



# Three Essays on Currency Union and Trade

Laura Lebastard

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# Three Essays on Currency Union and Trade

Thèse de doctorat de l'Université Paris-Saclay  
préparée à l'Université Paris-Sud

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Thèse présentée et soutenue à Sceaux, le 6 décembre 2017, par

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*Je dédie cette thèse à l'Union Européenne*

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*"Hâtez-vous lentement; et, sans perdre courage,  
Vingt fois sur le métier remettez votre ouvrage :  
Polissez-le sans cesse et le repolissez ;  
Ajoutez quelquefois, et souvent effacez."*

Nicolas Boileau, *L'Art poétique*, 1674



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# Résumé en français

Dans le cadre de cette thèse, j'étudie en profondeur le lien entre les unions monétaires et le commerce, et je détermine les mécanismes sous-jacents aux effets significatifs découverts par la littérature. J'étudie ce lien dans les deux directions: comment les unions monétaires accroissent le commerce et comment le commerce met en place les conditions appropriées pour une union monétaire optimale.

L'idée de mon premier chapitre est de mesurer l'effet de chaque caractéristique de l'union monétaire (transparence des prix, impossibilité de dévaluer et absence de coûts de transaction) sur le commerce. Je constate que l'absence d'incertitude quant au taux de change est la caractéristique ayant le plus grand effet sur le commerce. En effet, contrairement au taux de change fixe, les unions monétaires s'engagent à maintenir un niveau du change fixe irrévocable. La crédibilité d'un tel engagement est extrêmement élevée, car le coût de la sortie d'une union monétaire et ses conséquences sont énormes. L'exemple de la Grèce, qui aurait eu besoin d'une dévaluation compétitive, mais qui a préféré payer un prix élevé en restant dans la zone euro, est un bon exemple de la force de cet engagement.

J'étudie ensuite l'effet des unions monétaires, et plus particulièrement de l'euro, pendant la crise économique de 2008. Parmi toutes les caractéristiques des unions monétaires, l'absence de volatilité des taux de change malgré la pression des marchés est celle qui fait la différence en période de crise économique. En effet, en temps de crise, les taux de change sont trois à quatre fois plus volatils que d'habitude, et l'absence de volatilité donne une prime aux membres d'une union monétaire.

Mon dernier chapitre change de perspective, car il étudie comment le commerce crée un environnement propice aux unions monétaires. J'étudie spécifiquement le commerce vertical, qui implique que les différentes étapes de production d'un bien se situent dans différents pays. Cette nouvelle organisation de la production favorise la transmission des chocs entre les pays partageant des chaînes de valeur mondiales. Il en résulte que les cycles économiques sont plus corrélés, ce qui rend les unions monétaires plus attrayantes. En effet, comme les chocs sont symétriques entre les pays, les politiques monétaires optimales sont les mêmes de part et d'autre de la frontière, il ne serait donc pas problématique qu'une seule banque centrale opère dans les deux pays.

Il est très important d'étudier les mécanismes par lesquels le commerce et les unions monétaires s'influencent mutuellement, car cela permet de concevoir de meilleures politiques publiques. En effet, savoir quelles sont les caractéristiques des unions monétaires qui importent pour le commerce permet aux politiques publiques de se concentrer sur les bons canaux.

## **Chapitre 1: Distinguer les effets de l'union monétaire sur le commerce**

Andrew Rose a relancé l'intérêt pour les unions monétaires avec son célèbre article "One money, One Market" (2000). Il affirme que les unions monétaires augmentent le commerce de 300 %. De nombreux articles ont testé la robustesse de ce résultat, concluant que les unions monétaires accroissent plutôt le commerce de 30 à 90 %, et la zone euro seulement de 2 à 30%. L'un des grands enjeux de cette littérature est de régler un problème d'endogénéité: les pays auraient pu choisir de former une union monétaire parce qu'ils commerciaient déjà beaucoup.

La littérature est très abondante sur l'effet des unions monétaires sur le commerce, mais aucune étude n'a distingué l'effet de chaque caractéristique de l'union monétaire sur l'augmentation du commerce observée. Trois caractéristiques de l'union monétaire pourraient jouer un rôle dans l'augmentation des échanges: la transparence des prix, les coûts de conversion et l'impossibilité de dévaluer. Il est important d'avoir une compréhension subtile des mécanismes en jeu derrière cette augmentation pour savoir quels sont les déterminants du commerce. En effet, cela permettrait aux décideurs politiques de savoir de la transparence des prix et de la fixation du taux de



change, laquelle a favorisé le commerce. Le premier chapitre de cette thèse aborde la question de la distinction de l'impact de chacune des caractéristiques de l'union monétaire sur le commerce.

Dans le premier chapitre de cette thèse, je profite des différents types de régimes de change fixe pour distinguer l'effet de chaque différence sur le commerce. Tout d'abord, je construis un modèle théorique micro-fondé pour expliquer comment les différentes caractéristiques des régimes de change (principalement le coût du commerce et la possibilité de dévaluation) influent sur le commerce. Mon modèle explique les différences entre les effets à court terme et à long terme sur le commerce de chaque régime en permettant aux entreprises de tenir compte de la longévité d'un ancrage pour évaluer sa crédibilité.

Mon modèle est lié à Melitz (2003). Ce modèle a l'avantage majeur d'expliquer simplement et intuitivement pourquoi toutes les entreprises n'exportent pas. J'ai choisi de baser mon modèle sur celui de Melitz parce que les mécanismes mis en évidence pour expliquer les micro-décisions d'une entreprise d'exporter ou non peuvent être utilisés pour expliquer le commerce bilatéral agrégé entre deux pays, en fonction des coûts commerciaux (comme les régimes de change). Je modifie la fonction d'utilité de l'entreprise en ajoutant une désutilité à la volatilité des bénéfices et en modulant le coût des échanges en fonction du régime de change, pour rendre le modèle plus réaliste. Je compare alors mes résultats à ceux de Melitz. Bien que je n'utilise que des données macroéconomiques dans mon analyse empirique, l'utilisation d'un modèle micro-fondé me semble appropriée car il permet de mieux comprendre les mécanismes impliqués.

Mon modèle prédit que les unions monétaires échangent davantage que les régimes de change fixe classique et un pour un. Il apparaît que le commerce des unions monétaires est stable au fil du temps, tandis que le commerce des régimes de change fixe augmente à mesure que leur crédibilité s'accroît. Par conséquent, les niveaux de commerce entre ces régimes convergent. De plus, à ma connaissance, mon modèle est le premier à expliquer pourquoi les régimes de change fixe, flottant et classique ont des effets semblables sur le commerce au cours des premières années, mais pas en régime permanent. Pour résumer les prédictions du modèle:

Cas 1: si la sensibilité à la volatilité des firmes est élevée, le commerce augmente de façon monotone avec la crédibilité du régime: l'union monétaire devrait donc augmenter le plus le

commerce, puis le régime de change fixe un pour un, le régime de change fixe classique, et enfin le régime de change flottant.

Cas 2: si la sensibilité à la volatilité des entreprises est faible, le commerce est le plus élevé pour les pays liés par un régime de change fixe crédible, mais il est également élevé (mais moins élevé) pour les pays dont le taux de change est le plus volatil (taux de change flottant). La raison est que l'augmentation de l'utilité pour l'entreprise moyenne dans le pays dont la monnaie se déprécie plus que compense la baisse de l'utilité pour l'entreprise moyenne dans le pays dont la monnaie s'apprécie. Dans ce cas, le régime de change flottant n'entraîne pas nécessairement un niveau d'échanges inférieur au régime de change fixe classique.

L'union monétaire permet aux petites entreprises d'exporter parce que les recettes minimum pour exporter sont plus faibles que pour les autres régimes.

En régime permanent, lorsque le régime de change gagne en crédibilité, seules les différences de coûts commerciaux expliquent les différences de niveau de commerce. Le modèle prédit qu'à l'état stationnaire, les régimes de change fixe ont un effet plus important sur le commerce que les régimes de change flottant.

Je vérifie ensuite empiriquement les prédictions de mon modèle et j'estime l'importance de l'influence des caractéristiques de chaque union monétaire. Pour ce faire, je compare les effets des différents régimes sur le commerce à différentes périodes de maturité afin de mesurer l'effet de chaque caractéristique à chaque étape. Je règle le problème des flux commerciaux nuls en utilisant un *Poisson Pseudo Maximum Likelihood*.

Ma méthodologie est basée sur le modèle de gravité, permettant de prédire le commerce entre deux pays, en fonction de la distance qui les sépare et de leur taille respective. J'inclus les effets fixes pays-temps, pour contrôler pour la croissance de l'activité économique. J'inclus les effets fixes paire de pays, qui capturent les variables spécifiques à une paire invariable dans le temps telles que la contiguïté des frontières, la distance, une langue commune ou des liens coloniaux. Je contrôle pour l'augmentation des échanges commerciaux découlant des traités de libre-échange en ajoutant une variable indiquant un accord de libre-échange. Enfin j'inclus une variable indiquant les unions monétaires, une variable indiquant les régimes de change fixe un pour un et une variable indiquant les régimes de change fixe classique. Ces variables indicatrices

me permettent de mesurer l'effet de chaque régime de change sur le commerce.

Cette régression souffre cependant d'un problème d'endogénéité: des pays, parce qu'ils commercent beaucoup, décident d'avoir une union monétaire ou un régime de change fixe un pour un. L'endogénéité potentielle n'est pas nécessairement captée par les effets fixes. Une façon de la capturer est d'utiliser une variable instrumentale.

J'utilise l'instrument développé par Barro et Tenreyro (2007). L'instrument exploite l'organisation en étoile du régime de change fixe. L'idée principale est d'utiliser les décisions indépendantes des pays de s'ancrer/être en union monétaire avec un pays principal. La probabilité que deux pays se rattachent au même pays d'ancrage est utilisée comme un instrument car elle est considérée comme exogène.

Je suis la même méthodologie que Barro et Tenreyro (2007) et j'estime la probabilité qu'un pays donné entre dans une union monétaire avec l'un des six principaux pays (Australie, France, Allemagne, Japon, Royaume-Uni et Etats-Unis) en utilisant un probit. Cette probabilité dépend de nombreux facteurs, comme la distance, les liens coloniaux, une langue commune, etc. Je calcule ensuite la probabilité conjointe que deux pays aient un point d'ancrage commun.

En utilisant la méthode des moindres carrés ordinaire, je constate que l'union monétaire accroît davantage le commerce que le régime de change fixe un pour un, leurs effets étant positif et significatif. Je ne trouve aucun effet du régime de change fixe classique par rapport au régime de change flottant. Les résultats sont conformes aux prédictions de mon modèle. Cependant, si l'on corrige les problèmes d'endogénéité, les effets du régime de change fixe un pour un deviennent non significatifs. Par ailleurs, les unions monétaires dès le début ont des effets très forts, alors que les régimes de change fixe classiques n'en ont aucun. Toutefois, à l'état d'équilibre, les effets des unions monétaires (qui demeurent stables au fil du temps) et des régimes de change fixe un pour un tendent à converger. Le régime de change fixe classique n'a d'effets (minimes) qu'après 15 ans, ce que mon modèle prédit également.

Mes résultats suggèrent que les régimes de change fixe un pour un ont une place à part dans la "famille des taux de change fixe". La différence entre le régime de change fixe un pour un et le régime de change fixe classique réside dans le fait qu'aucune conversion de prix n'est

nécessaire pour le régime de change fixe un pour un, alors que le régime de change fixe classique doit s'acquitter d'un coût de conversion supplémentaire. Lorsqu'un choc perturbe la balance commerciale, un pays avec un simple régime de change fixe dévalue sa monnaie pour rétablir l'équilibre, et la plupart du temps, il se ré-ancre à la même monnaie. Cependant, un pays qui a un régime de change fixe un pour un perd sa spécificité s'il dévalue. L'incitation est ainsi beaucoup plus forte de conserver l'ancrage. Par conséquent, le choc devrait être beaucoup plus important pour provoquer une dévaluation. Ceci explique la différence d'espérance de vie entre les deux types d'ancrage: elle est de 3 ans pour un ancrage classique, alors que les régimes de change fixe un pour un ont une durée de vie moyenne de 21 ans (contre 27 ans pour les unions monétaires). Cet écart implique potentiellement des différences fondamentales entre eux. Prenant en compte cette information, les investisseurs et les exportateurs agissent différemment et cela a un impact sur l'activité économique.

L'effet du régime de change fixe un pour un étant endogène, cela signifie que la crédibilité des unions monétaires a encore plus d'impact que ce que l'on pensait auparavant, car les effets sur le commerce ne proviennent pas de la fixité du taux de change ou de la transparence des prix. Le fait que l'effet de l'union monétaire sur le commerce découle de la crédibilité de son régime de change fixe est la principale contribution de ce chapitre.

## **Chapitre 2: L'euro a-t-il protégé ses membres de l'effondrement du commerce?**

La crise financière a fait chuter le produit intérieur brut mondial (PIB) de 4% et le commerce mondial de 15% (surréaction de 18 en 2009 contre 1,9 sur la période 1990-2008). Baldwin (2009) a déclaré que "le grand effondrement du commerce a été déclenché - et a contribué à être propagé - par la récession économique mondiale". Tous les pays pour lesquels l'Organisation Mondiale du Commerce a publié des données ont enregistré une baisse des importations et des exportations au cours du second semestre de 2008 et du premier semestre de 2009. L'Europe a été touchée en moyenne plus durement que le reste du monde par la grande crise du commerce, avec une chute des échanges de 25% entre 2008 et 2009. Les pays d'Europe de l'Est ont connu la plus forte baisse, en particulier les nouveaux membres de l'est de la zone euro, dont les échanges commerciaux ont chuté de 28 %. Curran (2009) a étudié l'Union européenne lors du grand effondrement commercial

et Shelburne (2010) les pays d'Europe de l'Est, mais pas spécifiquement la zone euro.

L'effet de l'euro sur le commerce a été largement étudié dans la littérature, avec une cinquantaine de publications en circulation. Selon ces études, la fourchette de l'effet positif de l'euro oscille entre 2 et 30 % (voir Rose, 2017 pour une analyse récente des métadonnées). Toutefois, à ma connaissance, personne jusqu'à présent n'a étudié l'effet de l'euro pendant une crise économique. Il n'est a priori pas évident de déterminer comment le commerce supplémentaire dû à l'introduction de la monnaie unique réagit à une crise. Est-il plus volatil, plus fragile? L'euro a-t-il protégé ses membres pendant le grand effondrement du commerce? La chute des échanges observée lors de la crise financière en Europe aurait-elle été plus importante sans l'euro? L'effet de l'euro est-il le même pour tous les secteurs? Pour répondre à ces questions, j'étudie dans mon deuxième chapitre l'effet de l'euro sur le commerce pendant le grand effondrement commercial, qui a le triple avantage d'être exogène par rapport à la zone euro, inattendu et mondial.

Pour évaluer l'impact de l'euro sur le commerce pendant la crise, j'estime un modèle de double différence, comparant la différence du commerce avant et après la crise dans la zone euro avec la différence de commerce à la même période pour les autres pays développés. J'inclus les effets fixes typiques des modèles de gravité: effets fixes importateur-temps, exportateur-temps et paire de pays. De cette façon, j'absorbe les caractéristiques invariantes dans le temps (distance, langage commun, colonie, etc.), mais aussi les caractéristiques variables dans le temps spécifiques aux pays (PIB par habitant, baisse du PIB pendant la crise, etc). Enfin, les effets fixes me permettent de capturer beaucoup de caractéristiques non observées.

Pour étudier le grand effondrement du commerce, j'ai d'abord borné la crise financière de 2008 à 2010. Mon groupe de traitement comprend les membres de la zone euro avant 2007 (Allemagne, Autriche, Belgique, Finlande, France, Grèce, Irlande, Italie, Luxembourg, Pays-Bas, Portugal et Espagne). En tant que groupe témoin, j'ai décidé de prendre les pays les plus développés de l'OCDE (Corée du Sud, Australie, Canada, Danemark, États-Unis, Corée du Sud, Islande, Israël, Japon, Norvège, Nouvelle-Zélande, Suède, Suisse et Royaume-Uni).

L'euro a eu un effet positif et significatif au cours de la grande crise commerciale de 2008-2010 par rapport aux autres pays développés de mon groupe de contrôle. Mes résultats sont robustes à de nombreux contrôles de robustesse (changement de groupe de contrôle, de période, retrait de pays de l'échantillon, etc.). Le commerce entre les membres de la zone euro a moins plongé que pour les autres pays développés, la reprise a également été plus rapide avec un rebond plus fort. Cependant, si l'on passe à des données sectorielles, il apparaît que l'effet positif et significatif que j'observe au niveau agrégé est dû à un effet de composition: l'euro n'a protégé que les secteurs qui exportent le plus. En effet, je constate que les secteurs les plus aidés par l'euro sont le secteur des machines (19% du commerce total), le secteur chimique (14% du commerce total), l'industrie métallurgique (11% du commerce total) et l'industrie des transports (15% du commerce total). Il semble que ces grands secteurs sont aussi plus indépendants financièrement et plus sensibles à la volatilité des taux de change. L'euro a eu un effet positif précisément sur les secteurs présentant de telles caractéristiques. En effet, les banques européennes ont été particulièrement touchées par la crise financière, les secteurs financièrement indépendants ont donc relativement mieux résisté. Deuxièmement, la volatilité des taux de change s'est accrue partout dans le monde pendant la crise, sauf dans la zone euro où elle est restée, par nature, stable. La monnaie unique a permis d'éviter les incertitudes liées au taux de change entre ses membres. C'est particulièrement important pour les industries qui font face à des prix rigides. L'euro a aidé les secteurs utilisant des prix référencés car il a maintenu les prix stables. L'euro a empêché l'incertitude sur les bénéfices des entreprises de la zone euro, alors que cette incertitude s'est accrue à l'extérieur. Par conséquent, l'euro bénéficie d'une prime à la stabilité du taux de change en période de crise économique.

### **Chapitre 3: Effets des chaînes de valeur mondiales sur la transmission des chocs et le taux de change**

Hummels, Ishii et Yi (2001) et Escaith, Lindenberg et Miroudot (2010) ont montré l'importance croissante des chaînes de valeur mondiales depuis les années 1970. Hummels, Rapoport et Yi (1998) soulignent l'augmentation du commerce vertical, qui représente plus de 25% de l'augmentation du commerce total dans la plupart des pays de l'OCDE étudiés. Dans certains petits pays,

comme les Pays-Bas, la part des échanges verticaux dans le commerce total avoisine les 50%. Le développement des technologies de l'information, de la normalisation internationale des marchandises et l'amélioration des transports et de la logistique encouragent l'expansion du commerce vertical. Il est très probable que les chaînes de valeur mondiales continueront à se répartir entre les industries et les pays.

Il en résulte que la politique économique nationale ne doit pas être considérée comme affectant uniquement le territoire national, sans tenir compte de l'intégration plus poussée de l'économie sur le marché mondial. Bems, Yi et Johnson (2009) soutiennent que le commerce vertical est un mécanisme de transmission des chocs intérieurs et qu'il a été l'un des principaux facteurs de l'effondrement synchronisé du commerce en 2009. L'OCDE (2010) arrive à la même conclusion. La prise en compte des nouvelles structures de production et de l'intégration croissante des économies mondiales est un véritable défi pour les concepteurs de politiques monétaires.

L'expansion des chaînes de valeur mondiales étant indéniable depuis vingt ans, il est important de tenir compte de ses effets sur la transmission des chocs dans la conception des politiques monétaires.

Dans le troisième chapitre de ma thèse, j'analyse l'effet des chaînes de valeur mondiales sur la transmission internationale de la productivité et des chocs monétaires dans différents régimes de change et devises des prix à l'exportation, et je discute des politiques monétaires optimales ainsi que de la coordination monétaire.

Partant du constat que les chaînes de valeur mondiales accroissent la synchronisation des cycles économiques, je construis un modèle pour en tirer les conséquences sur les règles de politique monétaire optimale.

Mon modèle est lié à Corsetti et Pesenti (2009). Ce modèle a l'avantage de la simplicité et de l'élégance car il peut être résolu à la main, et il conserve de puissantes capacités de prédiction. Il étudie l'effet du commerce sur la synchronisation des cycles économiques des partenaires commerciaux et en tire des conséquences en terme de politique monétaire optimale. Je m'intéresse à la même question, mais pour une forme particulière de commerce: les chaînes de valeur mondiales. J'adopte donc leur approche, en changeant la fonction de production par l'ajout d'une

étape intermédiaire, pour mieux prendre en compte l'évolution du commerce mondial. J'étudie ensuite en quoi mes résultats diffèrent des leurs. Mon modèle explique simplement comment les chocs de productivité et monétaires se transmettent d'un pays à l'autre, et plus généralement comment les chaînes de valeur mondiales augmentent la corrélation des cycles économiques. Enfin, mon modèle formule des recommandations en matière de politique monétaire et traite de la pertinence de la coordination de la politique monétaire.

Dans le cas des échanges verticaux, les économies sont beaucoup plus liées que dans le modèle de Corsetti et Pesenti (2009), les échanges étant seulement horizontaux. En effet, le modèle de Corsetti et Pesenti (2009) néglige un canal de transmission des chocs de productivité, et ainsi sous-estime la propagation des chocs. En effet, leur modèle n'aborde que le canal traditionnel: le bien final domestique est moins cher, de sorte que l'indice des prix à la consommation à l'étranger diminue. Le deuxième canal que j'explore est inhérent au commerce vertical: le choc de productivité diminue le prix du bien intermédiaire, de sorte que le bien final étranger devient également moins cher. Par conséquent, l'indice des prix à la consommation étranger diminue également par ce canal. L'impact du choc de productivité sur l'économie nationale et étrangère dépend principalement de la part du bien intermédiaire domestique utilisée pour produire le bien final.

Le commerce vertical a également un impact sur la volatilité du taux de change. Le taux de change est en effet beaucoup moins flottant, plus "visqueux", à mi-chemin entre le taux de change fixe et le taux de change flottant. C'est le cas parce que les économies évoluent beaucoup plus ensemble, les chocs étant symétriques. Par conséquent, le taux de change n'a pas à fluctuer puisque les variations du taux de change expriment une différence dans les prix relatifs entre les pays. Si les prix nationaux et étrangers évoluent ensemble, le taux de change reste constant. Dans le cas du commerce vertical, ma fonction d'emploi est un peu différente de celle de Corsetti et Pesenti (2009) car elle inclut le taux de change à court terme (défini comme la différence entre l'offre monétaire intérieure et étrangère). Par conséquent, elle établit un lien entre l'emploi et l'inflation. Cela coïncide avec la courbe de Phillips et la théorie de Mundell (1961). Les deux études montrent une relation inverse entre les taux de chômage et l'inflation.



# Introduction

## How to measure the effect of monetary and economic integration on trade

Inside the big European Union circle of economic integration, a smaller circle of countries has been developed, keen for a stronger economic integration: the members of the Eurozone. Baldwin (2006) qualifies the euro as the “world largest economic policy experiment” since a common currency strongly modifies the equilibrium of the area on many levels (inflation, business cycles, trade, interest rate, etc.). Such a disruption has never been done before on such a large scale; the founding states of the Eurozone represent 20% of world output, 30% of world trade and 300 million people.

My thesis explores the effects of monetary and economic integration on trade. The gravity model allows economists to measure this integration. The gravity model was inspired by astrophysics to measure the gravity force between two planets depending on their size and the distance between them. The idea is the same in economics: the gravity force in this case is trade, the two planets are countries, and their size is their gross domestic product (GDP). Economists refined the model by adding control variables influencing trade (common language, former colony, common border, island, landlocked country, etc.). It is possible to replace these variables by country-pair, exporter-time and importer-time fixed effects to capture unobserved characteristics. The equation predicts trade remarkably well. Economists compare predicted trade with real trade, and try to explain the deviations. For example, adding a free trade agreement (FTA) dummy to the regression allows us to measure the effect of a FTA on trade.

The gravity model predicts that a region equidistant with two other regions of equal size must have the same level of trade with each of them. McCallum (1995) compares the trade between USA states and Canadian provinces. He found that trade is 20 times higher between two regions within a country compared with a region of the same size at an equal distance but on the other side of the border. This famous result is known as the "border effect". The border effect proves that the market between the USA and Canada is fragmented. This might be due to protectionist barriers (tariff or non-tariff barriers), home bias of households, firms and administrations, institutional differences (e.g. difference in contracts) or transaction costs (different currencies, etc.). In the case of the American-Canadian border, since the countries speak a common language, have similar cultural values, and have a free trade agreement, there is a high probability that the different currencies are playing a role. Indeed, currency unions which are closely integrated, represent the level just below federation in terms of integration. According to the literature, a currency union increases trade by between 30% and 60% on average.

## Different exchange rate regimes

A currency union is a type of exchange rate regime. Economists usually divide exchange rates regimes into two categories, floating and fixed. However, the situation is far from being binary since there is a multiplicity of exchange rate regimes. First, there is the free floating regime: the central bank does not intervene in the currency exchange rate. Japan and Australia, for example, have pure floating regimes. Then there is the managed floating regime (or dirty float): in cases of extreme appreciation or depreciation, central bank intervenes to stabilize the currency. Singapore has opted for this regime. There is also the crawling peg (usually considered a fixed exchange rate): it allows depreciation or appreciation to happen gradually. The most famous example is China. Its currency slowly but regularly appreciates against the US dollar. Then there is the peg within horizontal bands: the rate is allowed to fluctuate in a fixed band (bigger than 1%) around the anchor's currency rate. The European Monetary System applies this exchange rate regime. There is also the strict fixed exchange rate: the currency is fixed to an anchor and does not fluctuate at all. An example of this is Denmark's currency which is pegged to the euro. Finally, there is the fixed exchange rate regime, the most extreme being currency union; since countries

use the same currency there is no possibility of deviation from the “anchor country”. For instance, Greece was unable to undertake a competitive devaluation in 2011 during the sovereign crisis. To complicate the situation even more, fixed exchange rate regimes can decide to peg either to another country, or to a basket of currencies (to be less exposed to a shock affecting only the anchor country).

The choice of exchange rate regime real has consequences for countries in terms of inflation management, trade, interest rates, business cycle stabilization, etc. In relation to trade, I found that classical fixed exchange rates increase trade only after 15 years.

## Different types of currency unions

Within the family of currency unions, economists distinguish two types: dollarization/euroization, and multilateral currency unions. Dollarization is the unilateral choice to abandon monetary policy independence completely by adopting the currency of another country - examples being Ecuador, El Salvador and Panama. Examples of euroization (unilaterally adopting the euro) are Kosovo and Montenegro (these countries had adopted the German mark then, following Germany, switched to the euro). Another possibility is the official agreed currency substitution, followed by Monaco and Andorra in adopting the euro. The countries opting for dollarization have in common either that they are very poor with institutions that lack credibility, or they are very small, with institutions not willing to manage an independent monetary policy. The main advantage of dollarization is to stabilize inflation in the case of weak institutions since the currency is credible independently of them. Another advantage is an increase in trade because the countries share a common currency.

The other possibility is a multilateral currency union: the countries share seigniorage and have a common central bank. In this case, there is no single country controlling the monetary policy in its interest but rather a shared monetary policy supposed to take into account every member of the currency union to choose the right inflation target. Multilateral currency unions member countries are usually bigger than countries in dollarization. The Franc CFA and the euro are two examples of multilateral currency unions.

## **Benefits and drawbacks of sharing a single currency**

There are benefits and drawbacks to belonging to a currency union. A first benefit is the ending of exchange rate volatility and uncertainty between the members of the currency union (since it is fixed irrevocably). Getting rid of uncertainty makes economic forecasting easier, and promotes investment. Consumers traveling within the currency union do not have to change currencies, and therefore face fewer administrative procedures. Currency unions reduce transaction costs: for example, there is no payment commission, and firms do not have to pay hedging costs to insure against currency fluctuations. Small firms are affected particularly by exchange rates fluctuations and the administrative costs of accountings in the different countries. Currency unions create trading blocks, with higher trade among their members and greater negotiating power in trade agreements with the rest of the world. There is also price transparency, allowing consumers to more easily compare the prices of goods. States are supposed to be more responsible for deficits since all members collectively would suffer from the resulting lack of credibility (resulting in turn, in higher interest rates). There is much less risk of high inflation (devaluation is not possible).

However, there are also drawbacks related to currency unions. First, monetary independence is scarified and there is loss of sovereignty over economic affairs. Countries cannot absorb shocks appropriately to their economy in a context of a personalized monetary policy. Furthermore, a single monetary policy is unlikely to satisfy every country, and especially if countries are heterogenous. Countries are necessarily dependent on one another, and the presence of a weak country can destabilize the entire currency union by weakening the currency.

## **Reasons for entering and exiting a currency union**

Entering or exiting a currency union is almost always because of political rather than economic reasons; “political glue holds [in place] a currency union” (Hochreiter and Siklos, 2004). During the XXth and the beginning of XXI century, more than twenty currency unions were in place. The biggest currency union is the euro, born from a political will to build something strong together. The second biggest currency union is the American dollar. Most of the countries which have adopted the American dollar are either small islands, or poor and unstable Latin

American countries. The third biggest currency union is the pound sterling, which united a lot of former British colonies before they became independent and left it. The next biggest currency union is the CFA Franc. It is an unusual currency union which unites former French colonies that remained in the currency union after independence. Also, unlike most other currency unions, there is no one hub country in the CFA Franc currency union; e.i. no single or pair of countries driving the monetary policy. Another currency union that lacks a hub is the East Caribbean Dollar which unites a lot of small isolated islands. The Deutschmark is another case of special currency union; Kosovo and Montenegro adopted the Deutschmark to stabilize their economies. Germany was the biggest economic power in the region which drove these countries' choices.

In conclusion, the reasons for entering and exiting currency unions often have very different roots. In my sample, the vast majority of the countries that have left currency unions were former colonies which obtained independence and abandoned their coloniser's currency. On the other hand, many countries in my database that joined a currency union are small (mostly islands) or poor countries that lacked the credibility or willingness to have a currency of their own (e.g., Liechtenstein, Naru, Kosovo, etc.). Other countries joined currency unions to strength political and economic links.

## **Trade and currency unions: what mechanisms are involved?**

In my thesis, I study in depth the link between currency union and trade, and try to understand the mechanisms behind the significant effects found in the literature. I study the link in both directions: how currency unions increase trade, and how trade creates the right conditions for an optimal currency union.

First, I try to understand how currency unions promote trade, in general and in times of crisis. Currency unions affect trade through three potential channels: price transparency, transaction costs, and absence of exchange rate volatility and uncertainty. Price transparency allows citizens to compare prices across borders and buy from where the good is cheapest. The internet is enabling price transparency to have even bigger impact by making ordering goods from abroad much easier. Transaction costs are drastically reduced with a single currency since banks are



The aim of my first paper is to measure the effect of each of these characteristics on trade. I find that the absence of exchange rate uncertainty has the biggest effect on trade. Indeed, contrary to a fixed exchange rate, currency unions commit to keeping exchange rate level irrevocable. The credibility derived from such a commitment is extremely high since the cost of leaving a currency union and the consequences would be enormous. The example of Greece which needed competitive devaluation but preferred to pay the high price by staying in the Eurozone is a good example of the power of this commitment.

In my second paper, I study the effect of currency unions, and more especially the euro, during economic crises. Among all the characteristics described above, the absence of exchange rate volatility despite market pressures is what makes a difference during an economic crisis. Indeed, in time of crisis, exchange rates become three to four times more volatile than usual, and this absence of volatility gives a premium to the members of a currency union.

My last paper takes the reverse view and studies how trade makes the economic environment more compatible with a currency union. Frankel and Rose (1998) show that trade increases business cycle correlation; therefore, since currency unions increase trade, shocks will become more symmetric over time. This finding suggests endogeneity in the optimal currency area (OCA). I study vertical trade specifically which implies that the various stages of the production of a good are located in different countries. This new production organisation favors even more shocks transmission among the countries involved in the global value chains. The result is that business cycles are more correlated which makes currency unions more attractive. Indeed, as the shock is symmetric among countries, the optimal monetary response is the same on each side of the borders and, therefore, is not a problem when a single central bank is responsible for all these countries.

Yi (2003) highlights the huge impact on global value chains of a small reduction in cross-border transaction costs. Since global value chains cross many borders, transaction costs add up, and any reductions in these costs has a more than proportional impact on vertical trade. Since currency unions reduce cross-border transaction costs, they promote the formation of global values chains among their members. In turn, transmission of shocks is much higher between countries linked

by global value chains. Therefore, global value chains increase business cycle synchronization.

Studying the mechanisms through which trade and currency unions influence each other is very important as it helps in the design of better public policy by identifying on which characteristics of currency unions it is important to focus.



## Summary

### Chapter 1: "Disentangling the Effects of Currency Unions on Trade"

#### The context

Andrew Rose's (2000) paper "One money, One Market" revived the interest in currency unions. He claims that currency unions increase trade by 300%. Numerous papers have tested the robustness of this result, and find that currency unions increase trade by between 30% and 90%. A major issue in this literature is the problem of endogeneity: countries could be in currency union because they trade a lot.

#### The question

The literature concerning the effect of currency union on trade is very prolific although there are no studies that distinguish which characteristics of the currency union regime drive the increased trade observed. Three characteristics of currency union might play a role in trade increases: price transparency, bank conversion costs, and the impossibility of devaluation. It is important to have a nuanced comprehension of the mechanisms behind this increase, to know what are the determinants of trade. It would help the policy makers to know which among price transparency and fixity of change promotes trade. The first chapter of this thesis disentangles the impact of each of the currency union characteristics on trade.

#### The methodology

**Theory** In the first chapter of this thesis, I use the different types of fixed exchange rate regimes to disentangle the effect of each difference on trade. First, I build a theoretical micro founded model to show explicitly how the different characteristics of the exchange rate regimes (mainly trade costs and possibility of devaluation) influence trade. My model explains the differences between the short duration and long duration effects on trade of each regime by letting firms take account of the longevity of a peg to value its credibility.

My model is related to Melitz (2003). His model has the major advantage of explaining simply and intuitively why not every firms export. I chose to base my model on Melitz's model since

the mechanism highlighted to explain the firm's micro decisions to export or not can be used to explain the aggregate bilateral trade between two countries, depending on trade cost as in exchange rate regimes. I change the firm's utility function by adding a disutility in profit volatility and by modulating the trade cost depending on the exchange rate regime to match with the empirical evidence. I then see how my results differ from his. Although I use only macro data in my empirical analysis, a micro-founded model seems appropriate because it provides better insights into the mechanisms involved.

**Empirics** I then check empirically the predictions of my model and estimate the size of the influence of each currency union characteristic. In order to do this, I compare the effects of the different regimes on trade at different stages of maturity to disentangle the effect of each characteristic at these different stages. I deal with the zero trade flows problem by using Poisson Pseudo Maximum Likelihood (PPML).

