUBLIC OF ITALY does not Granger Cause KINGDOM OF BELGIUM	2.63183	0.0506
REPUBLIC OF PORTUGAL does not Granger Cause REPUBLIC OF ITALY	7.40328	9.E-05
REPUBLIC OF ITALY does not Granger Cause REPUBLIC OF PORTUGAL	4.99411	0.0022
REPUBLIC OF PORTUGAL does not Granger Cause KINGDOM OF BELGIUM	1.85602	0.1376
KINGDOM OF BELGIUM does not Granger Cause REPUBLIC OF PORTUGAL	3.59864	0.0142