My methodology is based on the gravity model. I include time-country fixed effects, to capture growth of economic activity. I include country-pair fixed effects which capture time-invariant pair-specific variables such as borders contiguity, distance, common language or colonial links. I control for trade increases from free trade agreements by including a FTA dummy. The baseline model estimated is the following:

$$\ln Export_{ijt} = \beta_1 CU_{ijt} + \beta_2 Peg1to1_{ijt} + \beta_3 Fixed_{ijt} + \beta_4 FTA_{ijt} + \lambda_{1it} + \lambda_{2jt} + \gamma_{ij} + \epsilon_{ijt}$$

Where  $\ln Export_{ijt}$  is the (log) of annual export from country  $i$  to country  $j$ ,  $CU_{ijt}$  is a dummy for currency unions,  $Peg1to1_{ijt}$  a dummy for pegs one-to-one and  $Fixed_{ijt}$  a dummy for classical fixed exchange rate.  $FTA_{ijt}$  is a dummy for free trade agreements.  $\lambda_{1it}$  and  $\lambda_{2jt}$  represent the time-country fixed effect on exporter and importer, and  $\gamma_{ij}$  the pair-country fixed effect.  $\epsilon_{ijt}$  is the error term.

There is one additional issue that I need to address in order to get a more reliable view on the effect of these different exchange rate regimes on trade. These regressions suffer from problems of endogeneity: countries, because they trade a lot, decide on a currency union or a peg one-to-one.

The potential endogeneity is not necessarily captured by the fixed effects. One way to capture it is to use an instrumental variable.

I use the instrument developed by Barro and Tenreyro (2007). The instrument uses the hub-and-spoke organisation of fixed exchange rate. The main idea is to use the independent decisions of countries to peg/ be in currency union with a main anchor. The likelihood that they peg to the same anchor is used as an instrument since it is considered to be exogenous.

I adopt the same methodology as Barro and Tenreyro (2007) and estimate the probability that a given country enters a currency union using one of the six main anchors in Barro and Tenreyro (Australia, France, Germany, Japan, the UK and the USA), employing a probit. This probability depends on several factors such as distance, colonial links, common language, etc. I then compute the joint probability that two countries have a common anchor.

## The results

**Theory** My model predicts that currency unions trade more than pegs one-to-one and classical fixed exchange rate regimes. The trade under currency union is stable over time, while trade under fixed exchange rate regimes increases as their credibility increases. Therefore, the levels of trade between these regimes converge. In addition, to my knowledge, my model is the first to explain why floating and classical fixed exchange rate regime have similar effects on trade in the first years, but not at steady state. To summarize the model predictions:

- Case 1: if the sensibility to volatility of the firms is high, then trade increases monotonically with peg credibility: currency union should therefore increase trade the most, then peg one-to-one, then the classical fixed exchange rate, then the floating exchange rate.
- Case 2: if the sensibility to volatility of the firms is low, the level of trade is the highest for countries linked by a credible peg but it is high also (but less high) for countries with the most volatile exchange rate (floating exchange rate). This is because the increase in utility for the average firm in the country with the devaluation more than compensates for the decreased utility of the average firm in the country with appreciation. In this case, a floating exchange rate does not necessarily lead to a lower level of trade than the classical fixed exchange rate.

- Currency union allows smaller firms to export because the cutoff revenue to export is lower than in the other regimes.
- At steady state, when the exchange rate regime gains credibility, only trade cost differences matter for trade. The model predicts that at steady state, fixed exchange rate regimes have a bigger effect on trade than floating exchange rate regimes.

**Empirics** Using an ordinary least squares (OLS), I find that currency union increases trade more than peg one-to-one, although both are positive and significant. I find no effect of classical fixed exchange rate compared to floating exchange rate. This is in line with my model predictions. However, by correcting for endogeneity issues, peg one-to-one effects turn insignificant.

Furthermore, currency unions from the outset have very strong effects, while classical fixed exchange rates have none. At steady state, the effects of currency union (which remain stable over time) and pegs one-to-one, tend to become more similar. Classical fixed exchange rate regimes have small effects only after 15 years, also predicted by my model.

The results suggest that pegs one-to-one are special in the “fixed exchange rate family”. The difference between peg one-to-one and classical fixed exchange rate lies in the fact that no price conversion is needed for peg one-to-one, while a classical fixed exchange has to “pay” an additional conversion cost. When a shock occurs, which upsets the trade balance, a country with a simple peg devalues its currency to restore the balance, and most of the time re-pegs to the same currency. However, a country with a peg one-to-one loses its specificity if it devalues. The incentive to keep the peg is much higher. Therefore, the shock would have to be much bigger to cause a devaluation. This explains the difference in life expectancy between the two types of peg which is 3 years for a classical peg, while pegs one-to-one have a lifespan of 21 years (against 27 years for currency unions). This gap potentially implies fundamental differences between them. Knowing this, investors and traders act differently and this has an impact on the economic activity.

As peg one-to-one effect is endogenous, it means that currency unions have an even greater impact than previously thought as the effects on trade do not come from the fixity of the exchange rate, or price transparency. The fact that the currency union effect on trade comes from its fixed exchange rate regime credibility is the main contribution of this paper.

## Chapter 2: Did the Euro Protect its Members during the "Great Trade Collapse"?

### The context

The financial crisis caused the world GDP to decrease by 4% and world trade by 15% (in 2009 overshooting by 18 against 1.9 in the 1990-2008 period). Baldwin (2009) states that "the great trade collapse was triggered by - and helped spread - the global economic slump". Every nation for which the World Trade Organization (WTO) reports data experienced a drop in both imports and exports during the second half of 2008 and the first half of 2009. On average, Europe has been hit harder than the rest of the world by the great trade collapse, with a trade drop of 25% between 2008 and 2009. East European countries experienced the most severe drop, especially the new eastern Eurozone members whose trade fell by 28%. Curran (2009) studied the European Union during the great trade collapse and Shelburne (2010) studied the east European countries, but not the Eurozone specifically.

### The question

The effect of the euro on trade has been studied in the literature with around 50 papers on the topic. According to these studies, the range of the euro positive effect fluctuates between 2% and 30% (see Rose, 2017 for a recent metadata analysis). However, to my knowledge, no work has been done so far on the euro effect during an economic crisis. It is a priori not clear how the additional trade due to introduction of the single currency reacts to a crisis. Is it more volatile, more fragile? Has the euro protected its members during the great trade collapse? Would the trade drop observed during the financial crisis in Europe have been bigger without the euro? Is the euro effect the same for every sector? To address these questions, I study the effect of the euro on trade during the great trade collapse, a context that provides three advantages: it was exogenous to the Eurozone, was unexpected and was worldwide.

### The methodology

To evaluate the impact of the euro on trade during the crisis, I estimate a difference-in-difference model of logged one-way trade (exports) at annual frequency, comparing the difference in trade

before and after the crisis in the Eurozone with the difference in trade in the same period for the other developed countries. I include typical gravity fixed effects: importer-time, exporter-time and pair-country fixed effects, in order to absorb time invariant characteristics (distance, common language, colony, etc.), and also time varying characteristics specific to the countries (GDP per capita, GDP drop during the crisis etc.). Finally, fixed effects allow me to capture several unobserved characteristics. This method which requires multiple high-dimensional fixed effects is very demanding but captures many confounding factors; having significant coefficients in these conditions is evidence of a strong effect. The regression equation is given by

$$\ln Export_{ijt} = \beta EUR_{ijt} * Crisis_t + \lambda_{1it} + \lambda_{2jt} + \lambda_{3ij} + \epsilon_{ijt} \quad (1)$$

with:

- $Export_{ijt}$  bilateral trade
- $EUR_{ijt} * Crisis_t$  Eurozone (both partners being in the Eurozone) during the financial crisis (2008-2010) dummy
- $\lambda_{1it}$  exporter-time fixed effect
- $\lambda_{2jt}$  importer-time fixed effect
- $\lambda_{3ij}$  pair-country fixed effect

To study the great trade collapse, I first set the time of the financial crisis at 2008 to 2010. My treatment group comprises members of the Eurozone prior to 2007 (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain).

As a control group, I have decided to take the most developed countries of the OECD (Australia, Canada, Denmark, Iceland, Israel, Japan, New Zealand, Norway, South Korea, Sweden, Switzerland, the United Kingdom and the United States).

## **The results**

The euro has a positive and significant effect during the 2008-2010 great trade collapse compared to the other developed countries in my control group. My results are robust to many robustness checks (changing the control group, the time period, excluding countries etc.).

Trade among the Eurozone members plunged less deeply than in the case of the other developed countries, and that recovery was quicker and exhibited a more powerful rebound.

However, at the sector level, it appears that the positive and significant effect I observe at the aggregate level is due to a composition effect: the euro protected only those sectors exporting the most. I find that the sectors that the euro helped the most are machinery (19% of total trade), chemical (14% of total trade), metal (11% of total trade) and transport (15% of total trade). It appears that these large sectors are also more financially independent and more sensitive to exchange rate volatility. The euro had a positive effect on precisely such sectors with these characteristics. The European banks were particularly hard hit by the financial crisis, the financially independent sectors did therefore comparatively better.

Also, exchange rate volatility during the crisis increased everywhere in the world except in the Eurozone where by nature it remained fixed. The single currency prevented uncertainty linked to exchange rates among its members. This is especially important for industries with sticky prices. The euro has helped the sectors using referenced prices by keeping prices stable. The euro removed the uncertainty on profits firms faced inside the Eurozone, while this uncertainty increased outside. Therefore, the euro provides a premium for exchange rate stability during economic crises.

### **Chapter 3: Effects of global value chains on shocks transmission and exchange rate**

#### **The context**

Hummels, Ishii and Yi (2001) and Escaith, Lindenberg and Miroudot (2010) demonstrate the growing importance of global value chains since the 1970s. Hummels, Rapoport and Yi (1998) highlight that increases in vertical-specialization-based trade account for more than 25% of the increase in total trade in most of the OECD countries tested. In some smaller countries, such as the Netherlands, the share of vertical trade in total trade approached 50%. The development of information technology, international standardization of goods, and improvements to transport and logistics encourage the expansion of vertical trade. It is likely that global value chains will continue to spread across industries and countries.

Numerous studies investigate the link between vertical trade and business cycles synchronisation. Sturgeon and Memedovic (2011) study three industries (electronics, automobiles and motorcycles, and apparel and footwear). They find evidence of increasing economic integration, but the level differs among the three industries. Other authors have studied individual sector but for a limited number of countries only. Brustein, Kurz and Tesar (2008) find that the output of American and Mexican firms is more correlated if the Mexican firms supply the American firms with intermediary goods. The intensity of production-sharing seems to be at least as important when accounting for bilateral firm output correlation, as the trade volume. Iossifov (2014) highlights the role of vertical trade in the business cycle synchronization of central and eastern European countries, and the Eurozone. Gangnes, Ma and Van Assche (2012) use Chinese trade data and find that vertical trade increased the sensitivity of trade to external business cycle shocks due to a composition effect, global value chains being more developed in higher income elasticity goods. Finally, Giovanni, Levchenko and Mejean (2017) using micro data of French firms find that indirect linkages account significantly to aggregate correlation of business cycles.

The consequence is that national economic policy should not be seen as affecting only the national territory, but should take account of the deeper integration of the economy on the global market. Bems, Yi and Johnson (2009) argue that vertical trade acts as a transmission mechanism for domestic shocks and is one of the main factors in the synchronized great trade collapse in 2009.



OECD (2010) reaches the same conclusion. Taking into account the new production structures and the growing integration of world economies is a problem for designers of monetary policy.

### **The question**

The expansion of global value chains over the last 20 years is undeniable, and when designing monetary policy rules, it is important to take account of their effect on the transmission of shocks. In chapter 3 of this thesis, I analyse the effect of global value chains on the international transmission of productivity and monetary shocks in different exchange rate regimes and export price currencies, and to discuss optimal monetary policies and monetary coordination.

### **The methodology**

Based on the observation that global value chains increase synchronisation of business cycles, I build a model to identify the consequences for optimal monetary rules.

My model is related to Corsetti and Pesenti (2009). This model has the advantage of simplicity and elegance since it can be solved manually but its predictions are powerful. It studies the effect of trade on business cycle synchronisation among trading partners, and derives optimal monetary policies. I am interested in the same issues, but for a particular form of trade: global value chains. Therefore, I adopt their approach, and change only the production function by adding an intermediate good stage. Vertical trade comes from the fact that final-good production requires both Home and Foreign intermediate goods. I then see how my results differ to theirs. My model explains simply how productivity and monetary shocks are transmitted from one country to another, and more generally how global value chains increase the correlation of business cycles. Finally, my model provides monetary policy recommendations, and discusses the relevance of monetary policy coordination.

### **The results**

With vertical trade, economies are more closely linked than in the Corsetti and Pesenti's (2009) case of only horizontal trade. Indeed, the intermediate good productivity shock is transmitted

by two channels instead of one, so shock transmission is much bigger. First, the traditional channel: the Home final good is cheaper, so the Foreign consumer price index decreases. The second channel is inherent to vertical trade: the productivity shock decreases the price of the intermediate good, so the Foreign final good also becomes cheaper. Therefore, the Foreign consumer price index also decreases through this channel. The impact of the productivity shock on the Home and Foreign economy depends mainly on the share of the Home intermediate good used to produce the final good.

Vertical trade also has an impact on exchange rate volatility. The exchange rate is less floating, more “viscous”, midway between a fixed and a floating exchange rate. It is because the economies are moving together much more, since the shocks are symmetric. Therefore, the exchange rate does not have to move since exchange rate movements express a difference in the relative prices between the countries. If the Home and Foreign price move together, the exchange rate remains constant.

With vertical trade, my employment function differs from Corsetti and Pesenti (2009) since it includes the short term exchange rate (defined as the difference between the Home and Foreign monetary supply). Therefore, it links employment and inflation. This coincides with the Phillips curve and Mundell’s (1961) theory. Both works show an inverse relationship between rates of unemployment and inflation.

# Chapter 1

## Disentangling the Effects of Currency Unions on Trade

### 1.1 Introduction

The literature concerning the effect of currency union on trade is very prolific although there are no studies that distinguish which characteristics of the currency union regime drive the increased of trade observed. Three characteristics of currency union might play a role in trade increases: price transparency, bank conversion costs, and the impossibility of devaluation. It is important to have a nuanced comprehension of the mechanisms behind this increase, to know what are the determinants of trade. It would help the policy makers to know which among price transparency and fixity of change promotes trade. This paper disentangles the impact of each of the currency union characteristics on trade.

To my knowledge, there are no studies that specifically investigate the link between peg one-to-one and trade. Peg one-to-one is the fixed exchange rate regime that is the closest to currency union since it allows price transparency because the conversion rate between currencies is equal to 1 (e.g. before the euro, 1 Luxemburg franc was exactly equal to 1 Belgian franc). The peg one-to-one regime is so close to the currency union regime that some authors pool them.<sup>1</sup> For my study, I built a new database referencing all the pegs one-to-one since 1948.

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<sup>1</sup>Rose (2000).

Table 1.1 presents the different types of fixed exchange rates the currency union, to classical fixed exchange rate, and their characteristics.

Table 1.1: Characteristics of several fixed exchange rate regimes compared with currency union, being the benchmark

Exchange rate regime	No monetary policy power	Currency change cost	Possibility of devaluation	No price transparency
Dollarization/ euroisation	X			
Peg One-to-one	X	X	X	
Fixed Exchange Rate	X	X	X	X

*Note:* Compared to currency union, dollarization has the same characteristics, but no monetary policy power. Peg one-to-one has two additional characteristics: cost for changing currency and possibility of devaluation. Finally, the fixed exchange rate regime has a last additional characteristic, it has no price transparency.

In this paper, I use the characteristics of the exchange rate regimes, highlighted in table 1.1 to disentangle the effect of each difference on trade. I consider these regimes together, and then compare them. First, I build a theoretical micro founded model to show explicitly how the different characteristics of the exchange rate regimes (mainly trade costs and possibility of devaluation) influence trade. My model explains the differences between the effects of each regime on trade in the short term and at steady state, by letting firms take account of the longevity of a peg to value its credibility.

My model is related to Melitz (2003). His model has the major advantage of explaining simply and intuitively why not every firms export. I chose to base my model on Melitz's model since the mechanism highlighted to explain the firm's micro decisions to export can be used to explain the aggregate bilateral trade between two countries, depending on trade cost as in exchange rate regimes. Although I use only macro data in my empirical analysis, a micro-founded model seems appropriates because it provides better insights into the mechanisms involved.

I therefore adopt Melitz's approach to compare trade for different fixed exchange rate regimes: currency union, peg one-to-one and classical fixed exchange rate. However, I change the firm's utility function by adding a disutility in profit volatility and by modulating the trade cost depending on the exchange rate regime to match with the empirical evidence. I then explain how

my results differ from his.

My model predicts that currency unions trade more than pegs one-to-one and classical fixed exchange rate regimes, due to higher credibility and smaller trade costs. I highlight two mechanisms that balance each other and explain this result: the "expectancy effect" (firms expecting a devaluation) and the "volatility effect" (firms with disutility in uncertainty). The latter is more powerful, and therefore, makes the firms prefer currency union. Moreover, trade under currency unions is stable over time, while trade under fixed exchange rate regimes increases as their credibility increases. Therefore, the levels of trade between the regimes studied converge. In addition, to my knowledge, my model is the first to explain why floating and classical fixed exchange rate regime have similar effects on trade in the first years, but not at steady state.

I then check empirically the predictions of my model and estimate the size of the influence of each currency union characteristic, employing a gravity equation. To do this, I compare the effects of the different regimes on trade at different stages of maturity to disentangle the effect of each characteristic at these different stages. I deal with the zero trade flows problem by using poisson pseudo-maximum likelihood (PPML).

I find that currency union increases trade more than peg one-to-one, although both are positive and significant. I find no effect of classical fixed exchange rate compared to floating exchange rate. This is in line with my model predictions. At steady state, the effects of currency union (which remains stable over time) and pegs one-to-one, tend to become more similar. Classical fixed exchange rate regimes have small effects only after 15 years, also predicted by my model, as the regime gains credibility over time. A major issue in this literature is the problem of endogeneity: countries could be in currency union because they trade a lot. Barro and Tenreyro (2007) build an instrumental variable (IV) which I use in this paper, in order to deal with this issue. They use the fact that many countries adopt the currency of an anchor country with which they have links. By doing so, they are in currency unions with other countries with which they do not have special links. Tenreyro and Barro (2007) use this exogenous link to create their instrumental variable. They find that Rose (2000) effect remains large, and is not due to endogeneity. In my paper, by correcting for endogeneity issues, peg one-to-one effects turn insignificant. Furthermore, currency unions from the outset, have very strong effects, while pegs

one-to-one have small effects and classical fixed exchange rates no effect.

As a robustness check, following Chen and Novy (2016), I study the impact of currency unions and pegs one-to-one depending on potential trade between the pairs, to check whether the effect is heterogenous, I find that it is.

The literature compares the effect of currency unions and fixed exchange rate regimes on trade. To the best of my knowledge, Fielding and Shields (2005) is the article closest to mine in being the only one to look at the difference between currency union and peg one-to-one by studying the CFA franc. Fielding and Shields (2005) find that “sharing a common currency is associated with substantially more bilateral trade, but only among the countries that are landlocked”. Fritz-Krockow and Jurzyk (2004) find that a classical fixed exchange rate regime has a significant positive impact, but a currency union does not provide additional benefits. In contrast, Klein and Shambaugh (2006) estimate large and significant effects of fixed exchange rate on bilateral trade, and an even larger effect for currency union. However, they do not include country-time fixed effects in their regression.

Andrew Rose’s (2000) paper “One money, One Market” revived interest in currency unions. He claims that currency unions increase trade by 300%. Numerous papers have tested the robustness of this result, and find that currency unions increase trade by between 30% and 90%.<sup>2</sup> Once there was sufficient data, many economists concentrated on the specific effect of the euro on trade. The general result is that bilateral trade in the Eurozone has increased significantly, between 5% and 40%<sup>3</sup> but much less than was estimated for the other currency unions.

Glick and Rose (2016) tested several methodologies to measure the effect of currency union on trade in the world and in the Eurozone and to compare them. They (as I did) found that the results were very sensitive to the econometric methodology, which did not allow a robust estimation. However, they conclude that the Eurozone has had significant and important effects. Their estimates are in the same range as previous papers studying other currency unions.

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<sup>2</sup>Glick and Rose (2002) 65%; Persson (2001) 50%; Nitsch (2002) 82%; Tenreyro (2001) 47%.

<sup>3</sup>Micco, Ordoñez and Stein (2003) 4%; De Nardis and Vicarelli (2006) 9%, Barr, Breedon and Miles (2003) 25%, Berger and Nitsch (2008) 7%; Flam and Nordstrom (2006) 14% and more recently Glick and Rose (2016) 43%.

The literature comparing fixed and floating exchange rate is much older and also smaller. Most of the earliest articles<sup>4</sup> estimate a large negative correlation between nominal variability of exchange rate and trade while studies published in the 1990's<sup>5</sup> report small and almost insignificant effects. The recent literature does not settle the question. Nilsson and Nilsson (2000) find that the more flexible the exchange rate, the greater the exports while Fritz-Krockow and Jurzyk (2004) find that the longer and more credible the peg, the higher the trade. Tenreyro (2007) indicates that nominal exchange rate variability has no significant impact on trade flows and Dorn and Egger (2013) find that “countries pegged trade more, but only after about 8 years”. Berman, Martin and Mayer (2012) analyse the reaction of exporting firms to exchange rate changes. They find that high productivity firms modify their export prices, while low productivity firms modify their export volume. This explains the weak impact of exchange rate movements on aggregate export volumes. This is in line with my findings of a non-significant difference between the floating and fixed exchange rate regime effect on trade.

Section two presents my model, disentangling the effects of each currency union characteristic on trade. Section three measures the effect of currency union, peg one-to-one and simple fixed exchange rate on trade empirically. Section 4 concludes the paper.

## 1.2 The model

### 1.2.1 Domestic market

The world consists of two symmetric countries, denoted as the Home country and the Foreign country; Foreign variables being denoted with a superscript star. Prices are flexible and in nominal terms. Utility functions are similar at Home and abroad and consumers face a similar consumption basket.

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<sup>4</sup>Abrams (1980) and Thursby and Thursby (1987).

<sup>5</sup>Frankel and Wei (1995), Eichengreen and Irwin (1998), and Frankel (1997).

### Households

The economy consists of households and firms. The representative Home household at period  $t$  maximizes expected intertemporal utility from consumption ( $C$ ), taking into account expected consumption at period  $s$ ,  $U_t = \mathbb{E}_t \left[ \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_s^{1-\gamma}}{1-\gamma} \right]$ ,  $0 \leq \beta \leq 1$  being the subjective discount factor and  $\gamma > 0$  the inverse of the intertemporal elasticity of substitution. Each firm produces a variety  $\omega$ , which is an imperfect substitute to all other varieties over a continuum of goods  $\Omega$  under monopolistic competition. Households consume the basket of goods  $C_t = \left( \int_{\omega \in \Omega} c_t(\omega)^{\frac{\theta-1}{\theta}} d\omega \right)^{\frac{\theta}{\theta-1}}$ , with  $\theta > 1$  being the symmetric elasticity of substitution across goods. The consumption-based price index at home is  $P_t = \left( \int_{\omega \in \Omega} p_t(\omega)^{\theta-1} d\omega \right)^{\frac{1}{\theta-1}}$ ,  $p_t(\omega)$  being the price of a good  $\omega$ . Finally,  $R$  denotes aggregate expenditure with  $R_t = P_t C_t = \int_{\omega \in \Omega} r_t(\omega) d\omega$ . Therefore we have  $c_t(\omega) = \left( \frac{p_t(\omega)}{P_t} \right)^{-\theta} C_t$  and  $r_t(\omega) = \left( \frac{p_t(\omega)}{P_t} \right)^{1-\theta} R_t$ .

### Firms

Prior to entry, firms face an identical fixed entry cost  $f_{D,t}$ , paid on a period-by-period basis.<sup>6</sup> Production function is the following  $C_t = LZ_t - f_E$ , production requiring only labor  $L$ , and aggregate labor productivity being indexed by  $Z_t$ . Let  $p_{D,t}$  being the nominal domestic price of home firm, and  $\rho_{D,t}$  the real price, with

$$\rho_{D,t}(z) \equiv \frac{p_{D,t}(z)}{P_t} = \frac{\theta}{\theta-1} \frac{w_t}{zZ_t}, \quad (1.1)$$

where  $w_t/Z_t z$  is the cost per unit of the consumption good  $C_t$ ,  $w_t$  being the real wage and  $z$  the relative productivity, different for each firm.

We therefore have

$$\frac{c_t(z_1)}{c_t(z_2)} = \left( \frac{z_1}{z_2} \right)^{\theta}, \quad (1.2)$$

$$\frac{r_t(z_1)}{r_t(z_2)} = \left( \frac{z_1}{z_2} \right)^{\theta-1}. \quad (1.3)$$

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<sup>6</sup>In the model of Melitz (2003), the fixed cost  $f_{D,t}$  is only paid in the first period.



**Profit and revenues for the firms**

Domestic profit for home firms expressed in real terms in units of the consumption basket is

$$d_{D,t}(z) = \frac{1}{\theta} \left[ \rho_{D,t}(z) \right]^{1-\theta} C_t - f_{D,t}, \quad (1.4)$$

and domestic revenues (being equal to the sales at home) for home firms

$$r_{D,t}(z) = \left[ \rho_{D,t}(z) \right]^{1-\theta} C_t. \quad (1.5)$$

In every period, a mass  $N_{D,t}$  of firms produces in the home country. These firms have a distribution of productivity level over  $[z_{min}, \infty]$  given by  $G(z)$ . Here is the average productivity level for all producing firm in each country

$$\tilde{z}_D \equiv \left[ \int_{z_{D,min}}^{\infty} z^{\theta-1} dG(z) \right]^{\frac{1}{\theta-1}}. \quad (1.6)$$

From (1.3), we can now calculate the domestic revenue of the average home firm

$$r_{D,t}(\tilde{z}_D) = \tilde{r}_{D,t} = \left[ \frac{\tilde{z}_D}{z_{D,min}} \right]^{\theta-1} r_{D,t}(z_{D,min}). \quad (1.7)$$

Therefore the domestic profit of the average home firm is

$$\tilde{d}_{D,t} = \frac{1}{\theta} \left[ \frac{\tilde{z}_D}{z_{D,min}} \right]^{\theta-1} r_{D,t}(z_{D,min}) - f_{D,t}. \quad (1.8)$$

The zero cutoff profit condition, by pinning down the profit of the cutoff firm implies

$$d_{D,t}(z_{D,min}) = 0 \iff r_{D,t}(z_{D,min}) = \theta f_{D,t},$$

therefore the domestic profit of the average firm is

$$\tilde{d}_{D,t} = \left( \left[ \frac{\tilde{z}_D}{z_{D,min}} \right]^{\theta-1} - 1 \right) f_{D,t}, \quad (1.9)$$

and the domestic revenue of the average firm is

$$\tilde{r}_{D,t} = \theta f_{D,t} \left[ \frac{\tilde{z}_D}{z_{D,min}} \right]^{\theta-1}. \quad (1.10)$$

### 1.2.2 Foreign market

Firms have a disutility in profit volatility (relative to the initial value and not to the mean) due to exchange rate fluctuations, expressed in its export utility function. By contrast, profit made in domestic market is not affected by this disutility because of market segmentation. Firms decide to enter on the foreign market before knowing the exchange rate. The firm sensitivity to volatility is captured by  $\alpha \geq 0$ . I define  $\alpha_{low}$  when  $\alpha \leq \bar{\alpha}$  and  $\alpha_{high}$  when  $\alpha > \bar{\alpha}$ .<sup>7</sup>

$$U_{X,t}(z) = \mathbb{E}_t(d_{X,t}(z)) - \alpha \sqrt{\mathbb{V}_t(d_{X,t}(z))}, \quad (1.11)$$

with  $\mathbb{E}_t$  the expectation and  $\mathbb{V}_t$  the volatility. In my case, the volatility comes from exchange rate variations. There are evidence firms seek ways to reduce their exposure to exchange rate risk through domestic-currency invoicing and hedging. Devereux *et al.* (2004) find that monetary stability increases the attractiveness of a currency to be used as invoicing currency. Döhring (2008) finds that about 50% of euro-area exports to countries outside the European Union (EU) are invoiced in euro, and this share is higher in exports to other EU countries. He also finds that euro area non-financial blue chip companies systematically use financial derivatives to hedge transaction risk.

### Price of exported goods

Only the most productive firms can export as exporting is costly, involving a melting-iceberg cost  $\tau_t \geq 1$  as well as a fixed cost  $f_{X,t} > f_{D,t}$  (in real terms  $w_t f_{X,t}/Z_t$ ) paid at each period. Let  $p_{X,t}$  be the general nominal export price of Home firm, and  $\rho_{X,t}$  the real price, the consumption-based real exchange rate is

$$\rho_{X,t}(z) \equiv \frac{p_{X,t}(z)}{P_t} = Q_t^{-1} \tau_t \rho_{D,t}(z), \quad (1.12)$$

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<sup>7</sup>Solving the model, I find that  $\bar{\alpha} = 2$ .

with  $Q_t \equiv \epsilon_t P_t^*/P_t$  and  $\epsilon_t$  the nominal exchange rate.

The firm's utility function does not modify the price structure, which remains the same as in Melitz (2003). Owing to  $\rho_{D,t}(z)$  shape (mark up being constant), the pass-through is equal to one, increasing the importance of the exchange rate regime.

Let the melting-iceberg cost be different if the firm exports to a country with the same currency, in peg one-to-one or in classical fixed exchange rate. Indeed, as seen in table 1.1, the potential costs are not the same. Let  $\tau_i > 1$  with  $i = \{1, 2, 3\}$ , with  $\tau_1$  being the transport cost,  $\tau_2$  the bank fees on foreign currency change and  $\tau_3$  the conversion cost (because of lack of price transparency). This implies

- a price for currency union,

$$\rho_{cu,X,t}(z) \equiv \frac{p_{cu,X,t}(z)}{P_t} = \frac{P_t}{P_t^*} \tau_{1,t} \rho_{D,t}(z),$$

- a price for peg one-to-one,

$$\rho_{peg,X,t}(z) \equiv \frac{p_{peg,X,t}(z)}{P_t} = \left(\frac{P_t^*}{P_t} \mathbb{D}\right)^{-1} \tau_{1,t} \tau_{2,t} \rho_{D,t}(z),$$

- a price for classical fixed exchange rate,

$$\rho_{fix,X,t}(z) \equiv \frac{p_{fix,X,t}(z)}{P_t} = \left(\epsilon \frac{P_t^*}{P_t} \mathbb{D}\right)^{-1} \tau_{1,t} \tau_{2,t} \tau_{3,t} \rho_{D,t}(z),$$

with  $\mathbb{D} = 1$  (no devaluation) with probability  $\mathbb{P}_t$  and for the sake of simplicity  $\mathbb{D} = 1/2$  (devaluation of one half) with probability  $1 - \mathbb{P}_t$ . The probability  $\mathbb{P}_t$  of no devaluation depends on the credibility  $\phi$  of the exchange rate regime, and its history (has the peg held for a long time already?).

Therefore, we obtain

- a probability to hold for currency union,  $\mathbb{P}_t(\phi_{CU}) = 1$ , since the commitment to hold the peg is extrem.

- a probability to hold for peg one-to-one,  $\mathbb{P}_t(\phi_{peg}) = \mathbb{P}_t(\phi_{peg}(\phi_{peg,t-1})) < \mathbb{P}_t(\phi_{CU})$ , since it is not possible to commit as much as the currency union.

- a probability to hold for fixed exchange rate,  $\mathbb{P}_t(\phi_{fix}) = \mathbb{P}_t(\phi_{fix}(\phi_{fix,t-1})) < \mathbb{P}_t(\phi_{peg})$ , since it is proved in the empirical part that the life expectancy of peg one-to-one is five times higher than classical fixed exchange rate.<sup>8</sup>

At steady state, if there has been no devaluation,  $\mathbb{P}_t(\phi_{peg})$  and  $\mathbb{P}_t(\phi_{fix})$  tend towards 1 with the credibility increase. Therefore, the difference in trade will only be caused by  $\tau_{2,t}$  and  $\tau_{3,t}$ . It is therefore possible to disentangle the effect of credibility from the effect of price transparency empirically.

The cost of exporting depends on the exchange rate regime. As only firms with a big enough markup can export, there will be now 4 different types of firms: those not exporting, those exporting only in the currency union, those exporting in the currency union and with countries being in peg one-to-one, and those exporting everywhere.

### Profits and revenues from sales abroad

The total profit of a home firm will be the sum of its profit at home and abroad:  $d_t(z) = d_{D,t}(z) + d_{X,t}(z)$  with  $d_{X,t}(z)$  being

$$d_{X,t}(z) = \frac{Q_t}{\theta} \left[ \rho_{X,t}(z) \right]^{1-\theta} C_t^* - \frac{w_t f_{X,t}}{Z_t}, \quad (1.13)$$

and export revenues (being equal to the sales abroad) for Home firms

$$r_{X,t}(z) = Q_t \left[ \rho_{X,t}(z) \right]^{1-\theta} C_t^*. \quad (1.14)$$

Among the home firms, there are  $N_{X,t} = [1 - G(z_{X,t})]N_{D,t}$  exporting firms. Here is the average productivity level for Home firm exporting

$$\tilde{z}_X \equiv \left[ \frac{1}{1 - G(z_{X,t})} \int_{z_{X,min}}^{\infty} z^{\theta-1} dG(z) \right]^{\frac{1}{\theta-1}}. \quad (1.15)$$

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<sup>8</sup>I can extend the model easily to include floating exchange rate. The price for a floating exchange rate would be the same than for classical fixed exchange rate, but  $\mathbb{P}_t = 0$  by definition, since there is no peg.

I follow Melitz (2003) and parametrize  $G(z)$  the same way with  $G(z) = 1 - (z_{D,min}/z)^k$  with shape parameter  $k > \theta - 1$ . Letting  $\nu \equiv (k/[k - (\theta - 1)])^{1/(\theta-1)}$ , we have  $\tilde{z}_D = \nu z_{D,min}$  and  $\tilde{z}_X = \nu z_{X,min}$ . We now have the share of home exporting firms  $N_{X,t}/N_{D,t} = (\nu z_{D,min}/\tilde{z}_X)^k$ .

Equation (1.3) remains the same, we can therefore use it the same way as before to calculate the export profit of the average home firm

$$\tilde{d}_{X,t} = \frac{1}{\theta} \left[ \frac{\tilde{z}_X}{z_{X,min}} \right]^{\theta-1} r_{X,t}(z_{X,min}) - \frac{w_t f_{X,t}}{Z_t}. \quad (1.16)$$

### Volatility disutility impact on profit and revenue

The cutoff firm productivity can now be calculated. I start by only study the effect of volatility disutility, and I will later add the distinction in trade cost for the three regimes.

Let  $\eta > 0$  be the change (positive or negative) in the exchange rate from the initial state. With the new firm utility, the cutoff firm has now the following revenue<sup>9</sup>

$$r_{X,t}(z_{X,min}) = \frac{w_t f_{X,t}}{Z_t} \theta \tau_t^{\theta-1} \left( \mathbb{P}_t(\phi) + \eta^\theta (1 - \mathbb{P}_t(\phi)) - \alpha(|1 - \eta^\theta|) \sqrt{1 - \mathbb{P}_t(\phi)} \right)^{-1}. \quad (1.17)$$

#### *Proposition 1: predicting cutoff revenue*

$r_{X,t}(z_{X,min})$  varies with  $\mathbb{P}_t(\phi)$ , in case of devaluation ( $1 - \eta^\theta < 0$ ) :

- if  $\alpha_{low}$ ,  $\frac{\partial r_{X,t}(z_{X,min})}{\partial \mathbb{P}_t(\phi)} > 0$  until  $\mathbb{P}_t(\phi) = 1 - \frac{\alpha^2}{4}$ , then  $\frac{\partial r_{X,t}(z_{X,min})}{\partial \mathbb{P}_t(\phi)} < 0$ . The minimum revenue required to enter on the foreign market is low for  $\mathbb{P}_t(\phi) = 0$  (which means both small and big firms export), increasing until  $\mathbb{P}_t(\phi) = 1 - \alpha^2/4$  (only big firms can export) and decreasing afterward.

Two different mechanisms occur when  $\mathbb{P}_t(\phi)$  tends toward 0 and 1. When  $\mathbb{P}_t(\phi)$  tends toward 0, the "expectancy" mechanism works: firms profit is higher in case of devaluation<sup>10</sup> and the firms expect it. The gain linked to the profit increase more than compensates the loss due to the volatility disutility. When  $\mathbb{P}_t(\phi)$  tends toward 1, the "volatility" mechanism

<sup>9</sup>  $r_{X,t}(z_{X,min})$  being defined as the minimum revenue to export, calculated in domestic currency, with no devaluation.

<sup>10</sup>  $d_{X,t}^{nodevaluation} - d_{X,t}^{devaluation} = 1 - \eta^\theta < 0$ .

works: small firms are more sensitive to the volatility than big firms (which make more profit) and enter on the market if the probability of no devaluation is high enough.

- if  $\alpha_{high}$ , then  $\frac{\partial r_{X,t}(z_{X,min})}{\partial \mathbb{P}_t(\phi)} < 0$ . The sensitivity to volatility is so high that the gain in profit in case of devaluation does not counterbalance the volatility disutility. Small firms enter only if  $\mathbb{P}_t(\phi)$  is high enough.

$r_{X,t}(z_{X,min})$  varies with  $\mathbb{P}_t(\phi)$  in case of appreciation ( $1 - \eta^\theta < 0$ ) :

- $\forall \alpha$ ,  $\frac{\partial r_{X,t}(z_{X,min})}{\partial \mathbb{P}_t(\phi)} < 0$ . In case of appreciation, the profit of the firms decrease, therefore "expectancy" mechanism works the other way and the function is monotonously decreasing. Again, small firms enter only if  $\mathbb{P}_t(\phi)$  is high enough.

The classical fixed exchange rate having the lowest probability of holding the peg among the fixed exchange rate regimes, this regime is less appealing for the firms. There is a hierarchy among the regimes: if a firm can export in a classical fixed exchange rate setup, it can also export in a peg one-to-one and currency union set up.<sup>11</sup> Likewise, if a firm can export in a peg one-to-one setup, it can also export in a currency union set up. I would have liked to check empirically that the minimum revenue threshold for currency union is lower than for peg one-to-one than for classical fixed exchange rate, but I do not have the data.

Revenue and profit of the average firm in case of no devaluation variate the same way than minimum revenue to export. For the sake of clarity and without loss of generality, all my following equations will be written in the case of no devaluation.<sup>12</sup>

$$\tilde{r}_{X,t} = \left[ \frac{\tilde{z}_X}{z_{X,min}} \right]^{\theta-1} \frac{w_t f_{X,t}}{Z_t} \theta \tau_t^{\theta-1} \left( \mathbb{P}_t(\phi) + \eta^\theta (1 - \mathbb{P}_t(\phi)) - \alpha(|1 - \eta^\theta|) \sqrt{1 - \mathbb{P}_t(\phi)} \right)^{-1}, \quad (1.18)$$

<sup>11</sup>The only exception being if  $\mathbb{P}_t(\phi) < 1 - \alpha^2/4$  and  $\alpha_{low}$  at the same time. However empirically, this setup is never observed for fixed exchange rate regimes.

<sup>12</sup>Writing in expectation terms would not have changed the results.

$$\tilde{d}_{X,t} = \left( \left[ \frac{\tilde{z}_X}{z_{X,min}} \right]^{\theta-1} \tau_t^{\theta-1} \left( \mathbb{P}_t(\phi) + \eta^\theta (1 - \mathbb{P}_t(\phi)) - \alpha(|1 - \eta^\theta|) \sqrt{1 - \mathbb{P}_t(\phi)} \right)^{-1} - 1 \right) \frac{w_t f_{X,t}}{Z_t}. \quad (1.19)$$

### Volatility disutility impact on trade

Using aggregation, my micro founded model offers macro prediction on trade that I can check in the empirical part. Trade is defined as the sum of exports (sales on their respective foreign markets) of Home and Foreign firms:  $T_t = Q_t N_{X,t} \tilde{r}_{X,t} + N_{X,t}^* \tilde{r}_{X,t}^*$ ,

$$\begin{aligned} T_t = & Q_t N_{D,t} \tau_t^{-k} (\theta f_{D,t})^{\frac{k}{\theta-1}} \left( \frac{k}{k - (\theta - 1)} \right)^{\frac{k}{\theta-1}} (\tilde{r}_{X,t})^{1 - \frac{k}{\theta-1}} \\ & + N_{D,t}^* \tau_t^{-k} (\theta f_{D,t}^*)^{\frac{k}{\theta-1}} \left( \frac{k}{k - (\theta - 1)} \right)^{\frac{k}{\theta-1}} (\tilde{r}_{X,t}^*)^{1 - \frac{k}{\theta-1}}. \end{aligned} \quad (1.20)$$

As the two countries are symmetric (similar size, fixed cost of entry on the domestic and foreign market, wage and aggregate labor productivity), the trade without devaluation can be written ( $K$  being a constant) as

$$\begin{aligned} T_t = & K \left( \mathbb{P}_t(\phi) + \eta^\theta (1 - \mathbb{P}_t(\phi)) - \alpha(|1 - \eta^\theta|) \sqrt{1 - \mathbb{P}_t(\phi)} \right)^{\frac{k}{\theta-1} - 1} \\ & + K \left( \mathbb{P}_t(\phi) + \eta^{-\theta} (1 - \mathbb{P}_t(\phi)) - \alpha(|1 - \eta^{-\theta}|) \sqrt{1 - \mathbb{P}_t(\phi)} \right)^{\frac{k}{\theta-1} - 1}. \end{aligned} \quad (1.21)$$

Trade follows the inverse movement of  $r_{X,t}(z_{X,min})$  in the devaluation case.<sup>13</sup> Indeed, smaller is the minimum revenue required to export, and bigger is the number of firms being able to export, increasing mechanically trade.

The countries being symmetric, if there is a devaluation for one side, it means a appreciation on the other side.

### Proposition 2: predicting trade

- If  $\alpha_{low}$ ,  $\frac{\partial T_t}{\partial \mathbb{P}_t(\phi)} < 0$  until  $\mathbb{P}_t(\phi) = 1 - \frac{\alpha^2}{4}$  and then  $\frac{\partial T_t}{\partial \mathbb{P}_t(\phi)} > 0$ . If the firms are not too sensible

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<sup>13</sup>  $2 - \eta^\theta - \eta^{-\theta} < 0$  always true.

to volatility ( $\alpha_{low}$ ), when there are high chances of changes in the exchange rate ( $\mathbb{P}_t(\phi)$  close to zero), on one side all the firms will export because they expect a devaluation, and on the other side only the biggest firms will export because they expect a devaluation. In total, trade is higher than when only the biggest firms export (when  $\mathbb{P}_t(\phi) = 1 - \frac{\alpha^2}{4}$ , the uncertainty being the highest). On the contrary, when there are low chances of changes in the exchange rate ( $\mathbb{P}_t(\phi)$  is close to one), in both countries all the firms export because the expected disutility of exchange rate volatility is low. The trade will maximum in this case.

- If  $\alpha_{high}$ ,  $\frac{\partial T_t}{\partial \mathbb{P}_t(\phi)} > 0$ . When the firms are very sensible to volatility ( $\alpha_{high}$ ), small firms on both sides will only export when they are sure there will be no changes in the exchange rate; trade will be the highest when the peg is very credible ( $\mathbb{P}_t(\phi)$  close to one). Trade will be the lowest when the peg is the less credible ( $\mathbb{P}_t(\phi)$  close to zero).

Trade is therefore the highest for currency union, then peg one-to-one, and then classical fixed exchange rate.<sup>14</sup>

The literature does not find significant differences in effect on trade between floating<sup>15</sup> and fixed exchange rate (what I also find). Therefore, regarding the results of my model, it is would imply that we are in the case where  $\alpha$  is low. Furthermore, fixed exchange rate regimes would always have a probability  $\mathbb{P}_t(\phi) > 1 - \frac{\alpha^2}{4}$  to hold the peg.

### Volatility disutility and differentiated trade costs

Combining volatility disutility and differentiated trade cost per regime, here are the different revenues of the cutoff firm for the three regimes:

- revenues of the cutoff firm in currency union

$$r_{cu,X,t}(z_{X,min}) = \frac{w_t f_{X,t}}{Z_t} \theta \tau_{1,t}^{\theta-1},$$

<sup>14</sup>The only exception being if  $\mathbb{P}_t(\phi) < 1 - \alpha^2/4$  and  $\alpha_{low}$  at the same time. However empirically, this setup is never observed for fixed exchange rate regimes.

<sup>15</sup>For pure floating exchange rate regimes,  $\mathbb{P}_t(\phi) = 0$ .



- revenues of the cutoff firm in peg one-to-one

$$r_{peg,X,t}(z_{X,min}) = \frac{w_t f_{X,t}}{Z_t} \theta (\tau_{1,t} \tau_{2,t})^{\theta-1} \left( \mathbb{P}_t(\phi) + \eta^\theta \tau_{3,t}^{1-\theta} (1 - \mathbb{P}_t(\phi)) - \alpha (|1 - \eta^\theta \tau_{3,t}^{1-\theta}|) \sqrt{1 - \mathbb{P}_t(\phi)} \right)^{-1},$$

- revenues of the cutoff firm in classical fixed exchange rate

$$r_{fix,X,t}(z_{X,min}) = \frac{w_t f_{X,t}}{Z_t} \theta \epsilon^{-1} (\tau_{1,t} \tau_{2,t} \tau_{3,t})^{\theta-1} \left( \mathbb{P}_t(\phi) + \eta^\theta (1 - \mathbb{P}_t(\phi)) - \alpha (|1 - \eta^\theta|) \sqrt{1 - \mathbb{P}_t(\phi)} \right)^{-1}.$$

Trade cost increase the tendency observed previously: the higher is the trade cost, and more it increases the minimum revenue required to enter in the foreign market (reducing the number of firms being able to export), and the less the trade is important.

In the long term,  $\mathbb{P}_t(\phi) = 1$  as the credibility increases over time. The only difference between the regimes is therefore in the trade costs

$$T_t = N_{D,t} (\theta f_{D,t})^{\frac{k}{\theta-1}} \frac{k}{k - (\theta - 1)} \left( \frac{w_t f_{X,t}}{Z_t} \theta \tau_t^{\theta-1} \right)^{1 - \frac{k}{\theta-1}} + N_{D,t}^* (\theta f_{D,t}^*)^{\frac{k}{\theta-1}} \frac{k}{k - (\theta - 1)} \left( \frac{w_t^* f_{X,t}^*}{Z_t^*} \theta \tau_t^{\theta-1} \right)^{1 - \frac{k}{\theta-1}},$$

with  $\tau_t = \tau_{1,t}$  for currency union,  $\tau_t = \tau_{1,t} \tau_{2,t}$  for peg one-to-one and  $\tau_t = \tau_{1,t} \tau_{2,t} \tau_{3,t}$  for classical fixed exchange rate.

Trade when  $\mathbb{P}_t(\phi) = 1$  (fixed exchange rate) is higher than when  $\mathbb{P}_t(\phi) = 0$ <sup>16</sup> (floating exchange rate), therefore at steady state, my model predicts that fixed exchange rate regime (if it has hold the peg) has a bigger effect on trade than floating exchange rate. That is indeed what I find empirically.

To summarize the model predictions:

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$$\begin{aligned} T_{t,\mathbb{P}=1} &= N_{D,t} (\theta f_{D,t})^{\frac{k}{\theta-1}} \frac{k}{k - (\theta - 1)} \left( \frac{w_t f_{X,t}}{Z_t} \theta \tau_t^{\theta-1} \right)^{1 - \frac{k}{\theta-1}} \\ &\quad + N_{D,t}^* (\theta f_{D,t}^*)^{\frac{k}{\theta-1}} \frac{k}{k - (\theta - 1)} \left( \frac{w_t^* f_{X,t}^*}{Z_t^*} \theta \tau_t^{\theta-1} \right)^{1 - \frac{k}{\theta-1}} > \\ T_{t,\mathbb{P}=0} &= N_{D,t} (\theta f_{D,t})^{\frac{k}{\theta-1}} \frac{k}{k - (\theta - 1)} \left( \frac{w_t f_{X,t}}{Z_t} \theta \tau_t^{\theta-1} \frac{1}{\eta^\theta - \alpha (|1 - \eta^\theta|)} \right)^{1 - \frac{k}{\theta-1}} \\ &\quad + N_{D,t}^* (\theta f_{D,t}^*)^{\frac{k}{\theta-1}} \frac{k}{k - (\theta - 1)} \left( \frac{w_t^* f_{X,t}^*}{Z_t^*} \theta \tau_t^{\theta-1} \frac{1}{\eta^\theta - \alpha (|1 - \eta^\theta|)} \right)^{1 - \frac{k}{\theta-1}} \end{aligned}$$

- Case 1: if the sensibility to volatility of the firms is high, then trade increases monotonically with peg credibility: currency union should therefore increase trade the most, then peg one-to-one, then the classical fixed exchange rate, then the floating exchange rate.
- Case 2: if the sensibility to volatility of the firms is low, the level of trade is the highest for countries linked by a credible peg but it is high also (but less high) for countries with the most volatile exchange rate (floating exchange rate). This is because the increase in utility for the average firm in the country with the devaluation more than compensates for the decreased utility of the average firm in the country with appreciation. In this case, a floating exchange rate does not necessarily lead to a lower level of trade than the classical fixed exchange rate.
- Currency union allows smaller firms to export because the cutoff revenue to export is lower than in the other regimes.
- At steady state, when the exchange rate regime gains credibility, only trade cost differences matter for trade. The model predicts that at steady state, fixed exchange rate regimes have a bigger effect on trade than floating exchange rate regimes.

Since I have only aggregate trade data, I am able only to check the macro predictions of my model (proposition 2) not the micro predictions (proposition 1). Trade data at country level have the triple advantage of exhaustiveness (a high number of countries), homogeneity (in the collection and organisation of data) and timespan extension. In the empirical part, I expect to find a higher level of trade for currency union, then peg one-to-one, compared to a fixed exchange rate. I expect to be in case 2 (consistent with the literature) and find there is no significant difference between a floating and a classical fixed exchange rate. I also expect trade to increase over time for peg one-to-one and fixed exchange rate regimes. At steady state, I expect to find a different effect on trade for floating and classical fixed exchange rates. Unfortunately, I do not have the data needed to check the prediction about the size threshold for firms to export.

## 1.3 Empirical results

### 1.3.1 The data set

Country level trade data are drawn from the Correlates of War Trade database (Barbieri and Keshk, 2012), for more than 200 countries between 1971 and 2009. Two-digit product disaggregation trade data are drawn from BACI (Gaulier and Zignago, 2010), for more than 200 countries between 1995 and 2015. FTA data are drawn from the Design of International Trade Agreements database (Dür, Baccini and Elsig, 2014), fixed exchange rate data from Shambaugh Exchange Rate Regime Classification<sup>17</sup> (Shambaugh, 2004), geographic data from the CEPII database "GeoDist" (Mayer and Zignago, 2011); and for the rest I use World Development Indicators from the World Bank (1960-2014).<sup>18</sup> Shambaugh's database establishes an inventory of all the de facto fixed exchange rates since 1971; I restrict my study to the post-1971 period and compare the effects on trade of different exchange rate regimes, float exchange rate being the benchmark. It is less interesting to study the period pre 1971 since the gold standard was still in place. Moreover, I consider an exchange rate as fixed only if it has 0% band<sup>19</sup> so that the only difference with peg one-to-one is the price transparency. If a currency is pegged, faces a devaluation and re-pegs to the same anchor, I consider the year of the devaluation as floating regime (with the anchor but also with all the countries still pegged to the anchor). The pairs of countries linked by a fixed exchange rates represent 7% of my observations.

I built a database<sup>20</sup> to reference the currency unions and another one for the pegs one-to-one (checking the currency of the countries year by year) since Rose's (2001) database mixes the two. More details on the construction of my database are provided in the appendix. My database differs from Rose's in that I distinguish between currency unions and pegs one-to-one, add currency unions, correct some dates and update the data. My database covers 35 currency unions and 255 countries/ regions from 1971<sup>21</sup> to 2015. Pairs of countries sharing the same currency represent 0.60% of my observations, and pairs of countries linked by a peg one-to-one represent

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<sup>17</sup>I do not use Ilzetzi, Reinhart and Rogoff (2017) exchange rate classification as I need bilateral data, and this classification does not provide the anchor of each currency in peg.

<sup>18</sup>Variables description can be found in the appendix.

<sup>19</sup>Pegtype=1 in Shambaugh classification.

<sup>20</sup>Helped by De Sousa (2012) Currency Unions database.

<sup>21</sup>In reality, my database starts in 1948 but I use the years previous to 1971 only to calculate the longevity of currency unions and pegs one-to-one.

0.60% of my observations. Moreover, pegs one-to-one dummies represent 9.2% of the total fixed exchange rates dummies. Summary statistics are provided in table B1 in the appendix.

It should be noted that countries in peg one-to-one have tight cultural links with their anchor since there is a propensity for a common language (even higher than among members of a currency union) and also a propensity to have colonial links. These countries on average are quite poor compared to currency union members or classical fixed exchange rate countries. They have small populations and small surface areas, and are geographically close to the anchor. They are also slightly more open in terms of trade. These characteristics are fairly in line with the determinants identified in the literature<sup>22</sup> for being part of a currency union, first theorised by Mundell in his paper on optimum currency areas. Furthermore, Ahn, Khandelwal and Wei (2011) highlight the role of intermediaries in facilitating trade for low productivity firms. They show that intermediaries are especially important in markets that are more difficult to penetrate. As peg one-to-one pairs and currency unions have tighter cultural links, we can speculate that intermediaries should be less important, and direct export less costly.

### 1.3.2 Methodology and first results

My methodology is based on the gravity model, which is standard in the empirical literature on the determinants of bilateral trade. I follow Glick and Rose (2016) in using Head and Mayer's (2014) LSDV (Least Squares with time-varying country Dummy Variables) technique, and include time-country fixed effects to capture growth of economic activity. I follow Flam and Nordström (2006) by having one-way trade (exports) instead of two-way trade (exports plus imports). In line with Baldwin and Taglioni's (2007) recommendation, I include country-pair fixed effects which capture time-invariant pair-specific variables such as border contiguity, distance, common language or colonial links. My data by construction are clustered by pair-country. The source of identification of the regime effects comes from switches in and out of regimes. I believe the use of these fixed effects provides the cleanest benchmark against which to assess the impact of currency unions, peg one-to-one and fixed exchange rate on (log) exports. The Hausman test supports the hypothesis of a fixed effect. I control for trade increases from free trade agreements

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<sup>22</sup>Openness for McKinnon (1990), distance, language, colonial heritage and size for Tenreyro (2001) and Marchesiani (2011).

by including a FTA dummy, following Micco, Stein and Ordoñez (2003) since this can influence bilateral trade. The estimated baseline model is the following

$$\ln Export_{ijt} = \beta_1 CU_{ijt} + \beta_2 Peg1to1_{ijt} + \beta_3 Fixed_{ijt} + \beta_4 FTA_{ijt} + \lambda_{1it} + \lambda_{2jt} + \gamma_{ij} + \epsilon_{ijt},$$

where  $\ln Export_{ijt}$  is the (log) of annual export from country  $i$  to country  $j$ ,  $CU_{ijt}$  is a dummy for currency unions,  $Peg1to1_{ijt}$  a dummy for pegs one-to-one and  $Fixed_{ijt}$  a dummy for classical fixed exchange rate.  $FTA_{ijt}$  is a dummy for free trade agreements.  $\lambda_{1it}$  and  $\lambda_{2jt}$  represent the time-country fixed effect on exporter and importer, and  $\gamma_{ij}$  the pair-country fixed effect.  $\epsilon_{ijt}$  is the error term.

As the peg one-to-one is a form of fixed exchange rate, my dependent variables are linked to each other, and I could have used a nested probit model, with countries facing a decision tree. However, there are very strong assumptions on the error term, leading (if the model is not well specified) to worse misspecifications than in a simple linear model. I therefore prefer a linear model. Econometrically speaking, the fact that the control variables are not independent is not a problem in the linear regression framework.

There is one additional issue that I need to address in order to get a more reliable view on the effect of these different exchange rate regimes on trade. These regressions suffer from problems of endogeneity: countries, because they trade a lot, decide on a currency union or a peg one-to-one. The potential endogeneity is not necessarily captured by the fixed effect. One way to capture it is to use an instrumental variable.

I use the instrument developed by Barro and Teneyro (2007). The instrument uses the hub-and-spoke organisation of fixed exchange rate. The main idea is to use the independent decisions of countries to peg/ be in currency union with a main anchor. The likelihood that they peg to the same anchor is used as an instrument since it is considered to be exogenous. For example, Portugal and Estonia are in currency union exogenously: they both wanted to link to the main anchors (Germany and France). Frankel (2010) uses a similar exogenous event in a case study

to show the effect on trade. Some former French colonies were pegged to France. When France joined the Eurozone, it created an exogenous peg between the rest of the Eurozone and these former colonies. Frankel shows that trade increased by 76% between the former French colonies and the Eurozone members (France excluded), proving causality.

I adopt the same methodology as Barro and Tenreyro (2007) and estimate the probability that a given country enters a currency union using one of the six main anchors in Barro and Tenreyro (Australia, France, Germany, Japan, the UK and the USA), employing a probit that is presented in table A5 in the appendix. This probability depends on several factors such as distance, colonial links, common language, etc. I then compute the joint probability that two countries have a common anchor. The key point is that bilateral relations are not transitive. For example, the distance from the two countries to their common anchor does not give a precise information on the distance between these countries. Similarly, since more than one language is spoken in some countries, the relation is nontransitive.

The joint probability to be in currency union is used as an instrument for the currency union dummy, and the joint probability to be in peg one-to-one is used as an instrument for the peg one-to-one dummy. The Sargan–Hansen test does not reject the instrument. However, I do not instrument the classical fixed exchange rate since an f-test rejects my instrument as not being sufficiently predictive.

I also modify Barro and Tenreyro’s instrument by extending the number of hubs, adding India, South Africa, Belgium, Portugal, Spain, Russia, and New Zealand. The list of hubs and spokes I provide in the appendix. The estimations do not change significantly.

I report in table 1.2 the results with the simple LSDV and IV.

Table 1.2: LSDV and IV methods

lnExport	(1) LSDV	(2) LSDV without fixed exchange rate	(3) IV
Currency Union <sub>ijt</sub>	0.502*** (0.0405)	0.550*** (0.0327)	4.774*** (0.680)
Peg one-to-one <sub>ijt</sub>	0.216*** (0.0578)	0.318*** (0.0544)	19.12 (14.73)
Fixed exchange rate <sub>ijt</sub>	-0.0113 (0.0108)		-0.376* (0.218)
FTA	0.262*** (0.0113)	0.206*** (0.00944)	0.250*** (0.0190)
Pair-country FE	YES	YES	YES
Exporter-year FE	YES	YES	YES
Importer-year FE	YES	YES	YES
Observations	419,348	541,063	359,871
R-squared	0.879	0.876	0.854
F-test	20.44	15.71	1.026
Prob > F	6.17e-06	7.37e-05	0.311

*Note:* The control group is the float exchange rate regime. The first stage of the IV can be found in table A5 in the appendix. Cluster by construction. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table 1.2 column 1 shows that currency union has a bigger impact on trade than peg one-to-one (65%<sup>23</sup> increase against 24%,<sup>14</sup> or approximately a 63% difference). Fixed exchange rate has no significant impact. This is in range with my model predictions in the case of  $\alpha_{low}$ .

The results discussed so far suggest that pegs one-to-one are special in the “fixed exchange rate family”. The difference between peg one-to-one and classical fixed exchange rate lies in the fact that no price conversion is needed for peg one-to-one, while a classical fixed exchange has to “pay” an additional conversion cost. When a shock occurs which upsets the trade balance, a country with a simple peg devalues its currency to restore the balance, and most of the time re-pegs to the same currency.<sup>24</sup> However, a country with a peg one-to-one loses its specificity if it devalues. The incentive to keep the peg is much higher. Therefore, the shock would have to be much bigger to cause a devaluation. This explains the difference in life expectancy between

<sup>23</sup>  $e^{0.502} \approx 1.65$ ;  $e^{0.216} \approx 1.24$ .

<sup>24</sup> Klein and Shambaugh (2008).

the two types of peg which is 3 years<sup>25</sup> for a classical peg, while pegs one-to-one have a lifespan of 21 years (against 27 years for currency unions). This gap potentially implies fundamental differences between them. Knowing this, investors and traders act differently and this has an impact on economic activity.

Frankel (2010) finds an increase in trade among the Eurozone members as early as 1997, showing an anticipation effect of the single currency. In table A7 in the appendix, I check whether there is anticipation before the switch to currency union, peg one-to-one and fixed exchange rate. To do that, I use one dummy per year before and after the switch to the new regime. I find anticipation effects up to six years before the introduction of a currency union, but no effect for peg one-to-one and fixed exchange rates. This is unsurprising since changing a currency is more cumbersome, and therefore can be anticipated better. The consequence is that the effect of currency unions is underestimated in table 1.2 column 1 (that is why I have much higher coefficients in table A7 column 1).

In line with Barro and Tenreyro (2007), table 1.2 column 3 shows that ordinary least square (OLS) results underestimate the impact of currency union on bilateral trade. However, the impact of peg one-to-one on trade is no longer significant. This means that the increase in trade is endogenous. Indeed, looking at the characteristics of the countries in peg one-to-one,<sup>26</sup> it appears that their propensity to share a common language with their anchor is very high (even higher than among countries sharing a common currency), and also they have strong colonial links. This may explain the endogeneity.

The instrument variable (IV) also takes care in part of the anticipation effect highlighted in table A7 column 1, since it mainly concerns the main anchor and not the collateral members of the currency union.

My results are in line with Meissner and Oomes (2009) who show that trade was a key determinant in the choice of the anchor for a pegged country while Marchesiani (2011) shows that “bilateral transactions between two countries are not a useful indicator of their membership in a common

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<sup>25</sup>This short peg period supports the idea in “The Mirage of Fixed Exchange Rates” Obstfeld and Rogoff (1995) that fixed exchange rates constantly adjust and are not that fixed: “literally only a handful of countries in the world today have continuously maintained tightly fixed exchange rates against any currency for five years or more.”

<sup>26</sup>See table B1 in the appendix.



currency area”.

Currency unions have an even greater impact than previously thought as the effects on trade do not come from the fixity of the exchange rate, or price transparency. The fact that the currency union effect on trade comes from its fixed exchange rate regime credibility is the main contribution of this paper.

### 1.3.3 Robustness checks

#### Additional tests

I check robustness by estimating a traditional gravity equation, without pair-country and time-country fixed effects, adding all the traditional controls as in Barro and Tenreyro (2007). Table A8 in the appendix presents these results.

This exercise suggests that currency unions increase trade by 127%<sup>27</sup> against 26%<sup>11</sup> for peg with time fixed effect, and by 65%<sup>11</sup> against 46%<sup>11</sup> with both time and country fixed effect. Fixed exchange rate effect on trade is very small in the first case (2.4%<sup>11</sup>) and insignificant in the second.

The first observation from a comparison with table 1.2 is that my results are quite different from one specification to the next. This discrepancy is highlighted by Glick and Rose (2016): estimates of the currency union effect on trade are sensitive to the exact econometric methodology. Therefore, I focus only on the relative difference between currency unions and pegs one-to-one and not on levels since they fluctuate so much.

Nevertheless, my findings for currency union are in the range of those in the literature.<sup>28</sup> However, they are higher than those obtained by measuring only the effect of the euro on bilateral trade.<sup>29</sup> Glick and Rose (2016) also find much bigger effects when they include the world in their sample rather than only the Eurozone.<sup>30</sup>

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<sup>27</sup>  $e^{0.820} \approx 2.27$ ;  $e^{0.230} \approx 1.26$ ;  $e^{0.498} \approx 1.65$ ;  $e^{0.378} \approx 1.46$ ;  $e^{0.0246} \approx 1.024$ .

<sup>28</sup> Persson (2001) finds 61% and Tenreyro (2001) 50%.

<sup>29</sup> Micco, Ordoñez and Stein (2003) finds between 6 and 26%; Bun and Klaassen (2007) finds 38%; Flam and Nordström (2006) 15%.

<sup>30</sup> Frankel (2010) tries to explain this discrepancy but fails to charge the three usual suspects: lack of hindsight because of the youth of the euro, difference in size since euro members on average are bigger, and endogeneity problems.

The story that emerges from both these tables is that currency union still has a bigger impact on trade than peg one-to-one. Table A8 shows the biggest effect differences between currency union and peg one-to-one compared to the LSDV methodology (table 1.2), around an 80% difference with only time fixed-effects, and a 30% difference with the addition of country-fixed effects. The coefficient of the fixed exchange rate dummies is not significant which means that a “classical” fixed exchange rate does not affect bilateral trade. My findings are in line with Tenreyro (2007).

**Controlling for zeros** One problem with the logarithm of export is that it leads to the exclusion of observations with zeros values. In order to address this potential bias, I follow Barro and Tenreyro (2007) and estimate the gravity equation with a Poisson Pseudo Maximum Likelihood (PPML). The results (table A9 in the appendix) are close to those obtained above and do not reverse the trend for currency union to have a bigger effect than peg one-to-one. This suggests that my coefficients are not affected by the exclusion of zero-value observations.

### **Regime duration**

Klein and Shambaugh (2006) establish that the expected duration of a peg increases dramatically if it survives two years. Klein and Shambaugh (2008) calculated the probability of a fixed exchange rate given that it was fixed the previous year, was 82%; and this conditional survival rate increases with the number of years duration in the spell. Fritz-Krockow and Jurzyk (2004) established that the longer the peg and more positive its impact on bilateral trade. According to Dorn and Egger (2013), the effect is significant after eight years.

I investigated whether my estimations are sensitive to the duration of the exchange rate regime by comparing the first years of a regimes with latest periods. Table 1.3 presents the effects of currency unions/pegs one-to-one/classical fixed exchange rates in the first 5 years, then between the 5th and 10th years, etc. up to over 20 years.

Table 1.3: First years versus latest years

lnExport	(1) Currency union	(2) Peg one-to-one	(3) Fixed exchange rate
Age 0-5 years	0.459*** (0.0386)	0.303*** (0.0521)	0.00309 (0.0112)
Age 6-10 years	0.579*** (0.0452)	0.321*** (0.0593)	0.00849 (0.0196)
Age 11-15 years	0.306*** (0.0728)	0.124** (0.0625)	0.0459 (0.0343)
Age 16-20 years	0.246** (0.101)	0.215*** (0.0585)	0.158*** (0.0420)
Age more 20 years	0.547*** (0.0934)	0.399*** (0.0582)	0.107** (0.0496)
Constant	1.117*** (0.00155)	1.119*** (0.00152)	1.106*** (0.00205)
Pair-country FE	YES	YES	YES
Exporter-year FE	YES	YES	YES
Importer-year FE	YES	YES	YES
Observations	637,754	637,754	421,083
R-squared	0.869	0.869	0.880

*Note:* here is how to read this table, in the first 5 years, currency unions increase trade by 46%, while when they are between 11 and 15 years old they increase trade by 31%. Cluster by construction. Standard errors in parentheses (\*\*\* p<0.01, \*\* p<0.05, \* p<0.1)

My model predicts that currency unions have a strong effect from the beginning, and are stable over time. However, my empirical results do not confirm the stability (the difference in the currency union effect between age 6-10 and age 11-15 is significant, but not between age 11-15 and age 16-20). My model predicts also that trade is smaller at the beginning for peg one-to-one and fixed exchange rate compared to currency union, and increases linearly over time. However, for peg one-to-one as for currency union, the empirical results show non-linearity for the 11 and 20 year periods (again, the coefficient differences are significant between ages 6-10 and ages 11-15, but not between ages 11-15 and ages 16-20). The curved shape can be explained by two contradictory mechanisms: on the one side, regime credibility increases and therefore, trade should increase. On the other side, De Sousa (2012) shows that the effect of currency union on trade is decreasing over time, and this might apply also to peg one-to-one.

After 20 years, the difference between currency union and peg one-to-one is quite small since

peg one-to-one has gained credibility. Therefore, the difference between the gap in the 0-5 year period, and the gap in the +20 year period represents the gain in commitment/credibility. At an infinite horizon, the gap between currency union and peg one-to-one would represent the cost of changing between currencies (embodied in  $\tau_{2,t}$  in my model) since there would be no longer any difference in credibility between currency union and peg one-to-one. The classical fixed exchange rate effect on trade is not significant in the first years, and becomes significant after 15 years although not very high (around 17%<sup>31</sup>). This is in range with what my model predicts.

### **Currency union and peg one-to-one effect varies across country pairs and across blocks**

Chen and Novy (2016) find heterogeneous effects of currency unions on trade, country pairs associated with small import shares benefiting currency union a lot, while country pairs associated with large import shares do not benefit. I replicate their methodology,<sup>32</sup> adding peg one-to-one. In the first stage, I predict the theoretical trade for each country pair by regressing observed (log of) bilateral trade on exogenous variables (distance, common border, common language, colony, same country) and exporter-year and importer-year fixed effects. In the second stage, I regress (log of) bilateral trade on the currency union dummy, an interaction between the currency union dummy and the predicted trade, peg one-to-one dummy, an interaction between the peg one-to-one dummy and the predicted trade, and exporter-year, importer-year and pair-country fixed effects. The results are presented in table 1.4.

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<sup>31</sup> $e^{0.158} \approx 1.17$ .

<sup>32</sup>However I use log of bilateral export as my dependent variable, and not log of bilateral export divided by the GDP of the exporter, divided by the number of different product categories exported by each country.

Table 1.4: Heterogenous effect of currency union and peg one-to-one

VARIABLES	(1) lnExport
Currency Union	0.585*** (0.0319)
Currency Union*Predicted Trade	-0.128*** (0.0228)
Peg one-to-one	0.329*** (0.0323)
Peg one-to-one*Predicted Trade	-0.0882*** (0.0198)
Observations	610,802
R-squared	0.870
Pair-country FE	YES
Exporter-year FE	YES
Importer-year FE	YES

*Note:* two-step method estimating the effect of currency union and peg one-to-one depending on the intensity of the potential trade between two countries. Cluster by construction. Standard errors in parentheses (\*\*\* p<0.01, \*\* p<0.05, \* p<0.1)

I find a negative and significant coefficient of Currency Union\*PredictedTrade, in line with Chen and Novy (2016). This means that the effect of currency union on trade is larger for pairs of countries that trade the least, and smaller for countries that trade the most. The heterogeneity of the effect applies also to peg one-to-one but is less marked.

Following Chen and Novy (2016), I split my sample into ten equally-sized intervals of predicted trade ranked by value, creating a dummy for each category. I then estimate the effect of currency union and peg one-to-one on each interval (table A10 in the appendix). I find that currency union has the biggest impact on the 50th-80th percentile. The effect of peg one-to-one on each decile is more chaotic with no clear pattern. This might be due to the endogeneity of this effect.

Finally, I take the six biggest currency unions with at least three pegs one-to-one attached to them<sup>33</sup> (pound sterling, US dollar, Franc CFA, Indian Rupee, French Franc and Portugal Escudo) and estimate their effect on trade separately. The results are presented in table A11

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<sup>33</sup>Euro has no peg one-to-one attached.

in the appendix. There is a great deal of heterogeneity in the effect on trade of both currency unions and pegs one-to-one. This is not surprising since these currency unions have such different histories and such diverse economic links.

### The case of vehicle currency pricing

Since many nondifferentiated goods exchanged on centralised markets are priced in dollars, the currency of the two partner countries does not really matter. I use Rauch's (1999) classification (2-digit product disaggregation) to test for vehicle currency pricing, dividing the sample between goods traded on an organized exchange and others. The results are presented in table 1.5.

Table 1.5: Effect of vehicle currency pricing

lnExport HS 2-digit product disaggregation	(1) All	(2) Goods traded on an organized exchange	(3) Goods not traded on an organized exchange
Currency Union	0.144*** (0.00867)	0.232*** (0.0165)	0.107*** (0.00994)
Peg one-to-one	0.0862** (0.0435)	-0.0158 (0.0861)	0.108** (0.0493)
Fixed exchange rate	-0.0181*** (0.00492)	-0.0186* (0.00960)	-0.0136** (0.00560)
Observations	13,604,591	3,767,913	9,833,080
R-squared	0.358	0.336	0.398
Pair-country FE	YES	YES	YES
Exporter-year FE	YES	YES	YES
Importer-year FE	YES	YES	YES
F-test	1.694	8.011	7.82e-05
Prob > F	0.193	0.00465	0.993

*Note:* The control group is the float exchange rate regime. Cluster by construction. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

First, looking at the whole sample at the two-digit product disaggregation, it is interesting that the effect of the currency union is still higher than the effect of peg one-to-one, both being smaller than in table 1.2. One reason for this might be that here, my sample here starts in 1995. De Sousa (2012) shows that the effect of currency union on trade decreases over time, which might be the same for peg one-to-one.

Second, columns 2 and 3 show that peg one-to-one has no effect on goods traded on an organised

market while currency union does. This might be because currencies used in currency unions are more powerful, and are more often used as a vehicle currency in organised markets. To sum up, the vehicle currency pricing system decreases the effect of the peg one-to-one.

### 1.3.4 Entry and exit

In this section, I am interested in comparing the effect of entering and exiting an exchange rate regime. I compare the first five years after entry in each exchange rate regime, to the five years before exit. The results are presented in table 1.6.

Table 1.6: Comparing the effect of an exchange rate regime on trade during its first 5 years and its last 5 years

VARIABLES	(1) lnExport
5 first years after entry Currency Union	0.336*** (0.0387)
5 last years before exit Currency Union	0.630*** (0.0794)
5 first years after entry Peg one-to-one	0.132** (0.0637)
5 last years before exit Peg one-to-one	0.221*** (0.0423)
5 first years after entry Fixed exchange rate	0.0146 (0.0130)
5 last years before exit Fixed exchange rate	-0.0507*** (0.0143)
Pair-country FE	YES
Exporter-year FE	YES
Importer-year FE	YES
Observations	635,952
R-squared	0.868

*Note:* in the first 5 years after being in currency union, trade was 34% higher compared to countries sharing a floating exchange rate. In the last 5 years before exiting currency union, trade was 63% higher compared to countries sharing a floating exchange rate. Cluster by construction. Standard errors in parentheses (\*\* p<0.01, \* p<0.05, \* p<0.1)

The effect on trade is always bigger for currency unions than for the other exchange rate regimes, whether we compare the first or the last years of the regime. The effect is bigger in the last years in the case of both currency union and peg one-to-one. This might be linked to the fact

that (as table 1.3 shows) the effect on trade tends to increase over time. My results contradict those in Glick and Rose (2016) who find a symmetry between the effects of entering and leaving a currency union. The difference observed between the effects on trade during the first and last years is featured in the model for peg one-to-one but not for currency unions. Finally, note that the classical fixed exchange rate has a negative and significant impact on trade during the last years before devaluation/ change of regime, which could be one reason for the above finding.

Reasons for entering and exiting currency unions often stem from very different roots. In my sample, the majority of exits are brutal. For example, many of the countries leaving currency unions were former colonies that became independent and abandoned their coloniser's currency. On the other hand, many countries in my database that joined a currency union are small (often islands) or poor countries that lack credibility or the willingness for a currency of their own (e.g., Liechtenstein, Naru, Kosovo, etc.). Other countries joined a currency union to strength political and economical links.

The reasons for entering and exiting a peg one-to-one are also diverse. A lot of former colonies left currency unions for peg one-to-one, either with their former coloniser, or with their neighbors which were also former colonies (this applies to former French colonies in Sub-Saharan Africa). The transition from currency union to fixed exchange rate is therefore smoother. In contrast, Belgium and Luxemburg left peg one-to-one in 1999 to achieve a tighter link: currency union. The other scenario is Argentina which in 2001 left peg one-to-one with the United States for a floating exchange rate under pressure from the markets. Similarly, in 1966 Bangladesh, Nepal and Sri Lanka broke with peg one-to-one with India when India decided to devalue the Indian rupee by 57% because of an internal economic crisis.

Finally, reasons for entering and exiting a classical fixed exchange rate vary. For example, in 1992 the European Union strengthened the European Monetary System to prepare for the single currency union, allowing very little fluctuations in the band. The oil countries decided to peg to the dollar in the 90's to stabilize their revenues. On the other hand, a lot of countries were pegged to the dollar during the gold standard, and abandoned the peg in the subsequent three years. Many Latin American countries faced severe economic crisis with high inflation in the 1980s which forced them to abandon the peg with the dollar. After decolonisation, numerous



former British colonies switched their peg from the pound sterling to the dollar. Finally, some countries have a fixed exchange rate regime with a band, whose width changes over time. My database considers the status of the regime depending on the band width adopted every year, I therefore have a lot of entries and exits depending on the small size of the band of the peg. Since the reasons for exiting and entering a exchange rate regime are different, it is not surprising that the effects are not the same.

Table A12 and A13 in the appendix show the conditional probability of being in a regime, depending on the previous regime, or the next one. The switches from fixed exchange rate to float exchange rate, and vice versa, represent the large majority of my observations, these two regimes being the most common. It is interesting that most countries were first in a fixed exchange rate before being in a currency union which indicates the existence of previous monetary links between the pairs. Similarly, most countries in peg one-to-one were previously in a currency union which suggest a willingness to lessen the shock of currency union exit.

I try to study specifically the effect of switching from one exchange rate regime to another. I work on a 20-year period: 10 years before and 10 years after a switch. Table 1.7 presents the results for entries: for example in column 1, among the switches to a floating regime, the coefficients represent the effect on trade of previously being in either currency union, peg one-to-one, or fixed exchange rate. Table 1.8 presents the results for exits.

Table 1.7: Comparing the last years of each regimes (control group: the first years of the common regime they switch to)

lnExport	(1) Switching to Float	(2) Switching to CU	(3) Switching to Peg	(4) Switching to Fixed
Last years in Currency Union	0.273** (0.109)		0.493 (1.134)	3.270*** (1.219)
Last years in Peg one-to-one	0.208** (0.0927)	0.0425 (54,374)		-0.364 (0.270)
Last years in Fixed exchange rate	-0.0836*** (0.0236)	0.00646 (0.120)	3.554 (2.213)	
Last years in Float exchange rate		0.0927 (0.0941)	-2.765 (158,016)	0.0138 (0.0266)
Pair-country FE	YES	YES	YES	YES
Exporter-year FE	YES	YES	YES	YES
Importer-year FE	YES	YES	YES	YES
Observations	90,663	4,468	1,154	73,058
R-squared	0.906	0.991	0.989	0.910
F-test	9.426	0.240	1.296	3.916
Prob > F	8.06e-05	0.786	0.274	0.0199

*Note:* switching from a currency union to a floating exchange rate, trade was 27% higher in the last 10 years of currency union compared to the 10 first years in float. Cluster by construction. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table 1.8: Comparing the first years of each regimes (control group: the last years of the common regime they switch from)

lnExport	(1) Switching from Float	(2) Switching from CU	(3) Switching from Peg	(4) Switching from Fixed
First years in Currency Union	0.324*** (0.105)		-14.72 (12,008)	0.365*** (0.0797)
First years in Peg one-to-one	-0.119 (0.211)	-0.0307 (0.371)		0.163 (0.370)
First years in Fixed exchange rate	-0.00824 (0.0260)	-0.146 (0.476)	-0.320* (0.164)	
First years in Float exchange rate		-0.0518 (0.361)	-0.411*** (0.133)	0.0836*** (0.0237)
Pair-country FE	YES	YES	YES	YES
Exporter-year FE	YES	YES	YES	YES
Importer-year FE	YES	YES	YES	YES
Observations	75,375	2,431	5,649	86,220
R-squared	0.913	0.970	0.967	0.910
F-test	5.305	0.0454	1.42e-06	6.184
Prob > F	0.00497	0.956	0.999	0.00206

*Note:* switching from a floating exchange rate to a currency union, trade was 32% higher in the first 10 years of currency union compared to the 10 last years in float. Cluster by construction. Standard errors in parentheses (\*\* p<0.01, \* p<0.05, \* p<0.1)

The effect of entering or exiting from a currency union (line 1 of table 1.7 and 1.8) is usually large and significant with the exception of leaving or entering a peg one-to-one. Therefore, it means that the exchange rate regimes are quite close. However, columns 2 in table 1.7 and 1.8 are never significant since the effect of peg one-to-one, fixed exchange rate and float are compared to currency union.

The effects of the first years and last years again are different, as in table 1.6. Also, care is needed when comparing the two tables, because the control groups are different, the columns in table 1.7 compare only countries entering in a certain regime, while the columns in table 1.8 compare only countries exiting from a certain regime.

## 1.4 Conclusion

To conclude, there is definitely something particular about peg one-to-one; it displays the characteristics of neither the currency union nor classical exchange rate. Its positive impacts on trade increase over time and tend at steady state, to be close to currency union effects; however, in contrast to currency union, their effects appear to be endogenous. Therefore, peg one-to-one should be studied separately from currency unions, in particular, to understand the reasons of its longevity. This might have important consequences since some researchers pool currency unions and peg one-to-one.

My study confirms the important and positive effects of currency union on trade and shows that they do not come from exchange rate fixity or price transparency but rather from credibility. Indeed, a common currency is seen as “a much more serious and durable commitment” than other monetary arrangements (McCallum, 1995), currency union regime credibility is even more important than most researchers thought: credible commitment and trust are the main engine of trade. Even if government changes, monetary policy does not.

The policy implications of this study concern the importance of exchange rate regime credibility for international trade. Government’s hand must be tied, and it appears that only currency union so sufficiently strong enough to achieve this, peg one-to-one being of little help. In addition, price transparency does not play a role in increasing trade.

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## 1.A Appendix: Map

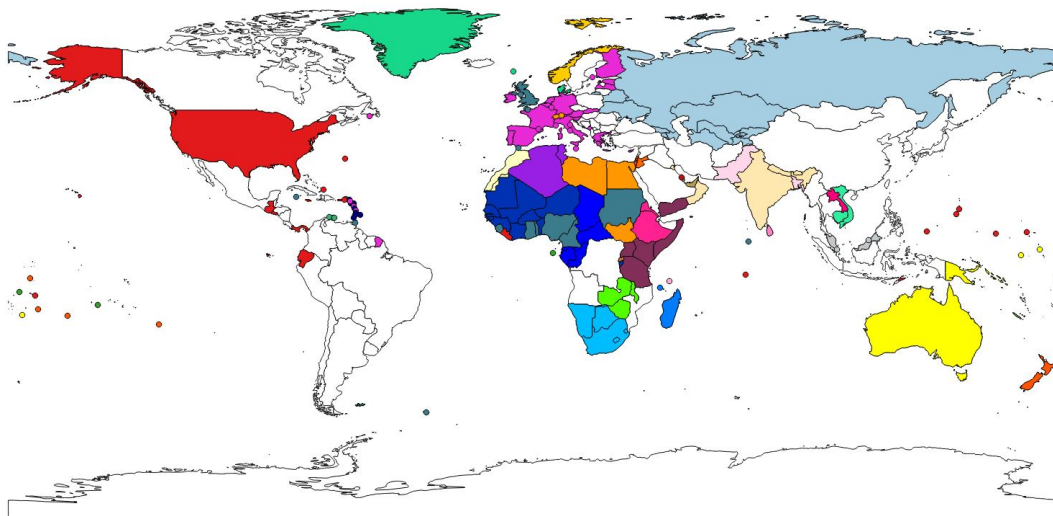


Figure A1: Currency unions since 1948, the most recent being represented above

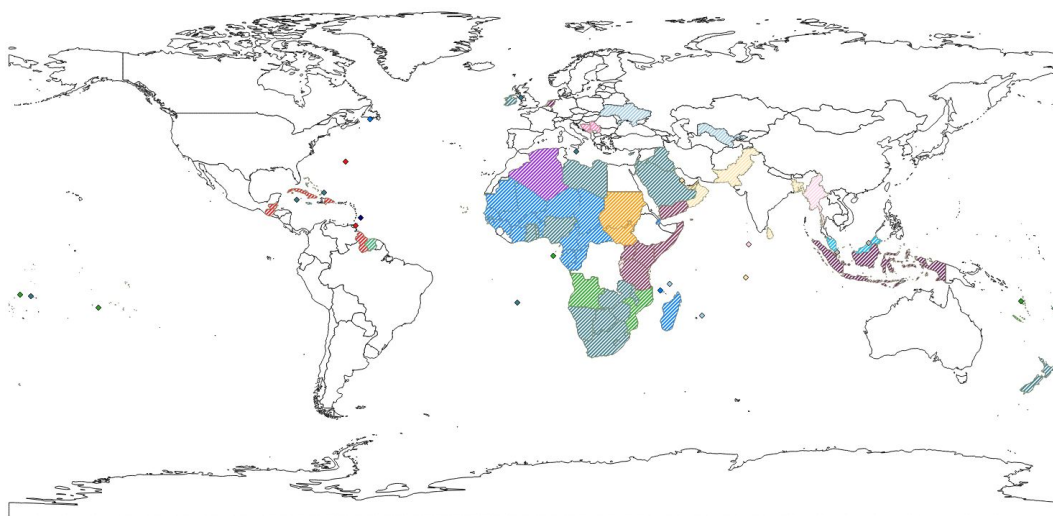


Figure A2: Pegs one-to-one since 1948, the main country or currency union to which they peg not being counted

## 1.B Appendix: Methodology for the construction of the databases

I decided to start my database from 1948 (in order for my results to be compared to Rose, 2000) and to include all countries with an iso3 code (today, there are 255 country code assigned). Each currency union and peg one-to-one has to last for more than one year to qualify for inclusion in my database. Regime changes June 30 are not considered for the year.

In order to build my currency union database, for each country I searched for the previous official currency(ies) for every year. If I found a match between two countries, the pair was classed as in currency union. I used the same methodology for the peg one-to-one database with a de facto classification (and no fluctuation band allowed) on the official market. The peg one-to-one ended if a devaluation was notified.

There are 35 currency unions in my database, the smallest gathering two countries, and the biggest (pound sterling) gathering 46 countries. Between 1948 and 2016, 142 regions/ countries were at some point involved in a currency union. Peg one-to-one account for 8% of the pegs. Between 1948 and 2016, 145 regions/ countries at some points were involved in peg one-to-one.

Next page, some summary statistics for each exchange rate regime.

Variable	Regime	Obs.	Mean	Std. Dev.	Min	Max
CommonBorder	All	3336216	0.012	0.109	0	1
	CU	39434	.1080286	.3104205	0	1
	Peg1:1	34430	.0368283	.1883429	0	1
	Fixed	91732	.0431256	.203141	0	1
CommonLanguage	All	3336216	0.177	0.381	0	1
	CU	39434	.6588731	.4740939	0	1
	Peg1:1	34430	.701946	.45741	0	1
	Fixed	91732	.3257969	.4686744	0	1
Colony	All	3336216	0.01	0.098	0	1
	CU	39434	.0849521	.2788139	0	1
	Peg1:1	34430	.0307871	.1727429	0	1
	Fixed	91732	.0176601	.1317135	0	1
Distance	All	3336216	8545.405	4683.881	59.61723	19951.16
	CU	39434	4079.538	4342.446	59.61723	18517.37
	Peg1:1	34430	6102.437	4594.335	111.0933	19227.74
	Fixed	91732	6995.551	4958.834	80.98481	19711.86
Surface	All	13032	3709523	1.24e+07	2	1.30e+08
	CU	3982	867813.9	3478862	2	2.74e+07
	Peg1:1	1701	307632.2	410171.6	50	2381740
	Fixed	1194	588083.9	1313594	300	9388250
Population	All	13429	1.43e+08	5.50e+08	4279	7.21e+09
	CU	4164	3.45e+07	1.37e+08	5563	1.27e+09
	Peg1:1	1758	5329419	7073528	5563	5.72e+07
	Fixed	1192	2.75e+07	1.30e+08	60704	1.30e+09
GDPperCapita	All	9916	1.11e+12	4.48e+12	1.60e+07	5.81e+13
	CU	3010	5.23e+11	2.03e+12	1.60e+07	1.83e+13
	Peg1:1	1326	2.57e+10	6.95e+10	1.12e+08	5.81e+11
	Fixed	1003	6.07e+10	1.66e+11	1.09e+08	2.04e+12

Table A1: Summary Statistics

## 1.C Appendix: List of currency unions and pegs one-to-one

Table A2: List of currency unions in my database

Currency union	Hub and spoke	Date	Added/modified compared to Rose
<b>East Caribbean Dollar</b>	Anguilla (UK)	1948 – 2015	Added
	Antigua and Barbuda	1948 – 2015	
	Barbados	1948 – 1973	Modified
	Cayman Islands (UK)	1952 – 1965	Added
	Dominica	1948 – 2015	
	East Caribbean States	1948 – 2015	Added
	Grenada	1948 – 2015	
	Jamaica	1952 – 1965	Added
	Montserrat (UK)	1948 – 2015	
	St. Kitts and Nevis	1948 – 2015	
	St. Lucia	1948 – 2015	
	St. Vincent	1948 – 2015	
	Trinidad and Tobago	1948 – 1965	
	Turks and Caicos Islands (UK)	1952 – 1965	Added
	Virgin Islands (UK)	1948 – 1958	Added
<b>Central America and the Caribbean</b>	Aruba (Netherlands)	1948 – 1985	Modified
	Curaçao (Netherlands)	1948 – 2015	
	Sint Maarten (Netherlands)	1948 – 2015	
	Bonaire, Sint Eustatius and Saba (Netherlands)	1948 – 2010	Added
<b>Australian dollar</b>	<i><b>Australia</b></i>	1948 – 2015	
	Christmas Island (Australia)	1956 – 2015	Added
	Kiribati	1948 – 2015	
	Nauru	1948 – 2015	
	Norfolk Island (Australia)	1948 – 2015	Added
	Papua New Guinea	1948 – 1975	Added
	Solomon Islands	1948 – 1978	
	Tonga	1948 – 1990	
	Tuvalu	1948 – 2015	
<b>Indian Rupee</b>	<i><b>India</b></i>	1948 – 2015	
	Bahrain	1948 – 1958	Added
	Bhutan	1948 – 2015	
	Kuwait	1948 – 1959	
	Nepal	1948 – 1965	Added
	Oman	1948 – 1958	Modified
	Pakistan	1948 – 1949	Modified
	Qatar	1948 – 1958	
	United Arab Emirates	1948 – 1958	Added
	Yemen Arab Republic	1948 – 1951	Modified
<b>Pakistan Rupee</b>	<i><b>Pakistan</b></i>	1948 – 2015	Modified
	Bangladesh	1948 – 1971	Added

*Note:* I have updatated and corrected Rose(2000) database, the last column notifies the changes (countries and currency unions added and dates changed)

Currency union	Hub and spoke	Date	Added/modified compared to Rose
<b>CFA Franc XOF</b>			
	Benin	1948 – 2015	
	Burkina Faso	1948 – 2015	
	Guinea	1948 – 1959	Modified
	Guinea Bissau	1948 – 1997	
	Ivory Coast	1948 – 2015	
	Mali	1948 – 1961	
	Mali	1984 – 2015	
	Mauritania	1948 – 1972	Added
	Niger	1948 – 2015	
	Senegal	1948 – 2015	
	Togo	1948 – 2015	Modified
<b>CFA Franc XAF</b>			
	Cameroon	1948 – 2015	
	Central African Rep	1948 – 2015	
	Chad	1948 – 2015	
	Congo	1948 – 2015	
	Equatorial Guinea	1948 – 1985	
	Gabon	1948 – 2015	
<b>CFA Franc XMCF</b>			
	Comores	1948 – 1993	
	Madagascar	1948 – 1981	
	Mayotte (France)	1948 – 1975	Added
<b>CFA Franc XCFG</b>			
	Reunion (France)	1948 – 1974	Modified
	St. Pierre and Miquelon (France)	1948 – 1972	Modified
<b>South Africa Rand</b>			
	<i>South Africa</i>	1948 – 2015	
	Botswana	1948 – 1976	
	Lesotho	1948 – 2015	
	Swaziland	1948 – 2015	
	Namibia	1948 – 1993	
<b>Malaya Dollar</b>			
	<i>Malaysia</i>	1948 – 1972	
	Singapore	1948 – 1966	
	Brunei	1948 – 1966	
	Christmas Island (Australia)	1948 – 1958	Added
	Cocos slands (Australia)	1948 – 1955	Added
<b>Danish Krone</b>			
	<i>Denmark</i>	1948 – 2015	
	Faeroe Islands (Denmark)	1948 – 2015	
	Greenland (Denmark)	1948 – 2015	
<b>French Franc</b>			
	<i>France</i>	1948 – 1999	
	Andorra	1948 – 1999	
	French Guiana (France)	1948 – 1999	
	Guadeloupe (France)	1959 – 1999	
	Martinique (France)	1959 – 1999	
	Mayotte (France)	1976 – 1999	Added
	Monaco	1948 – 1999	
	Morocco	1948 – 1959	Modified
	Reunion (France)	1975 – 1999	Modified
	St. Pierre and Miquelon (France)	1973 – 1999	Modified
	Tunisia	1948 – 1959	Modified

Currency union	Hub and spoke	Date	Added/modified compared to Rose
<b>CFP Franc</b>	French Polynesia (France)	1958 – 2015	
	New Caledonia (France)	1986 – 2015	
	Wallis and Futuna (France)	1962 – 2015	
<b>Escudo</b>	<i><b>Portugal</b></i>	1948 – 1999	
	Azores (Portugal)	1948 – 1999	Added
	Cape Verde	1948 – 1975	
	Guinea-Bissau	1948 – 1974	
	Madeira Islands (Portugal)	1948 – 1999	Added
<b>Qatar-Dubai Riyal</b>	Qatar	1966 – 1973	Modified
	United Arab Emirates	1966 – 1973	Modified
<b>Peseta</b>	<i><b>Spain</b></i>	1948 – 1999	
	Andorra	1948 – 1999	
	Equatorial Guinea	1948 – 1968	Modified
	Morocco	1948 – 1956	Added
	Western Sahara	1948 – 1975	Added
<b>East African Currency Area</b>	Kenya	1948 – 1966	
	Uganda	1948 – 1966	
	Tanzania	1948 – 1966	
<b>Pound Sterling</b>	<i><b>United Kingdom</b></i>	1948 – 2015	
	Bermuda	1948 – 1969	
	British Indian Ocean Territories (UK)	1966 – 2015	Added
	Cameroon	1948 – 1961	Added
	Cyprus	1948 – 1960	
	Falkland Islands (UK)	1948 – 2015	
	Gibraltar (UK)	1948 – 2015	
	Guernsey (UK)	1948 – 2015	Added
	Maldives	1948 – 1975	Added
	Nigeria	1948 – 1961	
	Sierra Leone	1948 – 1965	Modified
	South Georgia and the South Sandwich Islands (UK)	1948 – 2015	Added
	Sudan	1948 – 1957	Added
	Togo	1948 – 1957	Added
	Trinidad and Tobago	1948 – 1962	Added
	Virgin Islands (UK)	1948 – 1958	Added
<b>United States Dollar</b>	<i><b>United States</b></i>	1948 – 2015	
	American Samoa (USA)	1948 – 2015	
	Bermuda	1971 – 2015	Modified
	British Indian Ocean Territories (UK)	1966 – 2015	Added
	Ecuador	2001 – 2015	Added
	El Salvador	2001 – 2015	Added
	Guam	1948 – 2015	
	Guatemala	2001 – 2015	Modified
	Liberia	1948 – 2015	
	Marshall Island	1948 – 2015	Added
	Micronesia	1948 – 2015	Added

Currency union	Hub and spoke	Date	Added/modified compared to Rose
<b>United States Dollar (end)</b>	Northern Mariana Islands (USA)	1948 – 2015	Added
	Palau	1948 – 2015	Added
	Panama	1948 – 2015	
	Puerto Rico (USA)	1948 – 2015	Added
	Timor Leste	2000 – 2015	Added
	Turks and Caicos Islands (UK)	1970 – 2015	Added
	United States Minor Outlying Islands (USA)	1948 – 2015	Added
	Virgin Islands (USA)	1948 – 2015	Added
<b>Swiss franc</b>	<i>Switzerland</i>	1948 - 2015	
	Liechtenstein	1948 - 2015	
<b>New Zealand Dollar</b>	<i>New Zealand</i>	1948 - 2015	
	Cook Islands (New Zealand)	1948 - 2015	
	Niue (New Zealand)	1948 - 2015	
	Pitcairn Islands (New Zealand)	1948 - 2015	
	Tokelau (New Zealand)	1948 - 2015	
<b>Euro</b>			Added
	Aland Islands (Finland)	1999 - 2015	
	Andorra	1999 - 2015	
	Austria	1999 - 2015	
	Azores (Portugal)	1999 - 2015	
	Belgium	1999 - 2015	
	Finland	1999 - 2015	
	France	1999 - 2015	
	French Guiana (France)	1999 - 2015	
	Guadeloupe (France)	1999 - 2015	
	Germany	1999 - 2015	
	Ireland	1999 - 2015	
	Italy	1999 - 2015	
	Luxembourg	1999 - 2015	
	Madeira Islands (Portugal)	1999 - 2015	
	Martinique (France)	1999 - 2015	
	Mayotte (France)	1999 - 2015	
	Monaco	1999 - 2015	
	Netherlands	1999 - 2015	
	Portugal	1999 - 2015	
	Reunion (France)	1999 - 2015	
	San Marino	1999 - 2015	
	Spain	1999 - 2015	
	St. Barthelémy (France)	1999 - 2015	
	St. Martin (France)	1999 - 2015	
	St. Pierre and Miquelon (France)	1999 - 2015	
	Vatican City	1999 - 2015	
	Greece	2001 - 2015	
	Kosovo	2002 - 2015	
	Montenegro	2002 - 2015	
	Slovenia	2007 - 2015	
	Cyprus	2008 - 2015	
	Malta	2008 - 2015	
	Slovakia	2009 - 2015	
	Estonia	2011 - 2015	
	Latvia	2014 - 2015	

Currency union	Hub and spoke	Date	Added/modified compared to Rose
Italy Lira			Added
	<i>Italy</i>	1948 - 1998	
	Vatican City	1948 - 1998	
	San Marino	1948 - 1998	
German deutsch mark			Added
	<i>Germany</i>	1948 - 1998	
	Kosovo	1948 - 1998	
	Montenegro	2000 - 2001	
Norway Krone			Added
	<i>Norway</i>	1948 - 2015	
	Svalbard and Jan Mayen Islands (Norway)	1948 - 2015	
	Bouvet Island (Norway)	1948 - 2015	
Soviet Ruble			Added
	<i>Russia</i>	1992 - 1998	
	Armenia	1992 - 1993	
	Azerbaijan	1992 - 1993	
	Belarus	1992 - 1994	
	Georgia	1992	
	Kazakhstan	1992 - 1993	
	Kyrgyzstan	1992	
	Tajikistan	1992 - 1994	
	Turkmenistan	1992 - 1993	
	Ukraine	1992	
	Uzbekistan	1992 - 1993	
Egyptian Pound			Added
	<i>Egypt</i>	1948 - 2015	
	Libya	1948 - 1951	
	Sudan	1948 - 1957	
	South Sudan	1948 - 1961	
Jordanian dinar			Added
	<i>Jordan</i>	1948 - 2015	
	Palestine	1948 - 1966	
	Palestine	1996 - 2015	
Israel New Sheqel			Added
	<i>Israel</i>	1948 - 2015	
	Palestine	1967 - 2015	
Jamaica Dollar			Added
	<i>Jamaica</i>	1948 - 2015	
	Turks and Caicos Islands (UK)	1948 - 2015	
	Cayman Islands (UK)	1948 - 1972	
French Indochina Piastre			Added
	Vietnam	1948 - 1955	
	Cambodia	1948 - 1955	
	Laos	1948 - 1955	
Viet Nam New Dong			Added
	<i>Vietnam</i>	1978 - 1985	
	Cambodia	1978 - 1979	
Ethiopian birr			Added
	<i>Ethiopia</i>	1948 - 2015	
	Eritrea	1993 - 1997	



Table A3: List of pegs one-to-one in my database

Currency	Pegs one-to-one	Date
<b>East Caribbean Dollar</b>		
	Barbados	1974 – 1975
	Guyana	1948 – 1970
	Trinidad and Tobago	1966 – 1975
<b>Central America and the Caribbean</b>		
	Suriname	1948 – 1994
<b>Indian Rupee</b>		
	Bahrain	1959 – 1965
	Bangladesh	1948 – 1949
	Bangladesh	1956 – 1965
	British Indian Ocean Territories (UK)	1948 – 1965
	Kuwait	1960
	Maldives	1948 – 1965
	Mauritius	1948 – 1965
	Myanmar	1948 – 1965
	Oman	1959 – 1965
	Pakistan	1956 – 1965
	Qatar	1959 – 1965
	Seychelles	1948 – 1965
	Sri Lanka	1948 – 1965
	United Arab Emirates	1959 – 1965
<b>Pakistan Rupee</b>		
	Myanmar	1948 – 1970
	Maldives	1948 – 1970
<b>Mauritius Rupee</b>		
	Seychelles	1948 – 1975
<b>Belgian Franc</b>		
	Burundi	1948 – 1963
	Rwanda	1948 – 196
	Congo	1948 – 1962
	Luxembourg	1948 – 1998
<b>South Africa Rand</b>		
	Namibia	1994 – 2015
<b>Malaya Dollar</b>		
	Singapore	1967 – 2015
	Brunei	1967 – 2015
<b>French Franc</b>		
	Algeria	1948 – 1963
	Guadeloupe (France)	1948 – 1958
	Martinique (France)	1948 – 1958
<b>CFP Franc</b>		
	French Polynesia (France)	1948 – 1957
	New Caledonia (France)	1948 – 1985
	Vanuatu	1948 – 1969
	Wallis and Futuna (France)	1948 – 1961

<b>Currency</b>	<b>Pegs one-to-one</b>	<b>Date</b>
<b>United States Dollar</b>		
	Argentina	1992 – 2001
	Bahamas	1971 – 2015
	Belize	1948
	Cuba	1948 – 1958
	Cuba	1986 – 2015
	Dominican Republic	1948 – 1984
	Guatemala	2001 – 2015
	Guyana	1948 – 1952
	Trinidad and Tobago	1948 – 1951
<b>German deutsch mark</b>		
	Bosnia and Herzegovina	1948 - 1998
	Montenegro	1994 - 1995
	Serbia	1994 - 1995
<b>Netherlands Guilder</b>		
	Indonesia	1948 - 1949
<b>Soviet Ruble</b>		
	Ukraine	1993
	Uzbekistan	1994
<b>Egyptian Pound</b>		
	Sudan	1958 - 1961

Table A4: List of currencies pegged one-to-one in my database

<b>Currency</b>	<b>Pegs one-to-one</b>
CFA Franc XOF	Peg with CFA Franc XAF
CFA Franc XMCF	Peg with CFA Franc XAF
CFA Franc XCFG	Peg with CFA Franc XAF

Currency	Pegs one-to-one	Date
<b>Escudo</b>		
	Angola	1948 – 1976
	Cape Verde	1976
	Guinea-Bissau	1975 – 1976
	Mozambique	1948 – 1976
	Sao Tome & Principe	1948 – 1977
<b>Qatar-Dubai Riyal</b>		
	Qatar	1974 – 2015
	United Arab Emirates	1974 – 2015
	Saudi Arabia	1952 – 1966
<b>Peseta</b>		
	Equatorial Guinea	1969 – 1977
<b>East African Currency Area</b>		
	Kenya	1967 – 1977
	Uganda	1967 – 1977
	Tanzania	1967 – 1977
	Somalia	1948 – 1971
	Yemen Arab Republic	1952 – 1971
<b>Pound Sterling</b>		
	Bahamas	1948 – 1965
	Botswana	1948 – 1960
	Cyprus	1961 – 1971
	Fiji	1948 – 1968
	Gambia	1948 – 1971
	Ghana	1948 – 1965
	Iraq	1948 – 1966
	Ireland	1948 – 1978
	Isle of Man (UK)	1948 – 2015
	Israel	1948 – 1953
	Jamaica	1948 – 1969
	Jersey (UK)	1948 – 2015
	Jordan	1948 – 1966
	Kuwait	1961 – 1966
	Lesotho	1948 – 1960
	Libya	1952 – 1966
	Malawi	1948 – 1970
	Malta	1948 – 1972
	New Zealand	1948 – 1967
	Namibia	1948 – 1960
	Nigeria	1962 – 1966
	Palestine	1948 – 1969
	Samoa	1948 – 1967
	Saudi Arabia	1948 – 1952
	South Africa	1948 – 1960
	St. Helena (UK)	1948 – 2015
	Swaziland	1948 – 1960
	Togo	1958
	Turks and Caicos Islands (UK)	1948 – 1969
	Zambia	1948 – 1966
	Zimbabwe	1948 – 1966

## 1.D Appendix: Data description

In this appendix, I describe in detail the variables used and give their sources.

- *Currency Union* : dummy for currency union and dollarized economies (1948-2015)
- *Peg one – to – one* : dummy for peg one-to-one (1948-2015)
- *Fixed exchange rate* : dummy for fixed exchange rate regime (Shambaugh database) (1971-2004)
- *exit CU* : dummy, 1 if there is a currency union exit in the ten years after database) (1971-2004)
- *entry CurrencyUnion* : dummy, 1 if there is a currency union entry in the ten years before
- *Currency Union 0 – 5 years*, *Currency Union 6 – 10years*, etc : dummy if the currency union is between zero and 5 years old, of between 6 and 10 years old..
- *Export* : annual bilateral trade flow data in current US millions of dollars (Correlates of War Trade database) (1948-2009)
- *Export 2 – digit* : annual bilateral (one-way) trade flow data at the HS 2-digit product disaggregation in thousands of US dollars (BACI database) (1995-2015)
- *FTA dummy* : dummy for Free Trade Agreements (Design of International Trade Agreements database) (1948-2015)
- *GDP per Capita* : GDP per capita in constant 2005 US dollar (World Development Indicators from the World Bank) (1960-2014)
- *Distance* : simple distance (most populated cities, km) (CEPII database "GeoDist")
- *Common Border* : dummy for common frontier (CEPII database "GeoDist")
- *Common Language* : dummy, 1 if a language is spoken by at least 9% of the population in both countries (CEPII database "GeoDist")
- *Colony* : dummy, 1 for pairs ever in colonial relationship (CEPII database "GeoDist")
- *Current Colony* : dummy, 1 for pairs currently in colonial relationship (CEPII database "GeoDist")
- *Population* : total population (World Development Indicators from the World Bank) (1960-2014)
- *Surface* : Land area in square kilometer (World Development Indicators from the World Bank)(1960-2014)
- *Landlocked* : dummy, if one of the two countries is landlocked (CEPII database "GeoDist")
- *Both Landlocked* : dummy, if the two countries are landlocked (CEPII database "GeoDist")
- *Island* : dummy, if one of the two countries is an island (CEPII database "GeoDist")
- *Both Island* : dummy, if the two countries are islands (CEPII database "GeoDist")

with

- Prefix "ln" for logarithm
- Prefix "max" for maximum
- Prefix "min" for minimum

## 1.E Appendix: Tables

Table A5: Propensity to adopt the currency, or to peg, to main anchor

CU or Peg one-to-one	(1) Probit estimates for currency union	(2) Marginal effect evaluated at mean for CU	(3) Probit estimates for peg1:1	(4) Marginal effect evaluated at mean for peg1:1	(5) Marginal effect evaluated at mean of CU pair	(6) Marginal effect evaluated at mean of peg1:1 pair
lnDistance	-0.789*** (0.0198)	-0.00523*** (0.000331)	-0.853*** (0.0493)	-2.57e-05** (1.23e-05)	-0.180*** (0.00612)	-0.000625*** (0.000198)
Common Border	0.190*** (0.0522)	0.00126*** (0.000370)	-0.620*** (0.170)	-1.87e-05** (9.30e-06)	0.0434*** (0.0120)	-0.000454** (0.000183)
Common Language	0.207*** (0.0344)	0.00137*** (0.000241)	2.021*** (0.138)	6.09e-05** (2.80e-05)	0.0474*** (0.00787)	0.00148*** (0.000433)
Colony	0.293*** (0.0452)	0.00194*** (0.000307)	0.0710 (0.0830)	2.14e-06 (2.87e-06)	0.0670*** (0.0105)	5.20e-05 (6.49e-05)
Current Colony	1.670*** (0.0970)	0.0111*** (0.000976)			0.382*** (0.0246)	
FTA dummy	0.549*** (0.0422)	0.00364*** (0.000312)	-0.772*** (0.119)	-2.33e-05* (1.22e-05)	0.125*** (0.0100)	-0.000565*** (0.000174)
max ln GDP per Capita	0.198*** (0.0196)	0.00131*** (0.000145)	-0.255*** (0.0265)	-7.69e-06** (3.83e-06)	0.0452*** (0.00461)	-0.000187*** (6.18e-05)
min ln GDP per Capita	-0.0347*** (0.0110)	-0.000230*** (7.33e-05)	-0.177*** (0.0243)	-5.33e-06** (2.66e-06)	-0.00793*** (0.00253)	-0.000129*** (4.08e-05)
max ln Population	-0.191*** (0.0278)	-0.00126*** (0.000194)	0.689*** (0.0638)	2.08e-05** (9.91e-06)	-0.0436*** (0.00646)	0.000504*** (0.000154)
min ln Population	-0.0790*** (0.0158)	-0.000524*** (0.000109)	0.171*** (0.0347)	5.14e-06* (2.69e-06)	-0.0181*** (0.00361)	0.000125*** (4.23e-05)
max ln Surface	0.343*** (0.0144)	0.00227*** (0.000151)	-0.227*** (0.0375)	-6.83e-06** (3.25e-06)	0.0784*** (0.00380)	-0.000166*** (5.15e-05)
min ln Surface	-0.0629*** (0.00892)	-0.000417*** (6.48e-05)	0.0194 (0.0205)	5.86e-07 (6.70e-07)	-0.0144*** (0.00208)	1.42e-05 (1.54e-05)
Observations	93,318	93,318	92,962	92,962	93,318	92,962

*Note:* Calculation of the probability of pair-countries to be linked through a peg or a currency union. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table A6: First stage of the IV

VARIABLES	(1) Currency Union	(2) Peg one-to-one
probability Currency Union	1.578*** (0.0891)	-0.0583*** (0.0101)
probability Peg one-to-one	0.551*** (0.181)	1.578 (1.172)
Fixed exchange rate	0.0195*** (0.000937)	0.0139*** (0.000673)
Observations	359,871	359,871
R-squared	0.787	0.843

*Note:* Standard errors in parentheses (\*\*\*)  $p < 0.01$ , (\*\*)  $p < 0.05$ , (\*)  $p < 0.1$



Table A7: Anticipations of the new regime: effect per year

lnExport	(1) Currency Union	(2) Peg one-to-one	(3) FixedExchange
Year Minus 8	0.127 (0.114)	-0.471 (0.389)	0.0441 (0.0372)
Year Minus 7	0.171 (0.118)	-0.216 (0.377)	0.0227 (0.0387)
Year Minus 6	0.402*** (0.125)	-0.235 (0.376)	-0.0105 (0.0390)
Year Minus 5	0.287** (0.132)	-0.297 (0.390)	-0.00559 (0.0387)
Year Minus 4	0.270* (0.139)	-0.366 (0.420)	0.0900** (0.0384)
Year Minus 3	0.347** (0.145)	-0.383 (0.420)	0.109*** (0.0385)
Year Minus 2	0.338** (0.152)	-0.264 (0.419)	0.0522 (0.0387)
Year Minus 1	0.435*** (0.160)	-0.00511 (0.302)	0.0649* (0.0382)
Year 0	0.449*** (0.173)	0.269 (0.269)	0.0605** (0.0300)
Year Plus 1	0.432** (0.191)	0.864*** (0.213)	0.0667 (0.0435)
Year Plus 2	0.866*** (0.209)	0.859*** (0.212)	0.0528 (0.0441)
Year Plus 3	0.550** (0.231)	0.408** (0.207)	0.0440 (0.0435)
Year Plus 4	0.640*** (0.242)	0.545*** (0.206)	0.0427 (0.0434)
Year Plus 5	0.598** (0.253)	0.252 (0.194)	0.101** (0.0435)
Year Plus 6	0.693*** (0.262)	0.277 (0.193)	0.0902** (0.0435)
Year Plus 7	0.770*** (0.271)	0.211 (0.191)	0.0520 (0.0435)
Year Plus 8	0.885*** (0.283)	0.0618 (0.185)	0.0667 (0.0446)
Observations	10,560	4,033	127,197
R-squared	0.976	0.959	0.888
Pair-country FE	YES	YES	YES
Exporter-year FE	YES	YES	YES
Importer-year FE	YES	YES	YES

*Note:* Control group : countries which will be in the regime studied in more than 8 years. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table A8: OLS method

lnExport	(1) Time fixed effect	(2) Time and country fixed effect
Currency Union	0.820*** (0.0373)	0.498*** (0.0345)
Peg one-to-one	0.230*** (0.0426)	0.378*** (0.0410)
Fixed exchange rate	0.0246** (0.0124)	0.00939 (0.0119)
lnDistance	-0.995*** (0.00499)	-1.229*** (0.00513)
Common Border	0.762*** (0.0209)	0.447*** (0.0193)
Common Language	0.471*** (0.00889)	0.499*** (0.00985)
Colony	1.209*** (0.0214)	1.281*** (0.0213)
Current Colony	-2.309*** (0.186)	-1.577*** (0.170)
FTA dummy	0.479*** (0.0105)	0.298*** (0.0105)
max ln GDP per Capita	0.959*** (0.00244)	0.433*** (0.00797)
min ln GDP per Capita	0.912*** (0.00270)	0.641*** (0.00768)
max ln Population	0.0210*** (0.00345)	-0.0427** (0.0214)
min ln Population	0.0471*** (0.00388)	0.0401* (0.0214)
max ln Surface	-0.127*** (0.00291)	
min ln Surface	-0.0563*** (0.00259)	
Landlocked	-0.382*** (0.00814)	
Both Landlocked	0.448*** (0.0225)	
Island	0.204*** (0.00921)	
BothIsland	0.878*** (0.0201)	
Year FE	YES	YES
Importer FE	NO	YES
Exporter FE	NO	YES
Observations	351,025	353,887
R-squared	0.654	0.718
F-test	119.4	5.850
Prob > F	0	0.0156

Note: Control group: floating exchange rate. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table A9: Poisson Pseudo Maximum Likelihood

lnExport	(1) Time fixed effect	(2) Time and country fixed effect
Currency Union	0.820*** (0.0373)	0.498*** (0.0345)
Peg one-to-one	0.230*** (0.0426)	0.378*** (0.0410)
Fixed exchange rate	0.0246** (0.0124)	0.00939 (0.0119)
lnDistance	-0.995*** (0.00497)	-1.229*** (0.00512)
Common Border	0.762*** (0.0209)	0.447*** (0.0193)
Common Language	0.471*** (0.00888)	0.499*** (0.00985)
Colony	1.209*** (0.0214)	1.281*** (0.0212)
Current Colony	-2.309*** (0.186)	-1.577*** (0.170)
FTA dummy	0.479*** (0.0105)	0.298*** (0.0104)
max ln GDP per Capita	0.959*** (0.00243)	0.433*** (0.00796)
min ln GDP per Capita	0.912*** (0.00270)	0.641*** (0.00768)
max ln Population	0.0210*** (0.00345)	-0.0427** (0.0214)
min ln Population	0.0471*** (0.00388)	0.0401* (0.0214)
max ln Surface	-0.127*** (0.00291)	
min ln Surface	-0.0563*** (0.00259)	
Landlocked	-0.382*** (0.00814)	
Both Landlocked	0.448*** (0.0225)	
Island	0.204*** (0.00921)	
BothIsland	0.878*** (0.0201)	
Year FE	YES	YES
Importer FE	NO	YES
Exporter FE	NO	YES
Observations	351,025	353,887
F-test	119.5	5.856
Prob > F	0	0.0155

*Note:* Control group: floating exchange rate. Standard errors in parentheses (\*\*\*) p<0.01, \*\* p<0.05, \* p<0.1)

Table A10: Effect of currency union and peg one-to-one for every decile of trade

VARIABLES	(1) lnExport
Currency Union*10th first percentile	-
Currency Union*10th-20th percentile predicted trade	-0.637 (0.646)
Currency Union*20th-30th percentile predicted trade	0.617*** (0.157)
Currency Union*30th-40th percentile predicted trade	0.496*** (0.0515)
Currency Union*40th-50th percentile predicted trade	0.601*** (0.0556)
Currency Union*50th-60th percentile predicted trade	0.946*** (0.126)
Currency Union*60th-70th percentile predicted trade	1.381*** (0.194)
Currency Union*70th-80th percentile predicted trade	0.677*** (0.0902)
Currency Union*80th-90th percentile predicted trade	0.177* (0.0974)
Currency Union*90th-100th percentile predicted trade	0.199** (0.0817)
Peg one-to-one*10th first percentile predicted trade	0.808*** (0.111)
Peg one-to-one*10th-20th percentile predicted trade	-0.0162 (0.138)
Peg one-to-one*20th-30th percentile predicted trade	1.259*** (0.0856)
Peg one-to-one*30th-40th percentile predicted trade	0.392*** (0.0671)
Peg one-to-one*40th-50th percentile predicted trade	0.285** (0.128)
Peg one-to-one*50th-60th percentile predicted trade	-0.290*** (0.0753)
Peg one-to-one*60th-70th percentile predicted trade	-1.137*** (0.167)
Peg one-to-one*70th-80th percentile predicted trade	0.515*** (0.115)
Peg one-to-one*80th-90th percentile predicted trade	-0.133 (0.112)
Peg one-to-one*90th-100th percentile predicted trade	0.446*** (0.0865)
Observations	635,952
R-squared	0.868
Pair-country FE	YES
Exporter-year FE	YES
Importer-year FE	YES

*Note:* Standard errors in parentheses (\*\*\* p<0.01, \*\* p<0.05, \* p<0.1)

Table A11: Effect of each currency union and the pegs one-to-one attached to it

lnExport	(1) Pound Sterling	(2) US dollar	(3) Franc CFA	(4) Indian Rupee	(5) French Franc	(6) Portugal Escudo
Currency Union	0.331* (0.198)	0.792*** (0.107)	0.294*** (0.0813)	0.717 (0.465)	1.040*** (0.278)	1.213** (0.527)
Peg one-to-one	0.401*** (0.0484)	-0.0624 (0.0679)	0.824*** (0.0791)	0.530*** (0.111)	1.570* (0.868)	0.916*** (0.247)
Observations	635,952	635,952	635,952	635,952	635,952	635,952
R-squared	0.868	0.868	0.868	0.868	0.868	0.868
Pair-country FE	YES	YES	YES	YES	YES	YES
Exporter-year FE	YES	YES	YES	YES	YES	YES
Importer-year FE	YES	YES	YES	YES	YES	YES

*Note:* In each column, the dummy variables are equal to one depending on the currency of interest. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

	Probability before float	Probability before fixed	Probability before CU	Probability before peg
Knowing now float	-	96%	0,90%	3%
Knowing now fixed	99%	-	0,0003%	0,0001%
Knowing now CU	33%	56%	-	12%
Knowing now Peg	34%	15%	51%	-

Table A12: Conditional probability of the previous regime, knowing the actual regime

	Probability after float	Probability after fixed	Probability after CU	Probability after peg
Knowing now float	-	99%	0,7%	0,04%
Knowing now fixed	99%	-	1%	0,2%
Knowing now CU	58%	2%	-	40%
Knowing now Peg	91%	3%	6%	-

Table A13: Conditional probability of the next regime, knowing the actual regime

## Chapter 2

# Did the Euro Protect its Members during the Great Trade Collapse?

### 2.1 Introduction

The effect of the euro on trade has been studied extensively in the literature with around 50 papers on the topic<sup>1</sup> (as of July 2017). According to these studies, the range of the euro positive effect fluctuates between 2% and 30% (see Rose, 2017 for a recent metadata analysis). However, to my knowledge, no work has been done so far on the euro effect during an economic crisis. It is a priori not clear how the additional trade due to introduction of the single currency reacts to a crisis. Is it more volatile, more fragile? Has the euro protected its members during the great trade collapse? Would the trade drop observed during the financial crisis in Europe have been bigger without the euro? Is the euro effect the same for every sector? To address these questions, I study the effect of the euro on trade during the great trade collapse a context that provides three advantages: it was exogenous to the Eurozone, was unexpected and was worldwide.

The literature identifies various factors explaining the great trade collapse. On the supply side, researchers highlight an important trade credit crunch (Auboin, 2009; Chor and Manova, 2012), large disruption to global value chains (Bems *et al.*, 2010) and a preference for protectionism (Evenett, 2009; Jacks *et al.*, 2011). Since European banks were hit particularly hard by the financial crisis, and therefore could not fully play their role of firm creditor, I expect the euro

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<sup>1</sup>For example Baldwin and Taglioni (2004), de Sousa and Lochard (2009), Flam and Nordstrom (2006), Bun and Klassen (2007), Berger and Nitsch (2008), Santos Silva and Tenreyro (2010), Glick and Rose (2016).

to have performed badly during the great trade collapse. Moreover, currency unions promote global value chains which worsened the great trade collapse; again I expect the euro to perform badly. However, protectionism should not play a role here since had protectionist measures been taken, this would have been at European not Eurozone level.

On the demand side, the literature points to a disproportionate fall in demand for tradable goods (Eaton *et al.*, 2016, McKibbin and Stoeckel, 2009), inventory adjustments (Alessandria *et al.*, 2010) and postponement of durable goods purchases due to a wait-and-see reaction (Baldwin, 2009). The Eurozone exports proportionally more durable goods than the other countries, therefore I expect it to have been hit harder by the great trade collapse.

Overall, I expect to find a negative effect of the euro on trade during the great trade collapse, in view of the causes of that collapse. However, I find that the euro amortized the great trade collapse. I control for all the causes of the great trade collapse and they do not shrink the positive and significant coefficient associated to the euro effect on trade during the crisis.

The financial crisis caused world GDP to decrease by 4% and world trade by 15% (in 2009 overshooting by 18 against 1.9 in the 1990-2008 period).<sup>2</sup> Baldwin (2009) states that "the great trade collapse was triggered by - and helped spread - the global economic slump". Every nation for which the WTO reports data experienced a drop in both imports and exports during the second half of 2008 and the first half of 2009. On average, Europe has been hit harder than the rest of the world by the great trade collapse, with a trade drop of 25% between 2008 and 2009.<sup>3</sup> East European countries experienced the most severe drop, especially the new eastern Eurozone members whose trade fell by 28%. Curran (2009) studied the European Union during the great trade collapse and Shelburne (2010) studied east European countries, but not the Eurozone specifically.

I contribute to the literature by specifically studying the Eurozone during a crisis. Using a difference-in-differences methodology on bilateral trade data, with exporter-time, importer-time and pair-country fixed effects, I find that the euro had a positive and significant effect on aggregate trade, not only during the drop, but also during the rebound and in the long run. The

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<sup>2</sup>Figure B1 in appendix shows the world trade drop and figure B3 shows world overshooting.

<sup>3</sup>Figure B2 in the appendix shows the average drop for every European country.



use of multiple high-dimensional fixed effects is demanding but it captures many confounding factors, and provides the cleanest benchmark against which to assess the impact of the euro during the great trade collapse. My results are robust to many robustness checks (changing the control group, and the time period, excluding countries etc.).

However, at the sector level, it appears that the positive and significant effect I observe at the aggregate level is due to a composition effect: the euro protected only those sectors exporting the most. I find that the sectors that the euro helped the most are machinery (19% of total trade), chemical (14% of total trade), metal (11% of total trade) and transport (15% of total trade). It appears that these large sectors are also more financially independent and more sensitive to exchange rate volatility. The euro had a positive effect on precisely such sectors with these characteristics. The European banks were particularly hard hit by the financial crisis, therefore, the financially independent sectors did comparatively better. Also, exchange rate volatility during the crisis increased everywhere in the world except in the Eurozone where by nature it remained fixed. Therefore, the euro provides a premium for exchange rate stability during economic crises.

In section 2, I study the effects of the euro during the crisis using aggregate data. In section 3, using sector data I check whether the effects observed at the aggregate level are driven by particular sectors. In section 4, I test the causes of the great trade collapse to understand the channels through which the effect of the euro occurs. Section 5 concludes.

## 2.2 Aggregate effect of the euro

### 2.2.1 Data set

Trade data are drawn from BACI, a world trade database developed by CEPII (Gaulier and Zignago, 2010) at the Harmonized System (HS) 6-digit product disaggregation,<sup>4</sup> for more than 200 countries between 2003 and 2015. Currency union data are drawn from my own database (Lebastard, 2017),<sup>5</sup> the durable good index is from Engel and Wang (2011), the financial de-

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<sup>4</sup>However, since the calculations are extremely long at such a disaggregated level, I use only country level trade data, and 1 and 2 digit product disaggregation.

<sup>5</sup>Relying on de Sousa (2012).

pendency index is from Choi (2017) and the global value chain index is calculated based on the OECD Global Value Chains indicators database (De Backer and Miroudot, 2013). For the remaining data, I use World Development Indicators from the World Bank (1960-2015). The variables are described in the appendix.

### 2.2.2 Methodology

To evaluate the impact of the euro on trade during the crisis, I estimate a difference-in-difference model of logged one-way trade (exports) at annual frequency, comparing the difference in trade before and after the crisis in the Eurozone with the difference in trade in the same period for the other developed countries. I use difference-in-difference rather than matching methods on country level data since the sample is small and the unobserved characteristics too numerous. I include typical gravity fixed effects: importer-time, exporter-time and pair-country fixed effects, in order to absorb time invariant characteristics (distance, common language, colony, etc.), and also time varying characteristics specific to the countries (GDP per capita, GDP drop during the crisis, etc.). Finally, fixed effects allow me to capture several unobserved characteristics. This method which requires multiple high-dimensional fixed effects is very demanding but captures many confounding factors; having significant coefficients in these conditions is evidence of a strong effect. I do not include separate control variables for the crisis period and the treatment group since they are absorbed by the fixed effects. I start my study in 2003, avoiding a path of trade change over time. I tried other time periods (see table B8 and B9 in the appendix) but the results changed very little. The regression equation is given by

$$\ln Export_{ijt} = \beta Euro_{ijt} * Crisis_t + \lambda_{1it} + \lambda_{2jt} + \lambda_{3ij} + \epsilon_{ijt}, \quad (2.1)$$

with:

- $Export_{ijt}$  bilateral trade
- $Euro_{ijt} * Crisis_t$  Eurozone (both partners being in the Eurozone) during the financial crisis (2008-2010) dummy
- $\lambda_{1it}$  exporter-time fixed effect

- $\lambda_{2jt}$  importer-time fixed effect
- $\lambda_{3ij}$  pair-country fixed effect

To study the great trade collapse, I first set the time of the financial crisis at 2008 to 2010, following the NBER, and drop observations post 2010. As robustness checks, I also study the long term effects of the euro, and take a longer time period for the crisis (2008-2015). The sovereign debt crisis began in 2011, therefore the shock was no longer exogenous to the Eurozone. However, my country fixed effects capture the effect of the internal crisis, such as in Greece one, so this should not be a problem.

My treatment group comprises members of the Eurozone prior to 2007 (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain). The reason for excluding the newest Eurozone members (Slovenia, Cyprus, Malta, Slovakia, Estonia, Latvia and Lithuania) is that the literature shows that the euro changes the trade trend which would not allow me to disentangle the effect of the euro from the effect of the crisis since they were simultaneous. I want to study countries at their steady-state trade which would be impossible had I included the new members.

As a control group, I have decided to take the most developed countries of the OECD.<sup>6</sup> Indeed, looking at table B1 in the appendix, their characteristics are the closest to the ones of the Eurozone, compared to the other potential control groups (the OECD countries,<sup>7</sup> Europe,<sup>8</sup> and only the other rich countries in Europe,<sup>9</sup> which is a tiny group of 5 countries). I have added to the table the new Eurozone members (east Eurozone) for interest.

### 2.2.3 Main results

The results of regression 2.1 are presented in table 2.1.

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<sup>6</sup>Most developed countries of the OECD: Australia, Canada, Denmark, Iceland, Israel, Japan, New Zealand, Norway, South Korea, Sweden, Switzerland, the United Kingdom and the United States.

<sup>7</sup>OECD countries: Australia, Canada, Chile, Czech Republic, Denmark, Hungary, Iceland, Israel, Japan, Mexico, New Zealand, Norway, South Korea, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

<sup>8</sup>European countries not in the Eurozone: Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Norway, Poland, Romania, Sweden, Switzerland and the United Kingdom.

<sup>9</sup>Richest countries of Europe not in the Eurozone: Denmark, Norway, Sweden, Switzerland and the United Kingdom.

Table 2.1: Difference-in-differences: effect of the euro during the crisis

	(1)	(2)	(3)	(4)
$\ln \text{Export}_{ijt}$	2003-2010	2003-2015	2003-2010	2003-2015
Euro*Crisis 2008-2010 $_{ijt}$	-0.0269* (0.0120)		0.0935*** (0.0224)	
Euro*Crisis 2008-2015 $_{ijt}$		-0.0707*** (0.0118)		0.0597*** (0.0192)
Observations	4,416	7,176	4,416	7,176
R-squared	0.991	0.986	0.993	0.991
Pair-country FE	YES	YES	YES	YES
Exporter-time FE	NO	NO	YES	YES
Importer-time FE	NO	NO	YES	YES
Exporter FE	YES	YES	NO	NO
Importer FE	YES	YES	NO	NO
Time FE	YES	YES	NO	NO

*Note:* Difference-in-differences approach between the first 12 Eurozone members and the other most developed countries in the world, before and after the financial crisis starting in 2008. Robust standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Not taking into account individual country time trends leads to incorrect conclusions about the euro effect, and negative and significant coefficients (columns 1 and 2 in table 2.1). This is because the exporter-time and importer-time fixed effects capture the time-varying effects of a GDP drop and a banking sector crisis. Indeed, the banking crisis was deeper in the Eurozone. The coefficients in columns 1 and 2 do not control for these facts which is why they are negative.

Column 3 in table 2.1 shows the correct estimation, controlling for individual country time trends as well as time-invariant pair characteristics. The euro now has a positive and significant effect (9.8%<sup>10</sup>) during the 2008-2010 great trade collapse compared to the other developed countries in my control group. In column 4, the long term effect is also positive and significant (6.2%<sup>11</sup>). As a robustness check, the results for all the OECD countries as the control group are presented in table B2 in the appendix. In addition, table B3 in the appendix shows results for the periods 2008-2011, 2008-2010, 2008-2013 and 2008-2014 as well.

I then test the effects of the euro year by year. Table 2.2 presents the results.

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<sup>10</sup>  $e^{0.0935} \approx 1.098$ ;  $e^{0.0597} \approx 1.062$ .

Table 2.2: Testing the effect of the euro year by year

$\ln \text{Export}_{ijt}$	(1) 2003-2015
Euro*2004 <sub>ijt</sub>	0.0399 (0.0506)
Euro*2005 <sub>ijt</sub>	0.0350 (0.0475)
Euro*2006 <sub>ijt</sub>	0.0652 (0.0466)
Euro*2007 <sub>ijt</sub>	0.0528 (0.0513)
Euro*2008 <sub>ijt</sub>	0.136*** (0.0485)
Euro*2009 <sub>ijt</sub>	0.114** (0.0481)
Euro*2010 <sub>ijt</sub>	0.146*** (0.0490)
Euro*2011 <sub>ijt</sub>	0.0776 (0.0496)
Euro*2012 <sub>ijt</sub>	0.0539 (0.0504)
Euro*2013 <sub>ijt</sub>	0.0986* (0.0512)
Euro*2014 <sub>ijt</sub>	0.0742 (0.0520)
Euro*2015 <sub>ijt</sub>	0.0858 (0.0544)
Observations	7,176
R-squared	0.991
Pair-country FE	YES
Exporter-time FE	YES
Importer-time FE	YES

*Note:* The benchmark is the year 2003. The control group is the most developed countries in the world (listed in the appendix). Robust standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Compared to the other developed countries, the euro did not have a significantly different effect on trade until 2008, when it becomes significant which is precisely when the financial crisis started.

This exercise suggests that trade among the Eurozone members plunged less deeply than in the case of the other developed countries, and that recovery was quicker and exhibited a more powerful rebound. Compared to 2003, the coefficients of years 2008 to 2010 are higher than in column 3 in table 2.1 (with years 2003 to 2007 as the benchmark). A potential reason for this stronger rebound is given by Bricongne *et al.* (2012) who find that during the great trade collapse, the usual number (not more) of small French firms exited the export market. Only the extensive margin of French trade was affected by the great trade collapse, not the intensive margin. This explains why the trade rebound in France was strong. Table B1 shows that on average, Eurozone firms are not as financially dependent as firms in the other developed countries. It is likely then, that the number of exits of European firms was less important than in the other developed countries for the same reason that French firms were better able to ride the crisis. It might explain the bigger rebound observed in table 2.2.

From year 2011 in table 2.2, the euro continued to have a positive effect on trade but it is no longer significant. This might be due to the sovereign debt crisis which started in 2011 in the Eurozone. Therefore, the Eurozone has done better than the other developed countries during the great trade collapse, and has not done worse afterwards, despite an internal crisis.

The literature suggests that the overall effect of the euro has been positive and significant (e.g. Glick and Rose, 2016); however, I find positive but not significant effects. The reason for this is that my benchmark is year 2003, so there is no comparison with Eurozone members before they had the euro. In addition, my control group comprises the developed countries, while most studies use the world as the control group.

#### 2.2.4 Robustness checks

I performed some robustness checks; the results for my main sample for the period 2003-2010 are presented in table 2.3. The results for the period 2003-2015 are presented in table B4 in the appendix; there is little variation with table 2.3.

Table 2.3: Difference-in-differences: robustness checks for the period 2003-2010

$\ln\text{Export}_{ijt}$	(1) All Eurozone including new members 2003-2010	(2) GDP drop of at least 5% in 2009 2003-2010	(3) Test for EU (control group, OECD) 2003-2010
Euro*Crisis 2008-2010 $_{ijt}$	0.0717*** (0.0190)	0.153*** (0.0335)	0.0889*** (0.0185)
European Union $_{ijt}$			0.0418 (0.0505)
Observations	4,048	3,040	6,960
R-squared	0.995	0.992	0.992
Pair-country FE	YES	YES	YES
Exporter-time FE	YES	YES	YES
Importer-time FE	YES	YES	YES

*Note:* In column 1 my treatment group comprises all the Eurozone members (new members included), my control group is the most developed countries in the world as listed in appendix. In column 2, I withdraw all the countries whose GDP decreased by less than 5%, my treatment group does not change. In column 3, I control for the EU membership, my control group being the OECD countries. Robust standard errors in parentheses (\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

In column 1 in table 2.3, I add to the equation 2.1 the east European countries after entry to the Eurozone.<sup>11</sup> The coefficients remain positive and significant, although the effect is slightly smaller (7.4%<sup>12</sup> against 9.8% in table 2.1). This small effect is not surprising; Shelburne (2010) observed that during the collapse, the first 15 members of the European Union (EU prior to 2004) did better compared to the 12 new members. He observed that east European countries were the most negatively impacted economies in the world in terms of GDP decline. If I take the OECD countries (including some of the central and eastern Europe countries) as a control group, the effects of the euro are only slightly bigger.

To account better for the GDP drop during the crisis, I exclude from my sample all countries whose GDP decreased by less than 5%; my treatment group remains the same, only the control group changes. Column 2 in table 2.3 presents the results. The coefficients are even higher than before. Indeed, the fact that GDP dropped by more than 5% during the crisis is an indicator of poor financial health, not necessarily all captured by my country-time fixed effects since there

<sup>11</sup>Slovenia joined the Eurozone in 2007, Cyprus and Malta in 2008, Slovakia in 2009, Estonia in 2011, Latvia in 2014 and Lithuania in 2015.

<sup>12</sup> $e^{0.0717} \approx 1.074$

are contagion effects among countries. This explains why my coefficient is higher than in table 2.1 column 1.

Finally, in column 3 in table 2.3, I check that it is the euro that is driving my results and not the European Union. I cannot use my developed country control group since none of the countries in the sample entered the European Union between 2003 and 2015, so my pair-country fixed effect would drop a European Union dummy. Instead, I use a bigger sample including all OECD countries.<sup>13</sup> My coefficients with OECD as control group but not controlling for the European Union membership remain positive and significant, and very close to the results in table B2 in the appendix.

I ran a couple of robustness checks. To check that the Euro\*Crisis coefficient reported in table 2.1 is not driven by one country in particular, I exclude all the Eurozone members one by one. The coefficient remains positive and significant. Tables B5 and B6 in the appendix present these results. Furthermore, as I want my shock to be exogenous, I remove the USA from the sample to ensure it is not driving my results: it is not. Furthermore, since my sample starts in 2003 and includes only developed countries, I have only 4% of zeros or missing variables. I run a PPML and the my coefficients are still positive and significant (table B7 in the appendix). Other robustness checks were made, changing the number of years in the sample (table B8 and B9 in the appendix) and changing the reference year from 2008 to 2009 (table B10 in the appendix). None of the results change significantly.

Finally, instead of focusing only on the Eurozone, I test the effects of currency unions in general on trade during the great trade collapse. In this specification, the world is my control group. Table B11 in the appendix presents the results. It seems that currency unions had a bigger effect during the great trade collapse, in both the short term (14.5%<sup>14</sup>) and the long run (8.3%<sup>14</sup>). Both coefficients are higher than the coefficients in table 2.1: currency unions in general had a higher effect on trade during the crisis than the euro. This was expected since it was observed in

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<sup>13</sup>Recall that the results of regression 2.1 with OECD countries as control group are presented in table B2 in the appendix.

<sup>14</sup> $e^{0.135} \approx 1.145$ ;  $e^{0.0798} \approx 1.083$ .



the literature,<sup>15</sup> that the effects of the euro on trade in general are much smaller than the effects of the other currency unions in the world. Furthermore, the control group is different.

To summarize, the euro had a positive and significant approximately 10% effect on aggregate trade during the crisis. This result is very robust and has not been highlighted by the literature so far.

So far, I have studied trade only at the country level. The effects of the euro at the aggregate level seem pretty robust. I next try to understand the reasons for this positive effect on trade, studying trade at sector level.

## 2.3 Heterogeneous effect of the euro across sectors

In this section, I work at a disaggregated level. I check whether or not the effect of the euro was homogenous across sectors, and if not, which sectors benefited most from the euro during the crisis.

### 2.3.1 Descriptive statistics

The Harmonized System (HS) classification includes 21 sectors (1-digit level) and 97 subsections (2-digit level), details are provided in the appendix.

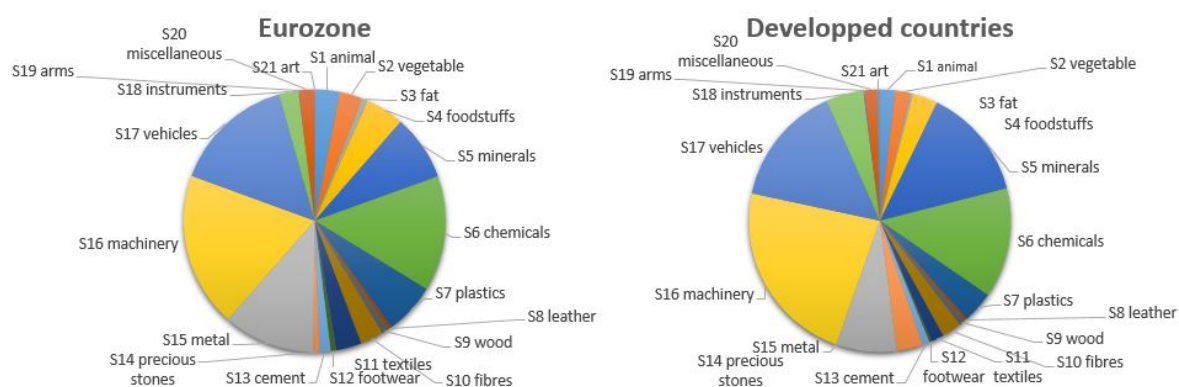


Figure 2.1: Weights of the sectors on total exports<sup>16</sup>

<sup>15</sup>e.g. Glick and Rose (2016).

Figure 2.1 shows that the Eurozone (the treatment group) and the developed countries (the control group) have globally the same structure of exports. For instance, the first biggest sectors both for my treatment group and my control group are machinery, vehicles and chemicals.

	Weight of the sectors		Drop between 2008 and 2009		Contribution to aggregate drop		Difference
	Euro	Dev	Euro	Dev	Euro	Dev	
S15 metal	11,34	7,48	37,99	38,84	4,31	2,90	1,41
S7 plastics	6,31	3,88	22,11	22,75	1,39	0,88	0,51
S6 chemicals	14,20	13,54	11,65	8,80	1,65	1,19	0,46
S11 textiles	3,17	1,61	14,21	20,04	0,45	0,32	0,13
S3 fat	0,75	0,31	25,25	23,83	0,19	0,07	0,12
S1 animal	3,10	1,89	9,42	11,86	0,29	0,22	0,07
S13 cement	1,38	0,90	19,02	23,66	0,26	0,21	0,05
S4 foodstuffs	4,77	3,08	6,93	9,39	0,33	0,29	0,04
S8 leather	0,44	0,29	21,35	21,14	0,09	0,06	0,03
S10 fibres	2,82	2,36	16,97	19,24	0,48	0,45	0,03
S19 arms	0,04	0,14	14,15	2,37	0,006	0,003	0,002
S2 vegetable	2,79	1,91	13,77	20,98	0,38	0,40	-0,02
S12 footwear	0,67	0,27	3,40	16,49	0,02	0,04	-0,02
S9 wood	0,93	0,85	21,70	27,37	0,20	0,23	-0,03
S20 miscellaneous	1,94	1,47	13,58	22,46	0,26	0,33	-0,07
S21 art	0,016	0,43	15,95	36,80	0,003	0,16	-0,15
S18 instruments	2,38	4,64	10,85	13,55	0,26	0,63	-0,37
S14 precious stones	0,73	3,22	25,26	21,35	0,18	0,69	-0,51
S17 vehicles	15,06	14,98	21,06	29,26	3,17	4,38	-1,21
S16 machinery	19,07	22,93	22,07	25,36	4,21	5,82	-1,61
S5 minerals	8,10	13,85	34,64	38,04	2,81	5,27	-2,46
			sum		20,96	24,56	-3,6

Table 2.4: Each sector's contribution to the aggregate drop

Table 2.4 shows the contribution of each sector to the observed drop in aggregate trade between 2008 and 2009 in the Eurozone and in the developed countries. Thus, the metal sector (S15) and the machinery sector (S16) together are responsible for more than 40% of the total drop in the Eurozone.<sup>17</sup> However, both these sectors do better than the same sectors in the

<sup>16</sup>S1: live animals, animal products; S2: vegetable products; S3: animal or vegetable fats and oils and their cleavage products; S4: prepared foodstuffs, beverages, tobacco; S5: mineral products; S6: chemicals; S7: plastics and articles thereof; S8: leather, furskins and articles thereof; S9: wood and articles of wood; S10: pulp of wood or of other fibrous cellulosic material; S11: textiles; S12: footwear, headgear, umbrellas, walking-sticks; S13: articles of stone, plaster, cement; S14: natural or cultured pearls, precious or semi-precious stones; S15: base metals and articles of base metal; S16: machinery and mechanical appliances, electrical equipment, parts thereof; S17: vehicles, aircraft, vessels and associated transport equipment; S18: optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; clocks and watches; musical instruments; S19: arms and ammunition; S20: miscellaneous manufactured articles; S21: works of art, collectors'pieces and antiques. More details in appendix 1.

<sup>17</sup>These new statistics are in lines with Araújo and Oliveira Martins (2009) and Curran (2009).

developed countries. The sectors showing the biggest differences in their contribution to the drops, are the mineral products sector (S5), machinery (S16) and transport equipment (S17).

### 2.3.2 Difference-in-differences approach at sector level

Since my sectors are heterogeneous, I now work at a disaggregate level and use sector fixed effects. My new regression is a difference in difference at sector level.

$$\ln Export_{ijts} = \beta Euro_{ijt} * Crisis_t * Sector_s + \lambda_{1its} + \lambda_{2jts} + \lambda_{3ijs} + \epsilon_{ijts}, \quad (2.2)$$

with:

- $Export_{ijts}$  bilateral trade at the sector level
- $Euro_{ijt} * Crisis_t * Sector_s$  sectors in the Eurozone (both partners being in the Eurozone) during the crisis dummy
- $\lambda_{1its}$  exporter-sector-time fixed effect
- $\lambda_{2jts}$  importer-sector-time fixed effect
- $\lambda_{3ijs}$  pair-country-sector fixed effect.

The results of this regression are presented in table 2.5.

Table 2.5: Difference-in-differences: sectorial level at the first and second digit

	(1) One-digit level 2003-2010	(2) Two-digit level 2003-2010	(3) One-digit level 2003-2015	(4) Two-digit level 2003-2015
$\ln \text{Export}_{ijts}$				
Euro*Crisis 2008-2010 $_{ijt}$	0.0323** (0.0157)	0.0340*** (0.0102)		
Euro*Crisis 2008-2015 $_{ijt}$			0.0526*** (0.0130)	0.0644*** (0.00854)
Observations	90,768	373,548	147,624	608,389
R-squared	0.973	0.957	0.968	0.948
Exporter-sector-time FE	YES	YES	YES	YES
Importer-sector-time FE	YES	YES	YES	YES
Pair-country-sector FE	YES	YES	YES	YES

*Note:* Regressions are run at the HS 1-digit and 2-digit product disaggregation level. The control group is the developed countries listed in the appendix. Robust standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table 2.5 shows that the euro still has a more significant effect in both the short (column 1 and 2) and long (column 3 and 4) term but much smaller than in table 2.1. This means that the positive and significant effect observed at the aggregate level is partly a composition effect; controlling for the size of the sector, with sector fixed effects, shrinks the effect. One reason for this might be that the sectors exporting the most are machinery and mechanical appliances<sup>18</sup> and vehicles, aircraft, vessels and associated transport equipment,<sup>19</sup> which rely on make-to-order production. Therefore, the impact of the crisis was postponed for a few months, or even a few years (e.g. the airbus order book for the A320 is filled up for the next ten years).

### 2.3.3 Effect of the euro on each sector during the crisis

To test my hypothesis that the biggest exporting sectors are those impacted the most positively by the euro, I use dummies  $euro * crisis * sector$  to measure the impact of the euro on each sector and do not initially add sector fixed effects (otherwise this would capture the effect of sector size). Table 2.6 presents the results.

<sup>18</sup>19% of total Eurozone members' export.

<sup>19</sup>15% of total Eurozone members' export.

Table 2.6: Difference-in-differences: effect of the euro per sector

lnExport <sub>ijts</sub> 1-digit	(1) Crisis 2008-2010 period 2003-2010	(2) Crisis 2008-2015 period 2003-2015
Euro*Crisis S1 <sub>ijts</sub> (animal)	0.638*** (0.133)	0.697*** (0.0849)
Euro*Crisis S2 <sub>ijts</sub> (vegetable)	0.196 (0.133)	0.294*** (0.0849)
Euro*Crisis S3 <sub>ijts</sub> (fat)	-1.538*** (0.134)	-1.383*** (0.0854)
Euro*Crisis S4 <sub>ijts</sub> (foodstuffs)	1.333*** (0.133)	1.383*** (0.0849)
Euro*Crisis S5 <sub>ijts</sub> (minerals)	0.564*** (0.133)	0.663*** (0.0849)
Euro*Crisis S6 <sub>ijts</sub> (chemicals)	2.397*** (0.133)	2.465*** (0.0849)
Euro*Crisis S7 <sub>ijts</sub> (plastics)	1.437*** (0.133)	1.493*** (0.0849)
Euro*Crisis S8 <sub>ijts</sub> (leather)	-1.324*** (0.133)	-1.191*** (0.0849)
Euro*Crisis S9 <sub>ijts</sub> (wood)	-0.710*** (0.133)	-0.779*** (0.0850)
Euro*Crisis S10 <sub>ijts</sub> (fibres)	0.654*** (0.133)	0.673*** (0.0849)
Euro*Crisis S11 <sub>ijts</sub> (textiles)	0.980*** (0.133)	0.960*** (0.0849)
Euro*Crisis S12 <sub>ijts</sub> (footwear)	-1.081*** (0.133)	-0.963*** (0.0849)
Euro*Crisis S13 <sub>ijts</sub> (cement)	-0.244* (0.133)	-0.336*** (0.0849)
Euro*Crisis S14 <sub>ijts</sub> (precious stones)	-1.569*** (0.133)	-1.484*** (0.0851)
Euro*Crisis S15 <sub>ijts</sub> (metal)	1.846*** (0.133)	1.837*** (0.0849)
Euro*Crisis S16 <sub>ijts</sub> (machinery)	2.747*** (0.133)	2.631*** (0.0849)
Euro*Crisis S17 <sub>ijts</sub> (vehicles)	1.623*** (0.133)	1.577*** (0.0849)
Euro*Crisis S18 <sub>ijts</sub> (instruments)	0.594*** (0.133)	0.628*** (0.0849)
Euro*Crisis S19 <sub>ijts</sub> (arm)	-3.872*** (0.142)	-4.092*** (0.0902)
Euro*Crisis S20 <sub>ijts</sub> (miscellaneous)	0.0722 (0.133)	0.0252 (0.0849)
Euro*Crisis S21 <sub>ijts</sub> (art)	-4.964*** (0.139)	-4.942*** (0.0879)
Observations	90,806	147,645
R-squared	0.509	0.530
Pair-country FE	YES	YES
Exporter-time FE	YES	YES
Importer-time FE	YES	YES

*Note:* The control group is the developed countries as listed in the appendix. Standard errors in parentheses (\*\*\*) p<0.01, \*\* p<0.05, \* p<0.1)

I run a Spearman rank test between the effects of the euro during the great trade collapse on each sector, and the contribution of each sector to total Eurozone exports. The correlation is 0.95 for 2008-2010, and 0.96 for 2008-2015, the hypothesis that the variables are independent is rejected at the 95% interval. Thus, it is clear that the euro helped the highest exporting sectors. This is in line with the statistics in table 2.4. In addition, the Eurozone has the biggest comparative advantages in these sectors which are also the most open.

### **2.3.4 Controlling for sector weight in total exports**

I control for sector weight in total exports by adding a sector fixed effect, to study the effect of the euro independent of export weight.

Table 2.7: Difference-in-differences: effect of the euro per sector with sector fixed effect

lnExport <sub>ijts</sub> 1-digit	(1) Crisis 2008-2010 period 2003-2010	(2) Crisis 2008-2015 period 2003-2015
Euro*Crisis S1 <sub>ijts</sub> (animal)	0.413*** (0.0924)	0.416*** (0.0612)
Euro*Crisis S2 <sub>ijts</sub> (vegetable)	0.469*** (0.0924)	0.515*** (0.0612)
Euro*Crisis S3 <sub>ijts</sub> (fat)	0.615*** (0.0932)	0.714*** (0.0617)
Euro*Crisis S4 <sub>ijts</sub> (foodstuffs)	0.325*** (0.0924)	0.326*** (0.0612)
Euro*Crisis S5 <sub>ijts</sub> (minerals)	0.163* (0.0924)	0.174*** (0.0612)
Euro*Crisis S6 <sub>ijts</sub> (chemicals)	-0.0423 (0.0923)	-0.0188 (0.0612)
Euro*Crisis S7 <sub>ijts</sub> (plastics)	0.321*** (0.0924)	0.383*** (0.0612)
Euro*Crisis S8 <sub>ijts</sub> (leather)	0.303*** (0.0924)	0.460*** (0.0612)
Euro*Crisis S9 <sub>ijts</sub> (wood)	0.417*** (0.0927)	0.480*** (0.0613)
Euro*Crisis S10 <sub>ijts</sub> (fibres)	0.285*** (0.0924)	0.412*** (0.0612)
Euro*Crisis S11 <sub>ijts</sub> (textiles)	0.325*** (0.0924)	0.411*** (0.0612)
Euro*Crisis S12 <sub>ijts</sub> (footwear)	0.714*** (0.0924)	0.896*** (0.0612)
Euro*Crisis S13 <sub>ijts</sub> (cement)	0.131 (0.0924)	0.116* (0.0612)
Euro*Crisis S14 <sub>ijts</sub> (precious stones)	-0.445*** (0.0925)	-0.477*** (0.0614)
Euro*Crisis S15 <sub>ijts</sub> (metal)	0.00816 (0.0924)	0.00207 (0.0612)
Euro*Crisis S16 <sub>ijts</sub> (machinery)	-0.313*** (0.0923)	-0.387*** (0.0612)
Euro*Crisis S17 <sub>ijts</sub> (vehicles)	-0.241*** (0.0924)	-0.244*** (0.0612)
Euro*Crisis S18 <sub>ijts</sub> (instruments)	-0.624*** (0.0924)	-0.654*** (0.0612)
Euro*Crisis S19 <sub>ijts</sub> (arms)	-0.637*** (0.0988)	-0.922*** (0.0651)
Euro*Crisis S20 <sub>ijts</sub> (miscellaneous)	-0.0395 (0.0924)	-0.0403 (0.0612)
Euro*Crisis S21 <sub>ijts</sub> (art)	-1.783*** (0.0968)	-1.836*** (0.0633)
Observations	90,806	147,645
R-squared	0.777	0.778
Pair-country FE	YES	YES
Exporter-time FE	YES	YES
Importer-time FE	YES	YES
Sector FE	YES	YES

Note: The control group is the developed countries as listed in the appendix. Standard errors in parentheses (\*\*\*) p<0.01, \*\* p<0.05, \* p<0.1)

Using a Spearman rank test between the euro effect using sector fixed effects<sup>20</sup> and revealed comparative advantage (hypothesis that variables are independent is rejected at the 95% interval); I find correlations of 0.83 for 2008-2010 and 0.78 for 2008-2015 .

It is to be expected that a country, or a group of countries will refocus on those sectors with highest comparative advantage during a crisis. It seems that euro increased this tendency.

The positive and significant effect on trade found at the aggregate level is driven by the sectors exporting the most, where the euro has the biggest comparative advantage. This result is new in the literature.

## 2.4 Identifying the channels

In this section, I test the different causes of the great trade collapse at sector level to understand through which channel the single currency protected the intra Eurozone trade.

### 2.4.1 Causes of the great trade collapse

The literature identifies many different causes for the great trade collapse. I test whether they played a role in the positive and significant effect of the euro observed in the long run in crises times. I test separately and then together the effect of global value chain (a proxy constructed by De Backer and Miroudot, 2013), financial dependency (proxied by external finance share, variable constructed by Choi, 2017) and fall in demand for durable goods (variable constructed by Engel and Wang, 2011). I do not add sector fixed effects since they would absorb the variables I use as controls. The results are displayed in table 2.8.

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<sup>20</sup>I tried also to control only for sector export weight; the results are presented in table B12 in the appendix. The results did not change.



Table 2.8: Difference-in-differences: testing causes of the great trade collapse

lnExport <sub>ijts</sub> 2-digit	(1) No control 2003-2015	(2) GVC 2003-2015	(3) Non durable 2003-2015	(4) Dependency 2003-2015	(5) All 2003-2015
Euro*Crisis 2008-2015 <sub>ijts</sub>	0.0553** (0.0269)	0.0580** (0.0255)	0.0555** (0.0266)	0.0553** (0.0277)	0.0589** (0.0262)
Global value chain <sub>s</sub>		0.285*** (0.00109)			0.310*** (0.00119)
Non durable good <sub>s</sub>			-0.658*** (0.00656)		-0.304*** (0.00679)
Financial dependency <sub>s</sub>				0.111*** (0.00764)	-0.454*** (0.00761)
Observations	609,469	609,469	609,469	578,982	578,982
R-squared	0.372	0.435	0.383	0.370	0.436
Pair-country FE	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES

*Note:* The control group is the developed countries as listed in the appendix. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table 2.8 shows few variations in the coefficients of *Euro \* Crisis08-15* in each column, they are all positive and significant. Therefore, it appears that none of these causes explains the positive effect of the euro.

Column 2 in table 2.8 shows that controlling for the intensity of vertical specialization does not suppress my euro effect.

Yi (2003) was the first to show how relatively small tariff reductions can cause relatively large increases in world trade through global value chains (the small transaction costs adding up each time a border is crossed). Given trans-borders transaction cost reductions, he predicted the increasing international vertical specialization in currency unions. Flam and Nordström (2006) found an increase in the number of global value chains in the Eurozone, trade in the machinery sectors contributing the most due to the single currency.

Since global value chains are considered in the literature as a multiplier effect of the great trade collapse, it might be expected that Eurozone members would not perform as well as the other

developed countries. However, some authors argue that global value chains do not play a big part in trade drops. Indeed, Bénassy-Quéré *et al.* (2009) prove that relative prices held constant, vertical trade should react proportionally to a drop in world GDP. Therefore, global value chains do not explain the observed overshooting of world trade on world GDP. Auboin (2009) shows that industries that are the biggest users of global value chains, are also those with the most financial dependency on banks (as shown also by my data). Therefore, the trade drop observed during the financial crisis is correlated to but not necessarily caused by vertical trade.

Finally, Altomonte and Ottaviano (2009) argue that trade flows within supply chains are more rather than less, resilient to large adverse shocks. Indeed, setting up organized supply chains entails some sunk costs, so firms would rather adjust the entire chain along the intensive as opposed to the extensive margin. Bricongne *et al.* (2012) findings are in the same direction. This might explain the stronger rebound I observe in the Eurozone after the 2009 trade drop. Using the same data as in table 2.8, and exploiting the results in table 2.7, I implemented a Spearman rank test. I find a negative relationship between global value chain and the euro effect during the crisis (-0.34 for 2008-2010 period and -0.33 for 2008-2015 period). As expected, vertical trade decreased particularly during the crisis, thus the Eurozone is not an exception. The fact that the results in table 2.8 column 2 do not change much does not contradict the results of the Spearman rank test since this does not take account of the weights of the sectors.

Column 3 in table 2.8 shows that controlling for exports of non-durable goods does not suppress my euro effect. This is because my treatment and control groups have the same export structure (figure 2.1), thus the euro effect does not come from exporting more or less durable goods than the other developed countries.

Column 4 in table 2.8 shows that controlling for the financial dependency of sectors does not suppress my euro effect. This is the case because my country-time fixed effect already controls for the banking sector crisis within each country. Implementing a Spearman rank test shows a negative relationship between financial dependency and the euro effect during the crisis (-0.62 for 2008-2010 period and -0.65 for 2008-2015 period). Again this is not surprising since European

banks were hit particularly hard by the financial crisis, and therefore the euro had a positive impact on the financially independent sectors, and a negative impact otherwise.

Protectionism is not part of the story since, had it played a role, it would have been at the European Union not the Eurozone level. In my specification, my pair-country fixed effect absorbs the effect of the European Union (there are no entries to the EU in my sample).

### 2.4.2 The euro, the crisis and uncertainty

Finally, Berman *et al.* (2012) show that agents are especially cautious during crisis periods. During the financial crisis, exchange rates were more volatile than usual (Coudert et al., 2011; Morales-Zumaquero and Sosvilla-Rivero, 2014). The single currency prevented uncertainty linked to exchange rates among members. This is especially important for industries with sticky prices. To measure price stickiness, I use Rauch's (1999) classification. Rauch differentiates sectors according to the way prices are settled (goods traded on an organized exchange, reference priced and differentiated products) to create an index for each of my 21 sectors. Using a Spearman rank test, I find correlations of 0.44 for 2008-2010 and 2008-2015 between the euro effect (using sector fixed effects) and the use of referenced prices.<sup>21</sup> In contrast, I find a correlation of -0.42 for use of differentiated products. Therefore, the euro has helped those sectors using referenced prices by keeping prices stable. Indeed, since the prices are referenced, and therefore stickier, it is difficult for the firms to modify them. The euro removed the uncertainty on profits firms faced inside the Eurozone, while this uncertainty increased outside, exchange rates being more volatile during the crisis. In my data, on average the sectors exporting the most use more referenced prices compared to other sectors. To sum up, since uncertainty is greater in times of economic crisis, currency unions have a premium from the absence of exchange rate volatility.

The main channel through which the euro protected intra Eurozone trade is exchange rate stability. The literature identifies a wait-and-see mechanism during the crisis, worsened by an important exchange rate volatility. The euro avoided this additional problem, which explains its

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<sup>21</sup> And a correlation of 0.35 for 2008-2010 and for 2008-2015 between the euro effect not using sector fixed effects and the use of referenced prices.

comparatively good performance in trade. This result is one of the main contributions of this paper.

## 2.5 Conclusion

To conclude, the euro protected its members during the great trade collapse. However, this protection was not homogenous, since the sectors exporting the most were the ones that benefited the most from this protection. The sectors exporting the most were more sensitive to the uncertainty linked to exchange rates. To my knowledge, the fact that the euro had a positive impact on trade during a major trade crisis has not previously been identified. However, it should be taken into account when measuring the advantages and drawbacks of a single currency. My specification does not allow differentiation between the impact of the euro and other factors confounded by euro membership (banking union, Sixpack, etc.). These reforms would not be expected to affect sectors differently, and therefore should not have driven the effect I have highlighted.

My results raise a new question which could be studied in a separate investigation: the effect of currency unions on trade generally during the great trade collapse. I find that the positive effect of the euro comes mostly from the absence of exchange rate volatility. This characteristic is common to all currency unions. The results in table B11 suggest a positive general effect of currency unions during the crisis. It would be interesting to compare the effect of different currency unions during the crisis to understand whether the effect was homogenous. It would help to know whether the effects of the euro stem from the single currency, or laws supporting Eurozone integration (such as the banking union).

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## 2.A Appendix: List of countries, sectors and variables

### 2.A.1 Countries

**My treatment group: *Eurozone members prior to 2007*:** Austria (AUT), Belgium (BEL), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Ireland (IRL), Italy (ITA), Luxembourg (LUX), the Netherlands (NLD), Portugal (PRT), and Spain (ESP)

**Added to my treatment group for robustness checks: *east Eurozone members*:** Slovenia (SVN), Cyprus (CYP), Malta (MLT), Slovakia (SVK), Estonia (EST), Latvia (LVA) and Lithuania (LTU)

**Favorit control group: *most developed countries of the OECD*:** Australia (AUS), Canada (CAN), Denmark (DNK), Iceland (ISL), Israel (ISR), Japan (JPN), New Zealand (NZL), Norway (NOR), South Korea (KOR), Sweden (SWE), Switzerland (CHE), United Kingdom (GBR) and United States (USA)

**Second favorite control group, used for robustness checks: *OECD countries*:** Australia (AUS), Canada (CAN), Chile (CHL), Czech Republic (CZE), Denmark (DNK), Hungary (HUN), Iceland (ISL), Israel (ISR), Japan (JPN), Mexico (MEX), New Zealand (NZL), Norway (NOR), South Korea (KOR), Sweden (SWE), Switzerland (CHE), Turkey (TUR), United Kingdom (GBR) and United States (USA)

### 2.A.2 HS classification

Description of all the sections is presented here:

<https://unstats.un.org/unsd/tradekb/Knowledgebase/50043/HS-2002-Classification-by-Section>

### 2.A.3 Variables

In this appendix, I describe in detail the variables used and give their sources.

- *Export* : annual bilateral (one-way) trade flow data in thousands of US dollars (BACI database) (1995-2015)
- *Export 1 – digit* : annual bilateral (one-way) trade flow data at the HS 1-digit product disaggregation in thousands of US dollars (BACI database) (1995-2015)
- *Export 2 – digit* : annual bilateral (one-way) trade flow data at the HS 2-digit product disaggregation in thousands of US dollars (BACI database) (1995-2015)
- *Euro \* Crisis2008 – 2010* : dummy for both countries being in the Eurozone between 2008 and 2010
- *Euro \* Crisis2008 – 2015* : dummy for both countries being in the Eurozone between 2008 and 2015



- *Euro \* CrisisS1* : dummy for both countries being in the Eurozone in sector 1, during the crisis
- *Euro \* 2004* : dummy for both countries being in the Eurozone in 2004
- *S1* : sector 1 (for more details about sector 1, the HS classification can be found in the appendix)
- *CU Crisis08 – 10* : dummy for both countries being in currency union between 2008 and 2010
- *CU Crisis08 – 15* : dummy for both countries being in currency union between 2008 and 2015
- *Currency Union* : dummy for both countries being in currency union together (and dollarized economies)
- *European Union* : dummy for both countries being in the European Union
- *FTA dummy* : dummy for Free Trade Agreements (Design of International Trade Agreements database) (1948-2015)
- *GDP* : GDP in current US dollar (World Development Indicators from the World Bank) (1960-2015)
- *GDP per Capita* : GDP per capita in constant 2005 US dollar (World Development Indicators from the World Bank) (1960-2015)
- *Debt* : Central government debt, in percentage of GDP (World Development Indicators from the World Bank) (1960-2016)
- *Overshooting* : trade growth between 2008 and 2009 divided by GDP growth between 2008 and 2009
- *Trade openness* : (import+export)/GDP, (imports and exports from BACI, GDP from World Bank World Development Indicators database)
- *Global Value Chain* : weighted average of the sectors global value chains index in 2008 (OECD Global Value Chains indicators)
- *Financial Dependency* : weighted average of the sectors external finance share (Choi index) (1987-2006)
- *Non Durable Good* : dummy for non-durable good (Engel and Wang index)
- *Real interest rate* : lending interest rate adjusted for inflation as measured by the GDP deflator (World Development Indicators from the World Bank) (1960-2015)
- *Domestic credit to private sector* : financial resources provided to the private sector by financial corporations (World Development Indicators from the World Bank) (1960-2015)

## 2.B Appendix: Maps

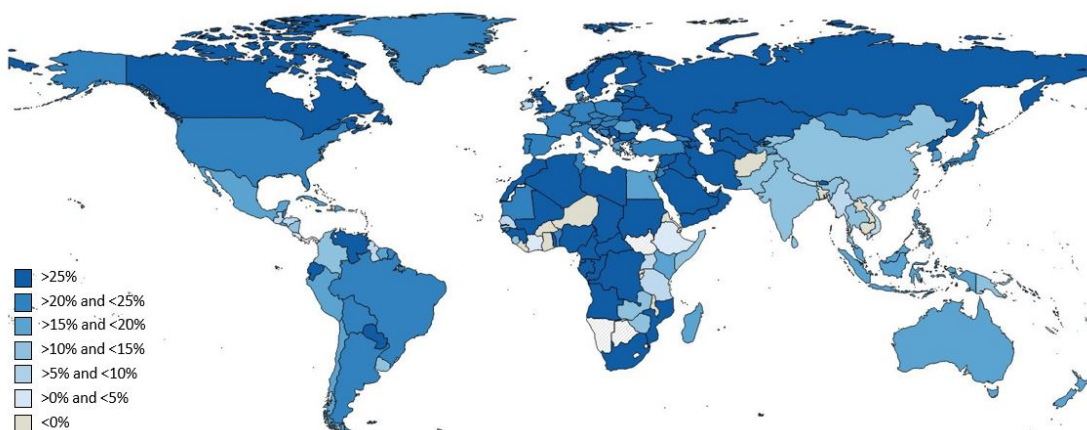


Figure B1: Trade drop in the world between 2008 and 2009

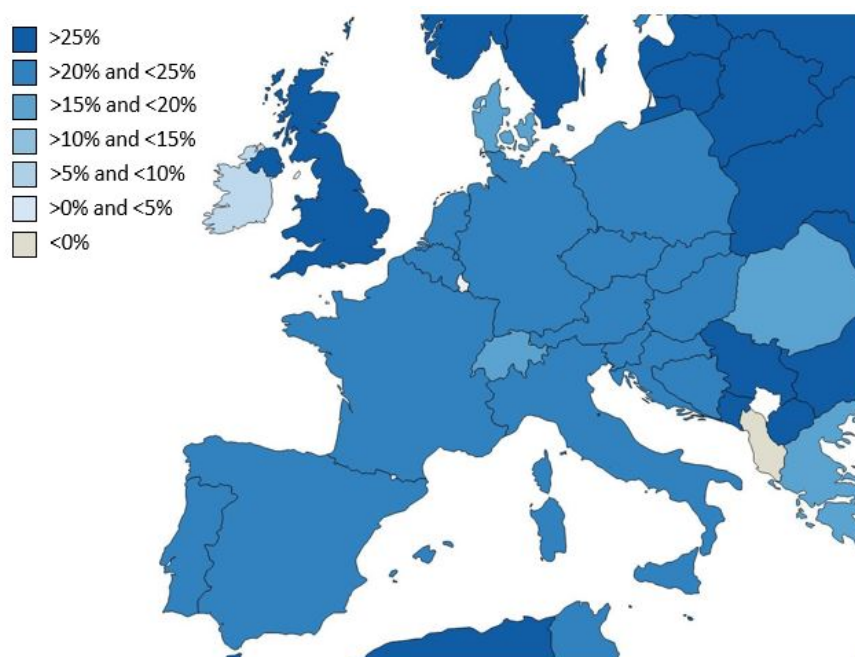


Figure B2: Trade drop in Europe between 2008 and 2009

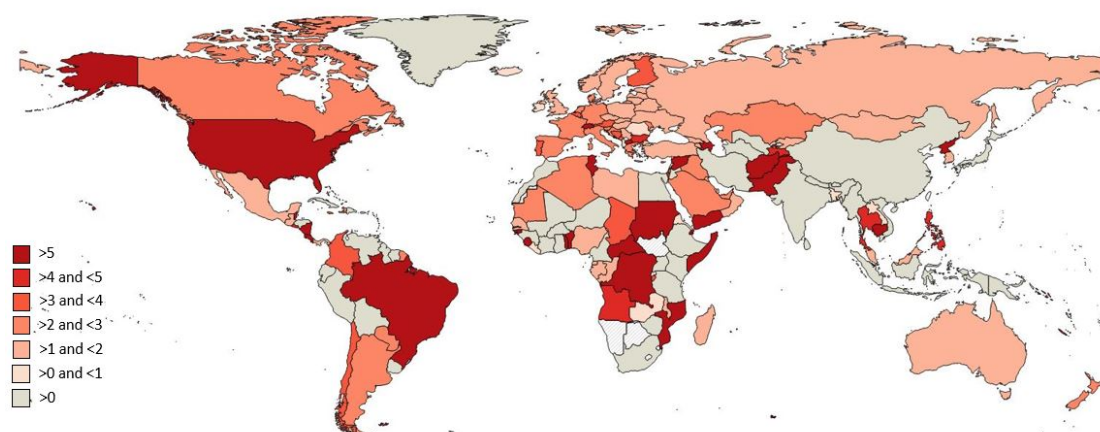


Figure B3: Overshooting: Trade/GDP (index, year 2008=100 for both) in the world between in 2009

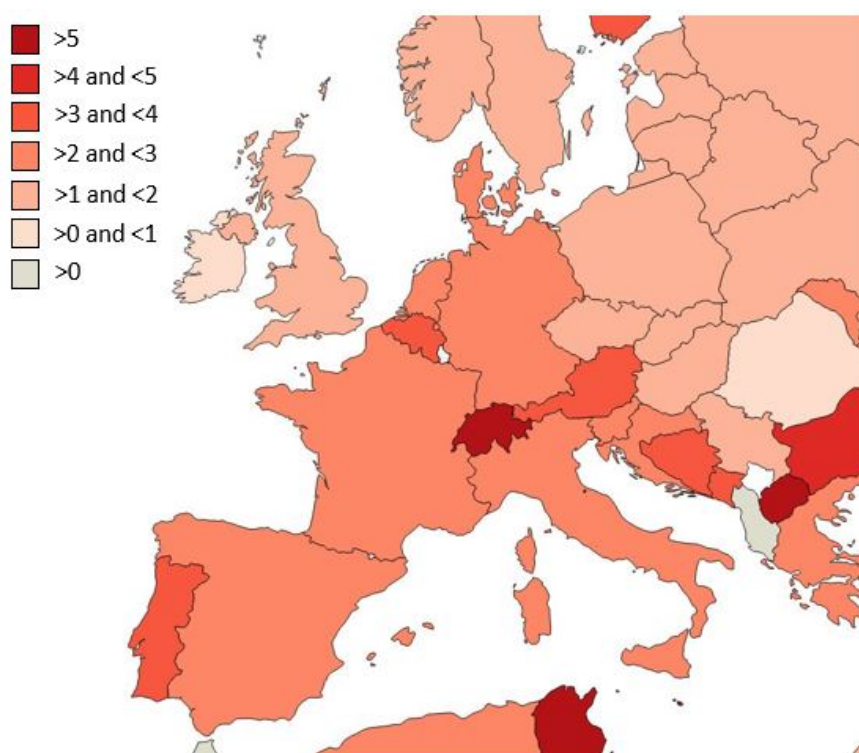


Figure B4: Overshooting: Trade/GDP (index, year 2008=100 for both) in Europe in 2009

## 2.C Appendix: More estimations

Variable	Group	Obs.	Mean	Std. Dev.	Min	Max
Debt in % of GDP in 2008	<b>Eurozone</b>	<b>12</b>	<b>63.29</b>	<b>38.65</b>	<b>6.76</b>	<b>132.42</b>
	World	127	51.92	37.40	.21	247.38
	OECD	22	49.04	30.94	.52	147.34
	Developed	13	55.66	34.28	18.39	147.34
	Rich Europe	5	41.92	10.78	25.40	55.65
	Europe	17	44.90	22.99	.52	92.69
	East Eurozone	7	50.95	31.23	.52	92.69
GDP per Capita in 2008	<b>Eurozone</b>	<b>11</b>	<b>45047.32</b>	<b>11017.55</b>	<b>24815.61</b>	<b>61235.4</b>
	World	188	14006.7	19534.79	182.6878	96880.51
	OECD	23	35640.61	22947.15	9578.57	96880.51
	Developed	13	50466.68	19835.68	20474.89	96880.51
	Rich Europe	5	67090.44	19189.09	46523.27	96880.51
	Europe	18	31887.5	25082.38	7296.123	96880.51
	East Eurozone	7	21839.46	7272.744	14961.57	35390.7
Trade openness in 2008	<b>Eurozone</b>	<b>11</b>	<b>.00071</b>	<b>.00037</b>	<b>.00033</b>	<b>.0016</b>
	World	188	.0013	.0048	.00018	.066
	OECD	23	.00071	.00032	.00022	.0013
	Developed	13	.00054	.00019	.00022	.00085
	Rich Europe	5	.00061	.00015	.00038	.00080
	Europe	18	.00094	.00040	.00038	.0021
	East Eurozone	7	.0012	.00044	.00077	.0021
Trade drop in % between 2008 and 2009	<b>Eurozone</b>	<b>11</b>	<b>-22.05</b>	<b>6.13</b>	<b>-34.27</b>	<b>-7.92</b>
	World	217	-14.96	63.99	-96.12	723.02
	OECD	23	-21.95	4.41	-30.93	-15.01
	Developed	13	-22.05	5.49	-30.93	-15.01
	Rich Europe	5	-24.23	6.16	-30.11	-16.15
	Europe	18	-25.06	6.58	-44.54	-16.15
	East Eurozone	7	-28.26	8.11	-44.54	-21.27
GDP drop in % between 2008 and 2009	<b>Eurozone</b>	<b>11</b>	<b>-8.65</b>	<b>2.29</b>	<b>-14.24</b>	<b>-6.57</b>
	World	187	-4.13	13.21	-34.87	84.73
	OECD	23	-12.43	7.55	-26.67	3.84
	Developed	13	-10.26	8.05	-26.67	3.84
	Rich Europe	5	-12.39	6.59	-17.68	-2.18
	Europe	18	-13.62	6.53	-26.48	-2.18
	East Eurozone	7	-14.25	8.14	-26.48	-5.00
Global value chain index	<b>Eurozone</b>	<b>11</b>	<b>5.57</b>	<b>.70</b>	<b>4.70</b>	<b>7.36</b>
	World	217	4.84	1.60	1.29	7.61
	OECD	23	5.42	.83	3.27	6.77
	Developed	13	5.57	1.02	3.27	6.77
	Rich Europe	5	6.01	.55	5.41	6.77
	Europe	18	5.54	.53	4.88	6.77
	East Eurozone	7	5.43	.47	4.88	6.27
Financial Dependency index	<b>Eurozone</b>	<b>11</b>	<b>-.45</b>	<b>.040</b>	<b>-.52</b>	<b>-.37</b>
	World	217	-.49	.090	-.76	-.21
	OECD	23	-.43	.063	-.53	-.27
	Developed	13	-.41	.068	-.524	-.27
	Rich Europe	5	-.41	.078	-.47	-.27
	Europe	18	-.45	.054	-.50	-.27
	East Eurozone	7	-.46	.026	-.50	-.43
Real Interest Rate in %	<b>Eurozone</b>	<b>11</b>	<b>5.30</b>	<b>2.06</b>	<b>2.07</b>	<b>8.69</b>
	World	158	2.55	7.35	-19.93	35.37
	OECD	20	3.50	3.34	-2.87	13.32
	Developed	11	2.91	2.73	-2.87	7.24
	Rich Europe	3	.11	2.59	-2.87	1.80
	Europe	16	2.08	2.48	-2.87	7.13
	East Eurozone	7	1.51	1.62	-1.18	3.04
Domestic Credit to Private Sector (% of GDP)	<b>Eurozone</b>	<b>12</b>	<b>108.95</b>	<b>34.95</b>	<b>62.35</b>	<b>170.17</b>
	World	227	54.65	44.82	2.68	212.25
	OECD	23	110.50	56.26	20.84	197.57
	Developed	13	149.50	38.38	70.44	197.57
	Rich Europe	5	154.91	36.97	118.57	194.76
	Europe	18	98.68	55.93	36.97	212.25
	East Eurozone	7	97.65	55.76	40.74	212.25

Table B1: Summary Statistics

Table B2: Difference-in-differences: OECD countries as a control group

	(1)	(2)
lnExport	2003-2010	2003-2015
Euro*Crisis 2008-2010	0.0869*** (0.0219)	
Euro*Crisis 2008-2015		0.0871*** (0.0192)
Observations	6,960	11,310
R-squared	0.992	0.989
Pair-country FE	YES	YES
Exporter-time FE	YES	YES
Importer-time FE	YES	YES

*Note:* Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table B3: Difference-in-differences: changing the lenght of the crisis

lnExport	(1)	(2)	(3)	(4)	(5)	(6)
	2003-2010	2003-2011	2003-2012	2003-2013	2003-2014	2003-2015
Euro*Crisis 2008-2010	0.0935*** (0.0230)					
Euro*Crisis 2008-2011		0.0799*** (0.0219)				
Euro*Crisis 2008-2012			0.0670*** (0.0213)			
Euro*Crisis 2008-2013				0.0658*** (0.0208)		
Euro*Crisis 2008-2014					0.0615*** (0.0205)	
Euro*Crisis 2008-2015						0.0597*** (0.0203)
Observations	4,416	4,968	5,520	6,072	6,624	7,176
R-squared	0.993	0.993	0.992	0.992	0.991	0.991
Pair-country FE	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES

*Note:* Control group: the most developed countries. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table B4: Difference-in-differences: robustness checks for the period 2003-2015

lnExport	(1) All Eurozone including new members	(2) GDP drop of at least 5% in 2009	(3) Test for EU (control group, OECD)
Euro*Crisis 2008-2015	0.0602*** (0.0179)	0.102*** (0.0252)	0.0875*** (0.0193)
European Union			0.00830 (0.0400)
Observations	6,578	4,940	11,310
R-squared	0.992	0.991	0.989
Pair-country FE	YES	YES	YES
Exporter-time FE	YES	YES	YES
Importer-time FE	YES	YES	YES

*Note:* In column 1 my treatment group comprises all the Eurozone members (new members included), my control group is the most developed countries in the world as listed in appendix. In column 2, I withdraw all the countries whose GDP decreased by less than 5%, my treatment group does not change. In column 3, I control for the EU membership, my control group being the OECD countries. Standard errors in parentheses (\*\*\* p<0.01, \*\* p<0.05, \* p<0.1)

Table B5: Difference-in-differences: excluding countries

lnExport	(1) 2003-2010
Euro*Crisis 2008-2010 no exclusion	0.0935*** (0.0230)
Euro*Crisis 2008-2010 exclusion AUT	0.116*** (0.0245)
Euro*Crisis 2008-2010 exclusion BEL	0.0853*** (0.0250)
Euro*Crisis 2008-2010 exclusion DEU	0.0997*** (0.0252)
Euro*Crisis 2008-2010 exclusion ESP	0.0927*** (0.0249)
Euro*Crisis 2008-2010 exclusion FIN	0.100*** (0.0244)
Euro*Crisis 2008-2010 exclusion FRA	0.0923*** (0.0251)
Euro*Crisis 2008-2010 exclusion GRC	0.0768*** (0.0238)
Euro*Crisis 2008-2010 exclusion IRL	0.0929*** (0.0230)
Euro*Crisis 2008-2010 exclusion ITA	0.0943*** (0.0251)
Euro*Crisis 2008-2010 exclusion LUX	0.0935*** (0.0230)
Euro*Crisis 2008-2010 exclusion NLD	0.103*** (0.0250)
Euro*Crisis 2008-2010 exclusion PRT	0.0758*** (0.0242)
Euro*Crisis 2008-2010 exclusion USA	0.112*** (0.0246)
Pair-country FE	YES
Exporter-time FE	YES
Importer-time FE	YES

*Note:* Control group: the most developed countries. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table B6: Difference-in-differences: excluding countries

lnExport	(1) 2003-2015
Euro*Crisis 2008-2015 no exclusion	0.0597*** (0.0203)
Euro*Crisis 2008-2015 exclusion AUT	0.0812*** (0.0217)
Euro*Crisis 2008-2015 exclusion BEL	0.0540** (0.0220)
Euro*Crisis 2008-2015 exclusion DEU	0.0660*** (0.0222)
Euro*Crisis 2008-2015 exclusion ESP	0.0656*** (0.0219)
Euro*Crisis 2008-2015 exclusion FIN	0.0692*** (0.0213)
Euro*Crisis 2008-2015 exclusion FRA	0.0598*** (0.0221)
Euro*Crisis 2008-2015 exclusion GRC	0.0377* (0.0209)
Euro*Crisis 2008-2015 exclusion IRL	0.0561*** (0.0208)
Euro*Crisis 2008-2015 exclusion ITA	0.0615*** (0.0220)
Euro*Crisis 2008-2015 exclusion LUX	0.0597*** (0.0203)
Euro*Crisis 2008-2015 exclusion NLD	0.0651*** (0.0219)
Euro*Crisis 2008-2015 exclusion PRT	0.0406* (0.0214)
Euro*Crisis 2008-2015 exclusion USA	0.0733*** (0.0216)
Pair-country FE	YES
Exporter-time FE	YES
Importer-time FE	YES

*Note:* Control group: the most developed countries. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )



Table B7: PPML: dealing with the zero flows problem

Export	(1) PPML 2003-2010	(2) PPML 2003-2015
Euro*Crisis 2008-2010	0.0405*** (0.0118)	
Euro*Crisis 2008-2015		0.0250* (0.0151)
Constant	12.45*** (0.0545)	14.49*** (0.0433)
Observations	4,416	7,176
R-squared	0.999	0.998
Pair-country FE	YES	YES
Exporter-time FE	YES	YES
Importer-time FE	YES	YES

*Note:* Control group: the most developed countries. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table B8: Difference-in-differences: changing the period of reference

lnExport	(1) 2005-2010	(2) 2004-2010	(3) 2003-2010	(4) 2002-2010
Euro*Crisis 2008-2010	0.0811*** (0.0251)	0.0839*** (0.0238)	0.0935*** (0.0230)	0.0909*** (0.0226)
Observations	3,312	3,864	4,416	4,968
R-squared	0.994	0.994	0.993	0.993
Pair-country FE	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES

*Note:* Control group: the most developed countries. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table B9: Difference-in-differences: changing the period of reference

	(1)	(2)	(3)	(4)
lnExport	2005-2015	2004-2015	2003-2015	2002-2015
Euro*Crisis 2008-2015	0.0473** (0.0237)	0.0501** (0.0216)	0.0597*** (0.0203)	0.0571*** (0.0195)
Observations	6,072	6,624	7,176	7,728
R-squared	0.992	0.991	0.991	0.991
Pair-country FE	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES

*Note:* Control group: the most developed countries. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table B10: Difference-in-differences: changing the start of the crisis (2009 instead of 2008)

	(1)	(2)
lnExport	2003-2010	2003-2015
Euro*Crisis 2009-2010	0.0756*** (0.0257)	
Euro*Crisis 2009-2015		0.0382* (0.0198)
Observations	4,416	7,176
R-squared	0.993	0.991
Pair-country FE	YES	YES
Exporter-time FE	YES	YES
Importer-time FE	YES	YES

*Note:* Control group: the most developed countries. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table B11: Difference-in-differences: effect of currency unions on trade during the crisis

	(1) 2003-2010	(2) 2003-2015
lnExport		
Currency Union*Crisis 2008-2010	0.135*** (0.0419)	
Currency Union*Crisis 2008-2015		0.0798** (0.0329)
Observations	205,514	339,992
R-squared	0.922	0.911
Pair-country FE	YES	YES
Exporter-time FE	YES	YES
Importer-time FE	YES	YES

*Note:* Control group: the world. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

Table B12: Difference-in-differences: effect of the euro per sector controlling for size

lnExport 1-digit	(1) Crisis 2008-2010 period 2003-2010	(2) Crisis 2008-2015 period 2003-2015
Euro*Crisis S1 (animal)	1.072*** (0.105)	1.130*** (0.0679)
Euro*Crisis S2 (vegetable)	0.706*** (0.105)	0.803*** (0.0679)
Euro*Crisis S3 (fat)	-0.510*** (0.106)	-0.357*** (0.0684)
Euro*Crisis S4 (foodstuffs)	1.343*** (0.105)	1.392*** (0.0678)
Euro*Crisis S5 (minerals)	-0.269** (0.105)	-0.169** (0.0679)
Euro*Crisis S6 (chemicals)	0.0177 (0.106)	0.0910 (0.0683)
Euro*Crisis S7 (plastics)	1.058*** (0.105)	1.115*** (0.0679)
Euro*Crisis S8 (leather)	-0.217** (0.105)	-0.0857 (0.0680)
Euro*Crisis S9 (wood)	0.272** (0.106)	0.201*** (0.0680)
Euro*Crisis S10 (fibres)	1.158*** (0.105)	1.176*** (0.0679)
Euro*Crisis S11 (textiles)	1.395*** (0.105)	1.374*** (0.0679)
Euro*Crisis S12 (footwear)	-0.0325 (0.105)	0.0836 (0.0679)
Euro*Crisis S13 (cement)	0.626*** (0.105)	0.531*** (0.0679)
Euro*Crisis S14 (precious stones)	-0.536*** (0.105)	-0.453*** (0.0681)
Euro*Crisis S15 (metal)	0.192* (0.106)	0.186*** (0.0681)
Euro*Crisis S16 (machinery)	-0.864*** (0.106)	-0.974*** (0.0690)
Euro*Crisis S17 (vehicles)	-0.973*** (0.106)	-1.013*** (0.0684)
Euro*Crisis S18 (instruments)	1.209*** (0.105)	1.241*** (0.0679)
Euro*Crisis S19 (arms)	-2.669*** (0.113)	-2.889*** (0.0722)
Euro*Crisis S20 (miscellaneous)	0.799*** (0.105)	0.750*** (0.0679)
Euro*Crisis S21 (art)	-3.752*** (0.111)	-3.732*** (0.0704)
Size	25.33*** (0.110)	25.27*** (0.0878)
Observations	90,806	147,645
R-squared	0.691	0.700
Pair-country FE	YES	YES
Exporter-time FE	YES	YES
Importer-time FE	YES	YES

*Note:* Control group: the most developed countries. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

## Chapter 3

# Effects of Global Value Chains on Shocks Transmission and Exchange Rate

### 3.1 Introduction

The expansion of global value chains over the last 20 years is undeniable, and when designing the monetary policy rules, it is important to take account of their effect on the transmission of shocks.

In this chapter, I analyse the effect of global value chains on international transmission of productivity and monetary shocks in different exchange rate regimes and export price currencies. I then discuss optimal monetary policy and monetary coordination.

Based on the observation that global value chains increase synchronisation of business cycles,<sup>1</sup> I build a model to identify the consequences for optimal monetary rules. Following Corsetti and Pesenti's (2009) model, I change the production function by adding global value chains. Indeed, it represents an increasing part of total world trade, which has important consequences in terms of shock transmission. My model explains simply how productivity and monetary shocks are transmitted from one country to another, and more generally how global value chains increase the correlation of business cycles. Finally, my model provides monetary policy recommendations, and discusses the relevance of monetary policy coordination.

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<sup>1</sup>e.g. Sturgeon and Memedovic (2011), Brustein *et al.* (2008), Giovanni *et al.* (2017).

I find that global value chains allow economies to be more closely linked than in Corsetti and Pesenti's (2009) model (with only final good trade). Intermediate good productivity shocks are transmitted by two channels rather than one, so shock transmission is much greater. The business cycles of countries are also more correlated since shocks are transmitted symmetrically in the two economies. In addition, the exchange rate is less volatile than in the original model. My model recommends that monetary policies respond in the same way whether the shock comes from home or abroad. There are no gains from coordination.

The chapter is organized as follows. Section 2 provides a literature review. Section 3 describes the model. Section 4 suggests some implications of the model. Section 5 concludes.

## 3.2 Literature review

### 3.2.1 Vertical trade and state of the art

Smith (1776) theorized about task segmentation and specialization to build a finished product; vertical trade goes a step further by adding geographic specialization to task segmentation. Vertical trade or global value chains or vertical specialization, is defined by Hummels, Ishii and Yi (2001) as occurring when: "A. a good is produced in two or more sequential stages, B. two or more countries provide value-added during the production of the good, C. at least one country must use imported inputs in its stage of the production process, and some of the resulting output must be exported". The A380 airbus is a good example of vertical specialization: the wings are made in the United Kingdom, the fuselage in Germany, the tail in Spain and the cockpit in France.

More generally, the link between trade and business cycle synchronization has been the subject of numerous studies which highlight a strong positive effect (Frankel and Rose, 1997; Clark and van Wincoop, 2001; Kose and Yi, 2006). Baxter and Kouparitsas (2005) show that this link is robust, even to the inclusion of gravity variables, suggesting an independent role of trade in transmitting business cycles.

Numerous studies investigate the link between vertical trade and business cycles synchronisation. Arkolakis and Ramanarayanan (2009) find empirically "international business cycle model

augmented with vertical specialization - i.e., the production of goods in multiple stages spread across countries – and quantitatively assess its ability to generate stronger business cycle synchronization between countries that trade more". Burstein, Kurz and Tesar (2008) reach the same conclusion. Sturgeon and Memedovic (2011) study three industries (electronics, automobiles and motorcycles, and apparel and footwear). They find evidence of increasing economic integration but the level differs among the three industries. Other authors have studied individual sectors but for a limited number of countries only. Brustein, Kurz and Tesar (2008) find that the output of American and Mexican firms is more correlated if the Mexican firms supply the American firms with intermediary goods. The intensity of production-sharing seems to be at least as important when accounting for bilateral firm output correlation, as the trade volume. Iossifov (2014) highlights the role of vertical trade in the business cycle synchronization of central and eastern European countries, and the Eurozone. Gangnes, Ma and Van Assche (2012) use Chinese trade data and find that vertical trade increased the sensitivity of trade to external business cycle shocks due to a composition effect, global value chains being more developed in higher income elasticity goods. Finally, Giovanni, Levchenko and Mejean (2017) using micro data of French firms find that indirect linkages add significantly to aggregate correlations in business cycles.

Hummels, Ishii and Yi (2001) and Escaith, Lindenberg and Miroudot (2010) demonstrate the growing importance of global value chains since the 1970s. Hummels, Rapoport and Yi (1998) highlight that increases in vertical-specialization-based trade account for more than 25% of the increase in total trade in most of the OECD countries tested. In some smaller countries, such as the Netherlands, the share of vertical trade in total trade approached 50%. The development of information technology, international standardization of goods, and improvements to transport and logistics encourage the expansion of vertical trade. It is likely that global value chains will continue to spread across industries and countries. The consequence is that national economic policy should not be seen as affecting only the national territory but should take account of the deeper integration of the economy on the global market. Bems, Yi and Johnson (2009) argue that vertical trade acts as a transmission mechanism for domestic shocks and is one of the main factors in the synchronized great trade collapse in 2009. OECD (2010) reaches the same conclusion. Taking into account the new production structures and the growing integration of world

economies is a problem for designers of monetary policy.

### 3.2.2 A long history of studies on optimal monetary policy

Studies on sticky prices, exchange rates and optimal monetary policy started some time ago. Friedman (1953) called for freely floating exchange rates as the most efficient mechanism to achieve relative price adjustment between countries when prices are sticky, since flexible exchange rates can deal with country specific productivity shocks or demand shocks.

Obstfeld and Rogoff (2002) worked on optimal monetary policies in open economies, and found that to deliver the best possible outcome, monetary authorities should respond only to domestic shocks; the allocation would be replicated under flexible prices. However, these conclusions are based on the assumption that the prices are set in the Producer Currency Pricing framework.

Devereux and Engel (2003) consider both cases (Producer Currency Pricing, PCP and Local Currency Pricing, LCP). In contrast to the PCP case, in LCP, monetary policies cannot replicate flexible price allocation since the pass-through from the exchange rate is zero. Therefore, the paper concludes that in this case, a fixed exchange rate would be optimal. Therefore, an optimal exchange rate regime depends on the currency of the export pricing.

Corsetti and Pesenti (2009) extend Devereux and Engel's (2003) analysis in various directions. They analyse the transmission of productivity and monetary shocks, the welfare gains from macroeconomic stabilization, the optimal monetary policies and the coordination required to achieve this goal. They highlight the role of exchange rate pass-through, and the choice of exchange rate regime according to the export pricing currency.

Devereux and Engel (2007) analyse the trade-off between the objectives of stabilizing consumption-based real exchange rates and allowing terms of trade adjustment. They use a vertical-trade model consistent with both evidence of weak exchange rate pass-through to consumer goods prices, and high pass-through to imported goods prices.

Brustein, Kurz and Tesar (2008) use a theoretical model that is close to mine which also predicts that business cycles are more synchronized. However, they provide no public policy implications. Shi and Xu (2007) and Wang and Zou (2015) are the closest papers to mine in the sense that they analyse the optimal monetary policy using a vertical-trade model. Shi and Xu (2007) choose



sticky prices for intermediate goods which provides different results: they find that the existence of the transborder spillover effect depends on the currency of export price setting. Wang and Zou (2015) introduce asymmetry in the pricing behavior of exporters in the Home and Foreign countries (Home exporters set prices in the currency of the producers, Foreign exporters set prices in the currency of the consumers). This implies that the responses of monetary authorities to productivity shocks from the stage of intermediate goods production are symmetric (which I also find) but asymmetric to productivity shocks from the stage of final goods production. Furthermore, they analyse optimal monetary policy when there is a shock in both the intermediate and final stages of production. They find that gains from cooperation are related to the covariance of productivity shocks in these two stages.

Finally, my work is linked to Mundell (1961) since I examine whether vertical trade can help a geographic area to become an optimal currency area. Mundell explains one of the key aspects as symmetry of the productivity shocks.

### 3.3 The model

My model is related to Corsetti and Pesenti (2009). This model has the advantage of simplicity and elegance since it can be solved manually but its predictions are powerful. It studies the effect of trade on business cycle synchronisation among trading partners, and derives optimal monetary policies. I am interested in the same issues, but for a particular form of trade: global value chains since it has an increasing part in the world trade. Therefore, I adopt their approach, and change the production function by adding an intermediate good stage, allowing for a new shock transmission channel. Vertical trade comes from the fact that a final-good production requires both Home and Foreign intermediate goods. I then explore how my results differ from theirs.

The world consists of two countries of equal size, denoted the Home country and the Foreign country; countries are denoted H and F respectively. I adopt the convention that terms denominated in Foreign currency are denoted by a star.

The economy consists of households, final-good firms and intermediate-good firms. Each country

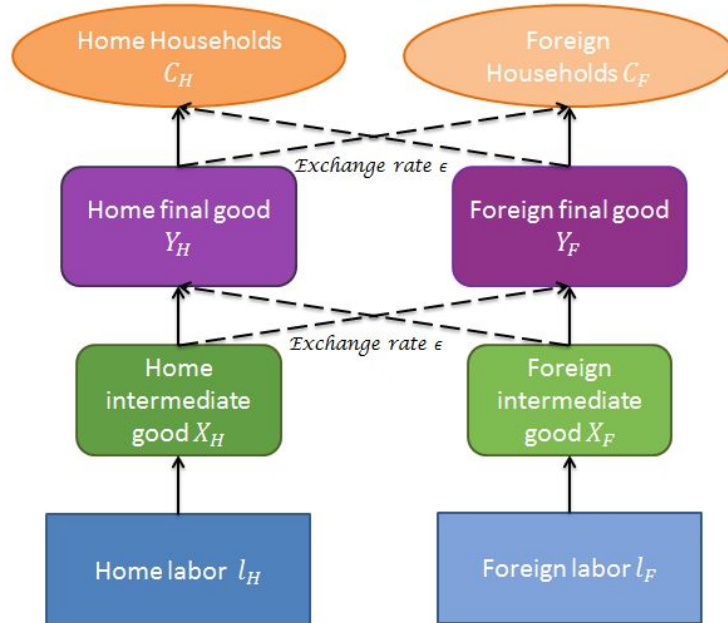
has one unit of population. Households and firms are defined over a continuum of unit mass. Households are indexed by  $j \in [0, 1]$  at home and  $j^* \in [0, 1]$  abroad, final-good firms are indexed by  $h \in [0, 1]$  at home and  $f \in [0, 1]$  abroad.

Each country is specialized in two types of tradable good: one type of intermediate good and one type of final good. In each country, monopolistic competitors produce imperfectly substitutable varieties of the same national final good, employing a combination of intermediate goods. Final-good firms sell in the two markets, domestic and foreign.

There is perfect competition in the two intermediate-good markets. All  $X_H$  goods are identical and perfect substitutes, and all  $X_F$  are identical and perfect substitutes. Countries are perfectly specialized: the Home country produces only the intermediate good  $X_H$  and the Foreign country produces the intermediate good  $X_F$ , the two goods are not perfect substitute.

Households are immobile across borders and consume only final goods. Households consume both domestic and foreign final goods. In both countries, the elasticity of substitution among different varieties of the same type of good ( $\theta$ ) is higher than the elasticity of substitution between types of goods H and F, which we posit is equal to 1 (following Corsetti and Pesenti, 2009).

Figure 3.1: the world economy



### 3.3.1 Households

Households have an identical utility

$$U_t(j) = \ln C_t(j) - \kappa \ell_t(j), \quad (3.1)$$

where  $\ell$  is hours worked.  $\kappa C$  is the marginal rate of substitution between consumption and leisure.  $C_t(j)$  is a consumption basket of the Home and Foreign goods

$$C_t(j) = C_{H,t}(j)^{1/2} C_{F,t}(j)^{1/2}. \quad (3.2)$$

For each household  $j$  in the Home country, the consumption indices of Home and Foreign brands are defined as

$$C_{H,t}(j) = \left[ \int_0^1 C_t(h, j)^{1-\frac{1}{\theta}} dh \right]^{\frac{\theta}{\theta-1}}, \quad C_{F,t}(j) = \left[ \int_0^1 C_t(f, j)^{1-\frac{1}{\theta}} dh \right]^{\frac{\theta}{\theta-1}}, \quad (3.3)$$

where  $\theta$  is the elasticity of substitution between varieties, with  $\theta > 1$ , and  $C_t(h, j)$  and  $C_t(f, j)$  are respectively consumption of Home brand  $h$  and Foreign brand  $f$  by Home agent  $j$  at time  $t$ . The Foreign households are analogously characterized.

The utility-based CPI  $P_t$  is defined as

$$P_t = 2P_{H,t}^{1/2} P_{F,t}^{1/2}, \quad (3.4)$$

where

$$P_{H,t} = \left[ \int_0^1 p_t(h)^{1-\theta} dh \right]^{\frac{1}{1-\theta}}, \quad P_{F,t} = \left[ \int_0^1 p_t(f)^{1-\theta} dh \right]^{\frac{1}{1-\theta}}, \quad (3.5)$$

$p_t(h)$  and  $p_t(f)$  being the Home-currency prices of the varieties.

It follows that the Home-currency individual demand curves for varieties  $h$  and  $f$  are respectively

$$C_t(h, j) = \left( \frac{p_t(h)}{P_{H,t}} \right)^{-\theta} C_{H,t}(j) \quad , \quad C_t(f, j) = \left( \frac{p_t(f)}{P_{F,t}} \right)^{-\theta} C_{F,t}(j). \quad (3.6)$$

The optimal consumption of nominal spending is

$$P_{H,t}C_{H,t}(j) = P_{F,t}C_{F,t}(j) = \frac{1}{2}P_tC_t(j). \quad (3.7)$$

### 3.3.2 Final-good firms

Households own the portfolio of all firms. Home final-good firm  $h$  produces  $Y(h)$  using  $X_{H,t}$  and  $X_{F,t}$  intermediate goods, according to the following production function

$$Y_t(h) = X_{H,t}(h)^\alpha X_{F,t}(h)^{1-\alpha}, \quad (3.8)$$

with  $\alpha$  being the share of Foreign and Home good used in the production function. Foreign final-good firm  $f$  produces  $Y(f)$

$$Y_t(f) = X_{F,t}(h)^\alpha X_{H,t}(h)^{1-\alpha}. \quad (3.9)$$

The final-good Home firm profit is

$$\Pi_{H,t}(h) = X_{H,t}(h)^\alpha X_{F,t}(h)^{1-\alpha} p_t(h) - X_{H,t}(h) p_{XH,t} - X_{F,t}(h) p_{XF,t}, \quad (3.10)$$

where  $p_{XH,t}$  is the price of the intermediate good  $X_{H,t}$  and  $p_{XF,t}$  of the intermediate good  $X_{F,t}$ .

From the cost-minimization problem, we can derive final-good firm  $h$ 's demand for  $X_{H,t}$  and  $X_{F,t}$

$$X_{H,t}(h)^* = \left( \frac{p_{XH}}{p_{XF}} \frac{1-\alpha}{\alpha} \right)^\alpha Y_t \quad , \quad X_{F,t}(h)^* = \left( \frac{p_{XF}}{p_{XH}} \frac{\alpha}{1-\alpha} \right)^{1-\alpha} Y_t. \quad (3.11)$$

Each final-good firm  $h$  is price-taker of the intermediate goods, so the marginal cost ( $MC_t$ ) of one unit is

$$MC_t(h) = \left( \frac{p_{XH,t}}{\alpha} \right)^\alpha \left( \frac{p_{XF,t}}{1-\alpha} \right)^{1-\alpha}. \quad (3.12)$$

Prices are flexible, imperfectly competitive firms set prices by charging an optimal mark-up over their marginal costs

$$p_t(h)^{flex} = \frac{\theta}{\theta-1} MC_t(h) = \frac{\theta}{\theta-1} \left( \frac{p_{XH,t}}{\alpha} \right)^\alpha \left( \frac{p_{XF,t}}{1-\alpha} \right)^{1-\alpha}. \quad (3.13)$$

### 3.3.3 Intermediate-good firms

Each intermediate-good firm produces a single variety, either  $X_{H,t}$  for Home firms or  $X_{F,t}$  for Foreign firms, which are not perfect substitute. Labor is the only input in production. Productivity (output per unit of labor) is subject to economy-wide shocks. The labor market is assumed to be perfectly competitive, but there is not labor mobility across countries.

Production function of  $X_{H,t}$  firms is

$$X_{H,t} = Z_{H,t} \ell_{H,t}, \quad (3.14)$$

where  $Z_{H,t}$  is the productivity of labor and  $\ell_{H,t}$  is the labor for the good  $X_{H,t}$ .

Their profit function is

$$\Pi_{XH,t} = X_{H,t} p_{XH,t} - w_{H,t} \ell_{H,t}. \quad (3.15)$$

Under perfect competition, profit is equal to zero

$$p_{XH,t} = \frac{w_{H,t}}{Z_{H,t}}. \quad (3.16)$$

In the same way, production function of  $X_F$  firms is

$$X_{F,t} = Z_{F,t} \ell_{F,t}. \quad (3.17)$$

Their profit function is

$$\Pi_{XF,t} = X_{F,t} p_{XF,t} - w_{F,t} \ell_{F,t}, \quad (3.18)$$

and

$$p_{XF,t} = \frac{w_{F,t}}{Z_{F,t}}. \quad (3.19)$$

### 3.3.4 Structure of the economy

As in Corsetti and Pesenti (2009), the model can be synthesized by means of three schedules: Aggregate Demand [AD], Aggregate Supply [AS], and the Natural Rate (of employment)<sup>2</sup> [NR].

Agents preferences are homogenous so a common CPI index implies equalization of consumption across agents:  $C_t(j) = C_t$ .  $C_t$  coincides with aggregate demand in real terms, while  $P_t C_t$  is aggregate nominal spending. Let  $\mu_t$  denote a variable that synthesizes the effect of monetary policy on aggregate nominal spending  $P_t C_t$ . The Aggregate Demand "AD" equation can then be written as:

$$P_t C_t = \mu_t. \quad (3.20)$$

$\epsilon_t$  is the nominal exchange rate defined as

$$\epsilon_t = \frac{\mu_t}{\mu_t^*}, \quad (3.21)$$

and

$$P_t C_t = \epsilon_t P_t^* C_t^*. \quad (3.22)$$

The Aggregate Supply "AS" equation relates output to total employment measured in terms of hours worked,

$$C_t = (Z_{H,t} \ell_{H,t})^\alpha (Z_{F,t} \ell_{F,t})^{1-\alpha} \tau,$$

with  $\tau$  being an index of international spillover, reflecting the macroeconomic impact of fluctuations of relative prices and terms of trade on the Home economy. It is defined as

$$\tau = \left[ \frac{P}{2} \left( \frac{1}{P_H} + \frac{1}{\epsilon P_H^*} \right) \right]^{-1}. \quad (3.23)$$

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<sup>2</sup>Natural rate of employment is the employment rate without shocks.

Figure 3.2: World economy model in steady state

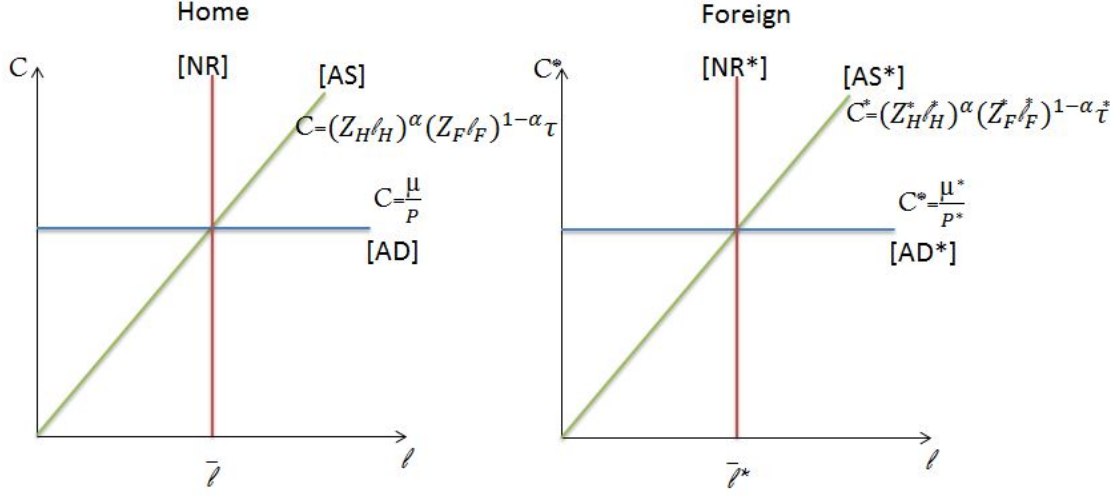


Figure 3.2 represents the general equilibrium at steady state both at home and abroad, with AS, AD and NR curves.

At any point in time, the intersection between "AD" and "AS" determines the equilibrium allocation of consumption  $C_t$  and labor  $\ell_{H,t}$  for given values of the exogenous variables  $\mu_t$ ,  $Z_{H,t}$  and  $Z_{F,t}$ , as well as for a given price level  $P_t$ . Of course, the price level is an endogenous variable in our system. We therefore need to analyze how firms optimally set their prices.

### 3.3.5 Flexible price case

The optimal price charged by the representative final-good firm will be

$$P_{H,t}^{flex} = \epsilon P_{H,t}^{*flex} = \frac{\theta}{\theta - 1} \left( \frac{w_{H,t}}{\bar{Z}_{H,t}} \right)^\alpha \left( \epsilon \frac{w_{F,t}}{\bar{Z}_{F,t}} \right)^{1-\alpha}, \quad (3.24)$$

$$P_{F,t}^{flex} = \epsilon P_{F,t}^{*flex} = \frac{\theta}{\theta - 1} \left( \frac{w_{F,t}}{\bar{Z}_{F,t}} \right)^\alpha \left( \frac{1}{\epsilon} \frac{w_{H,t}}{\bar{Z}_{H,t}} \right)^{1-\alpha}.$$

With a perfectly competitive labor market, the equilibrium wage rate in units of consumption ( $W/P$ ) is equal to the marginal rate of substitution (MRS) between consumption and leisure of

the representative agent

$$w_H = \kappa P_t C_t. \quad (3.25)$$

From this equation and the flexible price equation, we can now calculate the rate of employment  $\ell_{H,t}$

$$\ell_{H,t} = \frac{\theta - 1}{\theta \kappa \tau} \alpha^\alpha (1 - \alpha)^{1-\alpha} \left( \frac{\mu_t / Z_{H,t}}{\mu_t^* / Z_{F,t}} \right)^{1-\alpha}. \quad (3.26)$$

With flexible prices, the monetary authorities do not need to intervene since in the absence of rigidities, the market regulates by itself.

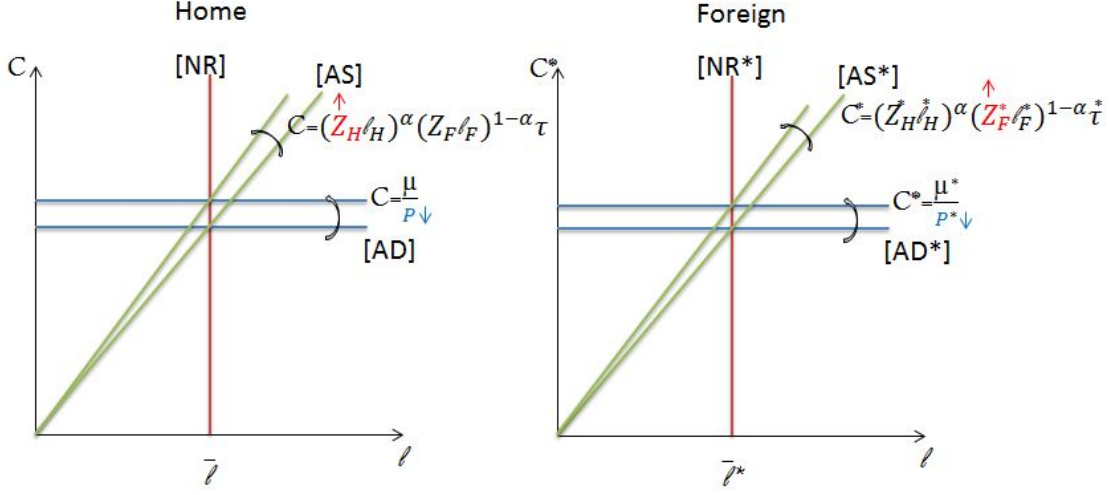
Consider a positive productivity shock on Home intermediate good ( $Z_{H,t}$  increases). Then, marginal cost of Home intermediate good decreases and Home intermediate-good price  $p_{XH,t}$  decreases. Since  $p_{XH,t}$  decreases, marginal cost of Home final good also decreases and  $P_{H,t}$  decreases (but less than  $p_{XH,t}$ ). Therefore, the Home consumer price index  $P_t$  decreases (but less than  $P_{H,t}$ ) and Home consumption  $C_t$  increases. The term of trade moves against the Home country and the exchange rate depreciates. For the Foreign country, the Home intermediate is cheaper, therefore the Foreign final good price falls too. Therefore the Foreign consumer price index  $P_t^*$  decreases (since both Foreign final good and Home final good are cheaper).  $C_t^*$  increases. The Home term of trade improves and the exchange rate appreciates and comes back to his initial level if  $\alpha = 1/2$ . At home, the consumer price index decreases even more since the Foreign final good is also now cheaper. Figure 3.3 shows the mechanisms just described. The exchange rate is stabilized. The decrease of  $p_{XH,t}$  has a bigger impact on the consumer price index than without vertical trade. It also offsets expenditure switching effect.

### 3.3.6 Rigid price case

We now consider the rigid price case, but only for final goods. Indeed, according to Clark (1999), intermediate-good prices are more flexible. Therefore, I choose to keep the intermediate-good prices flexible while the final-good prices are rigid.



Figure 3.3: International transmission of productivity shocks under flexible prices and floating exchange rate



**Producer Currency Pricing** Firms preset prices in their own currency and let prices abroad move one-to-one with the exchange rate. With PCP, firms optimally set

$$P_{H,t}^{PCP} = \epsilon P_{H,t}^{*PCP} = \frac{\theta}{\theta - 1} E_t \left[ \left( \frac{w_{H,t}}{Z_{H,t}} \right)^\alpha \left( \epsilon \frac{w_{F,t}}{Z_{F,t}} \right)^{1-\alpha} \right], \quad (3.27)$$

$$P_{F,t}^{PCP} = \epsilon P_{F,t}^{*PCP} = \epsilon \frac{\theta}{\theta - 1} E_t \left[ \left( \frac{w_{F,t}}{Z_{F,t}} \right)^\alpha \left( \frac{1}{\epsilon} \frac{w_{H,t}}{Z_{H,t}} \right)^{1-\alpha} \right],$$

and

$$\ell = \frac{\theta - 1}{\theta \kappa \tau} \alpha^\alpha (1 - \alpha)^{1-\alpha} E_t \left[ \left( \frac{\mu_t / Z_{H,t}}{\mu_t^* / Z_{F,t}} \right)^{1-\alpha} \right]. \quad (3.28)$$

Consumption moves depending both on Home and Foreign monetary policy

$$C_t = \left( \frac{\mu_t}{P_{H,t}} \right)^{1/2} \left( \frac{\mu_t^*}{P_{F,t}} \right)^{1/2},$$

$$C_t = \frac{\theta - 1}{\theta \kappa} \alpha^\alpha (1 - \alpha)^{1-\alpha} \frac{\mu_t}{\left[ E_t \left( \left( \frac{\mu_t}{Z_{H,t}} \right)^\alpha \left( \frac{\mu_t}{Z_{F,t}} \right)^{1-\alpha} \right) \right]^{1/2} \left[ E_t \left( \left( \frac{\mu_t^*}{Z_{F,t}} \right)^\alpha \left( \frac{\mu_t^*}{Z_{H,t}} \right)^{1-\alpha} \right) \right]^{1/2}}. \quad (3.29)$$

We now calculate the optimal policy response to a  $Z_H$  shock, all else being equal. First without coordination ( $\mu^*$  is given), the government wants to maximize  $E(U)$ ,

$$E_t(U_t) = E_t(\ln C_t - \kappa \ell_{H,t}) = E_t(\ln \mu_t) - E_t(\ln P_{H,t}^{1/2} P_{F,t}^{1/2}) - \kappa \ell_{H,t},$$

$$E_t(U_t) = E_t(\ln \mu_t) - \frac{1}{2} E_t(\ln \frac{\mu_t}{Z_{H,t}^\alpha Z_{F,t}^{1-\alpha}}) + \text{constant},$$

$$\frac{\partial E_t(U_t)}{\partial \mu_t} \equiv \mu_t^{-1} - \frac{1}{2} \frac{Z_{H,t}^\alpha Z_{F,t}^{1-\alpha}}{E_t(\mu_t / Z_{H,t}^\alpha Z_{F,t}^{1-\alpha})} = 0. \quad (3.30)$$

Therefore  $\mu_t = \beta Z_{H,t}^\alpha Z_{F,t}^{1-\alpha}$ ,  $\beta$  being a constant known in advance by the firms.

The government still has an inward-looking policy as his policy does not depends on the Foreign monetary policy. Monetary policy responds to both Home and Foreign shocks: the country responds the same way to Home and Foreign shocks.

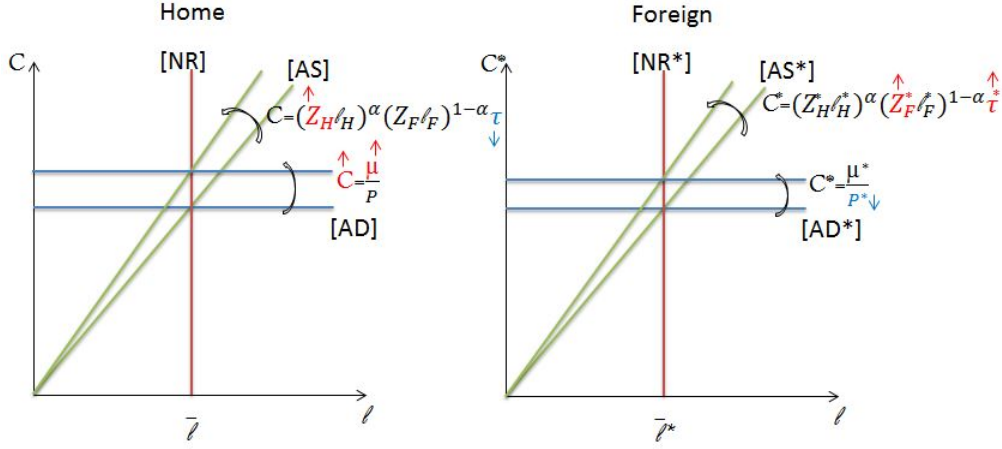
The Foreign country being symmetrical, it will have the same monetary policy function. So maximizing an average of the two functions will give the same monetary rules. There is no gain to cooperation.

Consider a positive productivity shock on Home intermediate good ( $Z_H$  increases). Then, marginal cost of Home intermediate good decreases and Home intermediate-good price  $p_H$  decreases (since prices are flexible for intermediate goods). Since  $p_H$  decreases, marginal cost of Home final good also decreases, and since prices are rigid, the mark-up of final-good firms increase. For the Foreign country,  $p_H$  is also cheaper and mark-up of Foreign final-good firms increases too.

If the Home government wants to increase welfare, it can implement a monetary expansion (increase  $\mu$ ). Then Home consumption increases. Exchange rate depreciates and term of trade falls. Foreign goods are more expensive and the Home consumer price index increases: there is inflation. Foreign country enjoys lower imported prices.

If the Foreign government does not implement any monetary expansion, then Foreign final-good price stays the same (only mark-up increases) and Home goods are cheaper: there is an expenditure switching effect. Foreign consumer price index decreases, Foreign consumption

Figure 3.4: International transmission of productivity shocks under PCP and floating exchange rate



increases. Figure 3.4 shows the impact of a monetary expansion at home but not abroad.

If the Foreign government chooses to implement a monetary expansion (which would increase welfare both at home and abroad), the exchange rate does not change and we have the same effects than in the flexible price case.

**Local Currency Pricing** Firms preset a price in domestic currency for the domestic market, and a price in Foreign currency for the export markets. With LCP, firms optimally set:

$$P_{H,t}^{LCP} = \frac{\theta}{\theta-1} E_t \left[ \left( \frac{w_{H,t}}{Z_{H,t}} \right)^\alpha \left( \epsilon \frac{w_{F,t}}{Z_{F,t}} \right)^{1-\alpha} \right], \quad P_{H,t}^{*LCP} = \frac{\theta}{\theta-1} E_t \left[ \frac{1}{\epsilon} \left( \frac{w_{H,t}}{Z_{H,t}} \right)^\alpha \left( \epsilon \frac{w_{F,t}}{Z_{F,t}} \right)^{1-\alpha} \right], \quad (3.31)$$

$$P_{F,t}^{LCP} = \frac{\theta}{\theta-1} E_t \left[ \epsilon \left( \frac{w_{F,t}}{Z_{F,t}} \right)^\alpha \left( \frac{1}{\epsilon} \frac{w_{H,t}}{Z_{H,t}} \right)^{1-\alpha} \right], \quad P_{F,t}^{*LCP} = \frac{\theta}{\theta-1} E_t \left[ \left( \frac{w_{F,t}}{Z_{F,t}} \right)^\alpha \left( \frac{1}{\epsilon} \frac{w_{H,t}}{Z_{H,t}} \right)^{1-\alpha} \right],$$

and

$$\ell = \frac{\theta-1}{\theta\kappa\tau} \alpha^\alpha (1-\alpha)^{1-\alpha} E_t \left[ \left( \frac{\mu_t/Z_{H,t}}{\mu_t^*/Z_{F,t}} \right)^{1-\alpha} \right], \quad (3.32)$$

$$C_t = \frac{\theta-1}{\theta\kappa} \alpha^\alpha (1-\alpha)^{1-\alpha} \frac{\mu_t^{1/2} \mu_t^{*1/2}}{\left[ E_t \left( \left( \frac{\mu_t}{Z_{H,t}} \right)^\alpha \left( \frac{\mu_t}{Z_{F,t}} \right)^{1-\alpha} \right) \right]^{1/2} \left[ E_t \left( \epsilon \left( \frac{\mu_t^*}{Z_{F,t}} \right)^\alpha \left( \frac{\mu_t^*}{Z_{H,t}} \right)^{1-\alpha} \right) \right]^{1/2}}. \quad (3.33)$$

We now calculate the optimal policy response to a  $Z_H$  shock, all else being equal. First without coordination ( $\mu^*$  is given), the government wants to maximize  $E(U)$ .

$$\begin{aligned}
E_t(U_t) &= E_t(\ln C_t - \kappa \ell_{H,t}) = \frac{1}{2} E_t(\ln \mu_t) + \frac{1}{2} E_t(\ln \mu_t^*) - E_t(\ln P_{H,t}^{1/2} P_{F,t}^{1/2}) - \kappa \ell_{H,t}, \\
&= \frac{1}{2} E_t(\ln \mu_t) - \frac{1}{2} E_t(\ln \frac{\mu_t}{Z_{H,t}^\alpha Z_{F,t}^{1-\alpha}}) - \frac{1}{2} E_t(\ln \frac{\mu_t}{Z_{F,t}^\alpha Z_{H,t}^{1-\alpha}}) + \text{constant}, \\
\frac{\partial E_t(U_t)}{\partial \mu_t} &\equiv \mu_t^{-1} - \frac{Z_{H,t}^\alpha Z_{F,t}^{1-\alpha}}{E_t(\mu_t / Z_{H,t}^\alpha Z_{F,t}^{1-\alpha})} - \frac{Z_{F,t}^\alpha Z_{H,t}^{1-\alpha}}{E_t(\mu_t / Z_{F,t}^\alpha Z_{H,t}^{1-\alpha})} = 0.
\end{aligned} \tag{3.34}$$

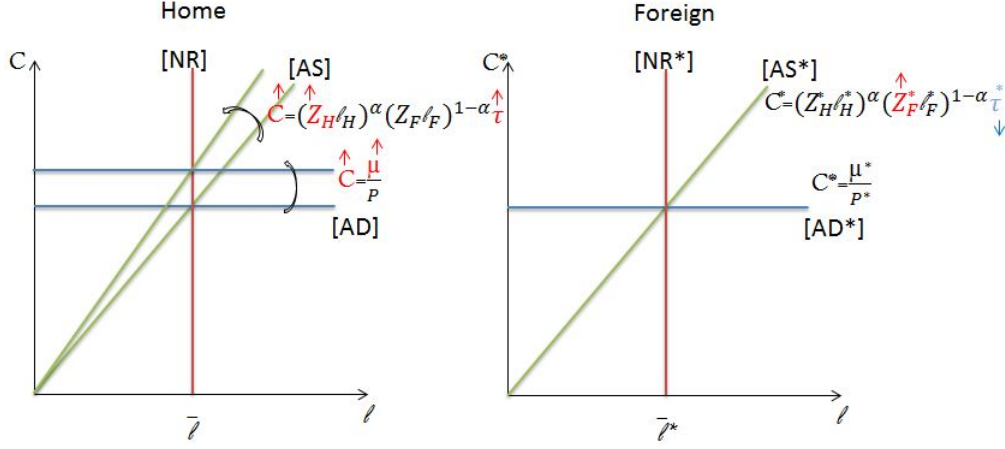
If  $\alpha = 1/2$ , then the government applies exactly the same policy for the PCP and LCP case. Otherwise, he considers the shock as a weighted average of the impact of the shock in the two countries, but still not coordinates.

Consider a positive productivity shock on Home intermediate good ( $Z_H$  increases). Then, marginal cost of Home intermediate good decreases and Home intermediate-good price  $p_H$  decreases (since prices are flexible for intermediate goods). Since  $p_H$  decreases, marginal cost of Home final good also decreases, and since prices are rigid, the mark-up of final-good firms increases. For the Foreign country,  $p_H$  is also cheaper and mark-up of Foreign final-good firms increases too.

If the Home government wants to increase welfare, it can implement a monetary expansion (increase  $\mu$ ). Then Home consumption increases. Exchange rate depreciates but term of trade improves because Home firms mark-up increases (since Foreign-currency prices are preset). It increases even more Home consumption. On the Foreign country side, final-good firms mark-up increases but prices remain the same. Foreign term of trade falls. The transmission effect is therefore ambiguous. Figure 3.5 shows the case where only Home country implements a monetary expansion.

It is in the Foreign country interest to also implement a monetary expansion. Then the transmission effect is positive.

Figure 3.5: International transmission of productivity shocks under LCP and floating exchange rate



### 3.3.7 Under fixed exchange rate

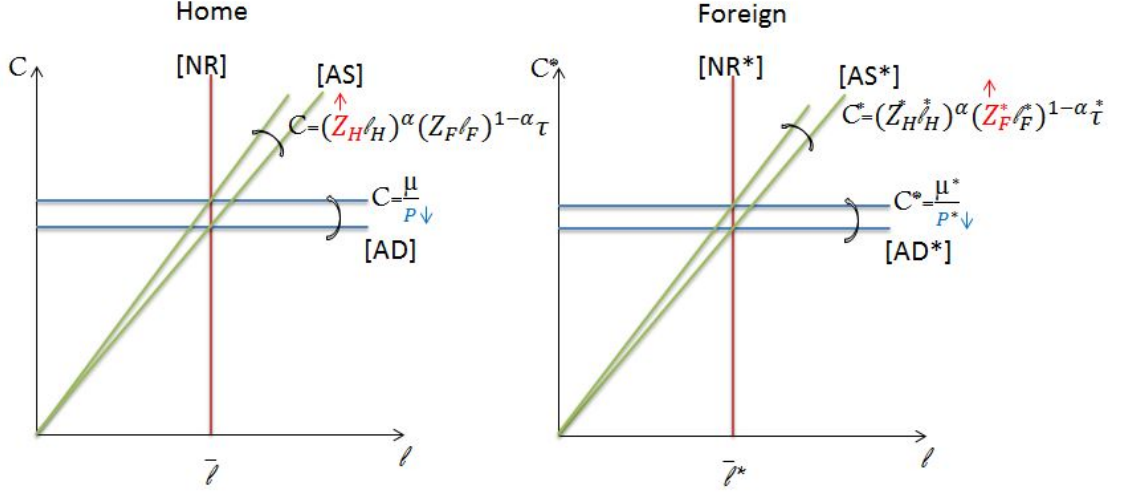
With fixed exchange rate,  $\epsilon_t = \beta$ ,

$$\ell = \frac{\theta - 1}{\theta \kappa \tau} \alpha^\alpha (1 - \alpha)^{1-\alpha} \left( \frac{\beta Z_{F,t}}{Z_{H,t}} \right)^{1-\alpha}. \quad (3.35)$$

**Flexible price case** Consider a positive productivity shock on Home intermediate good ( $Z_H$  increases). Then, marginal cost of Home intermediate good decreases and Home intermediate-good price  $p_H$  decreases. Since  $p_H$  decreases, marginal cost of Home final good also decreases and  $P_H$  decreases (but less than  $p_H$ ). Therefore, the Home consumer price index  $P$  decreases (but less than  $P_H$ ) and Home consumption  $C$  increases. Exchange rate is fixed. For the Foreign country, the Home intermediate and final goods are cheaper, therefore the Foreign final-good price falls too. Therefore the Foreign consumer price index  $P^*$  decreases.  $C^*$  increases. At home, the consumer price index decreases even more since the Foreign final good is also now cheaper. The result is the same than under flexible exchange rate if  $\alpha = 1/2$ . Figure 3.6 shows the mechanisms just described.

**PCP and LCP case** With a fixed exchange rate, PCP and LCP cases are the same, since the exchange rate is known in advance (there is no uncertainty).

Figure 3.6: International transmission of productivity shocks under flexible prices and fixed exchange rate



We can calculate the optimal monetary policy when prices are rigid (Home and Foreign countries are forced to coordinate).

$$\begin{aligned} E_t\left(\frac{1}{2}U + \frac{1}{2}U_t^*\right) &= \frac{1}{2}E_t(\ln \mu_t) - \frac{1}{4} \ln E_t\left(\frac{\mu_t}{Z_{H,t}^\alpha Z_{F,t}^{1-\alpha}}\right) - \frac{1}{4} \ln E_t\left(\frac{\mu_t^*}{Z_{F,t}^\alpha Z_{H,t}^{1-\alpha}}\right) \\ &+ \frac{1}{2}E_t(\ln \mu_t^*) - \frac{1}{4} \ln E_t\left(\frac{\mu_t}{Z_{H,t}^\alpha Z_{F,t}^{1-\alpha}}\right) - \frac{1}{4} \ln E_t\left(\frac{\mu_t^*}{Z_{F,t}^\alpha Z_{H,t}^{1-\alpha}}\right) + constant. \end{aligned}$$

$\mu_t$  being equal to  $\beta \mu_t^*$ ,

$$\frac{\partial E_t\left(\frac{1}{2}U + \frac{1}{2}U_t^*\right)}{\partial \mu_t} \equiv (1 + \beta) \frac{1}{\mu_t} - \frac{Z_{H,t}^\alpha Z_{F,t}^{1-\alpha}}{E_t(\mu_t / Z_{H,t}^\alpha Z_{F,t}^{1-\alpha})} - \frac{Z_{F,t}^\alpha Z_{H,t}^{1-\alpha}}{E_t(\mu_t / Z_{F,t}^\alpha Z_{H,t}^{1-\alpha})} = 0. \quad (3.36)$$

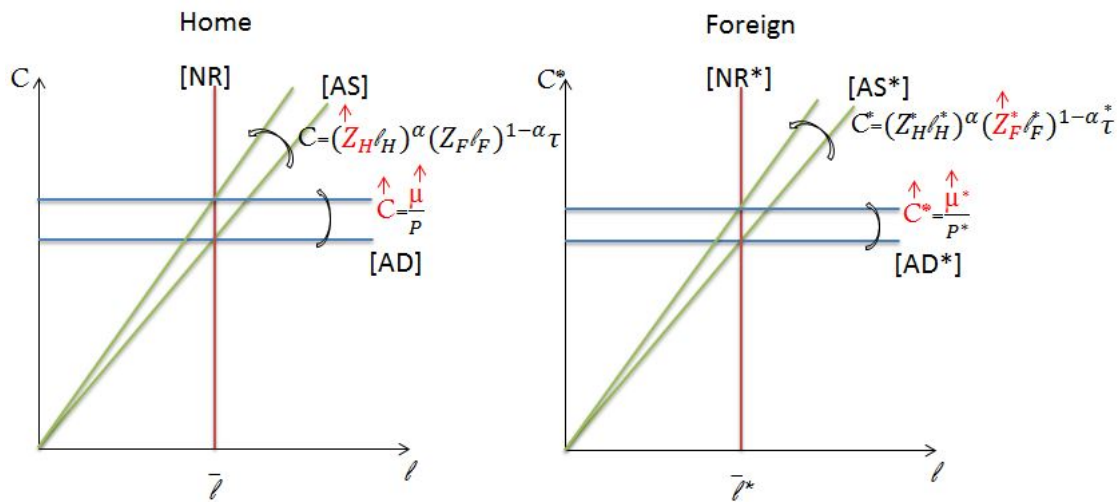
The optimal policy solves equation 3.36. The countries consider the shock as a weighted average of the impact of the shock in the two countries.

Consider a positive productivity shock on Home intermediate good ( $Z_H$  increases). Then, marginal cost of Home intermediate good decreases and Home intermediate-good price  $p_H$  decreases (since prices are flexible for intermediate goods). Since  $p_H$  decreases, marginal cost of Home final good also decreases, and since prices are rigid, the mark-up of final-good firms in-

creases. For the Foreign country,  $p_H$  is also cheaper and mark-up of Foreign final-good firms increases too.

Since the exchange rate is fixed, the Home and Foreign central banks cannot unilaterally implement a monetary expansion. To increase the welfare of both countries, they would need to coordinate so that the two monetary expansions are of the same size. This way, they would go back to the flexible price case. Figure 3.7 shows the mechanisms just described.

Figure 3.7: International transmission of productivity shocks under fixed prices, fixed exchange rate, monetary expansion at home and abroad



In this case, it would be easier to have a monetary union, with a single central bank implementing a monetary expansion so that the coordination between the countries is perfect. However, the size of the expansion is a problem: if the two countries use the same proportion of  $X_H$  ( $\alpha = 1/2$ ), then the productivity shock is the same on both side and the two countries need the same level of monetary expansion. However, if the productivity shock is not the same on both sides, then the central bank maximizes the global utility, in one country there will be too much inflation, and in the other too much unemployment.

## 3.4 What we learn from this model

### 3.4.1 Main findings

While Corsetti and Pesenti's (2009) model provides distinct optimal monetary policies depending on whether the prices are producer or local currency prices, my model does not since the distinction between the two is not so relevant in the case of global value chains.

Under flexible price, the productivity shock is transmitted in exactly the same way in the two economies. Moreover, the shock has a bigger impact than in Corsetti and Pesenti (2009) since it affects both Foreign and domestic final goods.

The optimal monetary policy is the same in the producer currency pricing (PCP) and the local currency pricing (LCP) case with the share of intermediate foreign product  $\alpha = 1/2$ . It is still inward looking, it responds both to a Home and Foreign productivity shock. Coordination and non-coordination still give the same result. If  $\alpha = 1/2$ , since the countries are affected in the same way by the productivity shock, they implement the same monetary policy, so the exchange rate does not change.

Under fixed exchange rate, the monetary policy changes very little compared to the floating case since the countries implement the same policy, which keeps the exchange rate stable. The fact that the exchange rate is fixed is not a problem if  $\alpha = 1/2$  since the shock is symmetric.

With vertical trade, economies are more closely linked than in the Corsetti and Pesenti's (2009) case of only horizontal trade. Indeed, Corsetti and Pesenti's model neglects a shock transmission channel, and therefore underestimate the propagation of shocks. Their model only focuses on the traditional channel: the Home final good is cheaper, so the Foreign consumer price index decreases. The second channel which I explore is inherent to vertical trade: the productivity shock decreases the price of the intermediate good, so the Foreign final good also becomes cheaper. Therefore, the Foreign consumer price index also decreases through this channel. The impact of the productivity shock on the Home and Foreign economy depends mainly on  $\alpha$ , the share of the Home intermediate good used to produce the final good.

Vertical trade also has an impact on exchange rate volatility. The exchange rate is less float-



ing, more “viscous”, midway between a fixed and a floating exchange rate. This is because the economies are moving together much more, and the shocks are symmetric. Therefore, the exchange rate does not have to move since exchange rate movements express a difference in the relative prices between the countries. If the Home and Foreign price move together, the exchange rate remains constant.

With vertical trade, my employment function differs from Corsetti and Pesenti (2009) since it includes the short term exchange rate (defined as the difference between the Home and Foreign monetary supply). Therefore, it links employment and inflation. This coincides with the Phillips curve and Mundell’s (1961) theory. Both works show an inverse relationship between rates of unemployment and inflation.

### 3.4.2 Monetary union

Mundell (1961) explains his concept of “optimum currency area”. One of his main points is that to have an optimum currency area, you need shocks to be symmetric in the area so that every part of the area needs the same optimal monetary policy. Indeed, if a shock is asymmetric, and there is a shift in demand from a good produced in a region to a good produced in another region, it produces unemployment in the first region, and inflation in the second. Then in the first region, to correct unemployment, the bank needs to put in place monetary expansion. However, this monetary expansion aggravates inflationary pressure in the second region. In this case, a “currency area cannot prevent both unemployment and inflation among its members” and the two regions would be better off with two different currencies floating with each other which would give them the mechanisms to regulate asymmetric shocks. Therefore, an optimum currency area can emerge only if regions are sufficiently homogenous as to be affected by the same shocks thus needing the same optimal monetary policy. My model shows that vertical trade allows the transmission of shocks to be much more “efficient” between the countries. With vertical trade, shocks are symmetric, which is also what empirical studies find.

My original idea when I began to write this chapter was to shed new light on the cost of transition to the euro. Indeed, economists have highlighted the cost of losing the mechanisms of stabilization linked to floating currencies. However, my model shows that these costs are

overestimated since the shocks are less asymmetric than previously thought, so the mechanisms are also less important than first envisaged.

Moreover, according to INSEE, the share of Eurozone countries' exports within the Eurozone is 67.3% and 63.4% for imports. Eurostat (2011) shows that intra Eurozone trade increases. Klein and Shambaugh (2006) predicted that: "a large significant effect of a fixed exchange rate on bilateral trade between a base country and a country that pegs to it" (21% increase in trade). Furthermore, Hummels, Rapoport and Yi (1998) finds that vertical trade represents 34.7% of Netherlands' total trade, 25.2% of Denmark's, 18.7% of France's, 16.3% of Germany's and 19.6% of Italy's total trade in 1990. In absolute values, Ferrarini (2013) explains that Germany is considered to dominate the region's processing vertical trade, its network trade being strongest with Austria, France and Italy. WTO and Senat (2010) find very strong trade growth in intermediate goods in the OECD countries, rising from a base of 100 in 1999 to more than 200 in 2008 (90% processed goods and 10% raw materials). Alfaro, Antràs, Chor and Conconi (2017) show that the rule of law promotes global value chains, with firms taking account of contractability when choosing to integrate or not a given stage of production. Therefore, Eurozone institutions should help the spread of global value chains among its members. All these elements show that Eurozone members are ever more dependent on each other, and therefore would be impacted by a shock the same way. Therefore, global chains value should help the Eurozone to synchronise the business cycles of its members, which is one of Mundell's criteria for an optimum currency area.

### 3.4.3 Limits of the model

My model has some limitations. First, the model scope is limited since all final goods consumed by users come from vertical trade, which is not the case in reality. Indeed, in North-North trade, vertical trade represents only 17% of total trade (Giovanni and Levchenko, 2010). Trade of services, representing one-fourth of total world trade in 2017 (Loungani *et al.*, 2008) with an increasing share (Crozet and Milet, 2016) is not taken into account by my model. Therefore, the share of foreign intermediate goods in final domestic goods  $\alpha$  being equal to one half is not very realistic.  $\alpha$  would be very heterogenous depending on the countries. In addition, 50% of the

final-good price is retail costs which again reduces the impact of vertical trade on the final-good price (and on the consumer price index) and therefore on the transmission of a productivity shock from one country to another.

Finally, in my model (as well as in Corsetti and Pesenti, 2009), the forward-looking nature of inflation is neglected. Indeed, my model presents a link between employment and inflation, a sort of original form Phillips curve. However, this equation is too simplistic as agents anticipate inflation, which does not appear in my model.

One extension to the model would be to add another tradable sector to each country. This would provide a more realistic view since most trade is not vertical. Another extension would be to make the prices of the intermediate good sticky: indeed, in my model, since intermediate-good prices are flexible, wages are flexible which contrasts to the data tell us. A final extension would be to introduce a wage in the final good production so that the prices of final goods become even more rigid than intermediate-good prices. Clark (1999) found “prices at early stages of production respond more to a monetary policy shock than do prices at subsequent stages of production”. Also, introducing an assembly cost in the final good would complicate the model a lot since a part of the population would therefore be assigned to this task. A shock in the intermediate stage would have an impact not only on the labor related to the other intermediate good (as in the model) but also that related to the final-good labor. It would be interesting to study the impact of this change on the results of to my model.

Finally, to extend this chapter, using the World Input-Output database, I have started an empirical study to check whether the global value chains promote business cycles synchronisation of trading partners as my model predicts. It is still a preliminary work which suffers from endogeneity issues, for which I did not find yet any good instrument. The draft of this empirical study can be found in appendix. The originality of this empirical study lies in the fact that I study 40 countries and 34 sectors at the same time (while the previous studies concentrate on a small amount of sectors<sup>3</sup>, or on one or two countries<sup>4</sup>). I can therefore draw more general

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<sup>3</sup>Sturgeon and Memedovic (2011).

<sup>4</sup>Brustein, Kurz and Tesar (2008); Gangnes, Ma and Van Assche (2012).

conclusions on the effects of global value chains. In addition, my methodology (linking output correlation and trade intensity) has never been applied in the context of global value chains. To my knowledge, my study is also the first one to compare the effects of intermediate good trade and final good trade on the synchronisation of business cycles.

### 3.5 Conclusion

To conclude, the business cycles of the countries are much more correlated than in Corsetti and Pesenti (2009) since the shocks are transmitted symmetrically between two economies. None of the countries as in Corsetti and Pesenti (2009), reap any advantage from coordinating. However, monetary policies remain inward looking since they depend on Home and Foreign productivity shocks, and not Foreign monetary shocks. If the share of Home intermediate goods used in the final-good production is the same in the two economies, then the optimal monetary policies are the same in both countries, and the exchange rate remains the same. In this case, a monetary union could be implemented since the symmetric shocks meet the Mundell's optimum currency area criteria.

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## 3.A Appendix: Empirical extension

As a future extension, I would like to include an empirical section. This is the first draft, potentially plagued by endogeneity issues, for which I have not find yet a good instrument. The aim of this empirical study is to test my model's predictions, in particular the effect of global value chains on business cycles synchronisation.

### 3.A.1 The data set

Trade data are from the World Input-Output Database (Timmer *et al.*, 2015), FTA data are from the Design of International Trade Agreements database (Dür, Baccini and Elsig, 2014), currency union data are from my own database (Lebastard, 2017),<sup>5</sup> geographic data are from the CEPII database "GeoDist" (Mayer and Zignago, 2011). The remaining data are based on World Bank World Development Indicators (1960-2014).<sup>6</sup> I have no missing values.

My database includes annual data covering 40 countries and 34 sectors from 1995 to 2011.<sup>7</sup> The Input-Output table provides all the information needed to study vertical trade: inputs imported by each sector in each country, gross output and exports from each sector. The advantage of WIOD is that it allows comparison across sectors, countries and time since the data are consistent. However, the downside of this database is that the data are annual data whereas I would have preferred monthly data because changes to retail prices occur more frequency than annually.<sup>8</sup>

### 3.A.2 Statistics description

I calculated country vertical specialization as the ratio of intermediate good inputs imported by a country on final good outputs exported to final Foreign consumers. The major flaw in this technique, highlighted by de Backer and Yamano (2012), is that it does not capture the involvement of the countries that produced the first stage intermediate good (which explains China's ranking in figure C1). Figure C1 shows that Luxemburg,<sup>9</sup> Hungary and Czech Republic are the most vertically specialized, while Brazil, Japan and the USA are the least specialised.<sup>10</sup> My results are in the range of Backer and Yamano (2012).

I calculate vertical specialization by sector in the same way, as the ratio of intermediate good inputs imported by a sector in final good outputs exported to final Foreign consumers. Figure C2 shows that mining and quarrying, construction and basic metals and fabricated metal sectors are the most vertically integrated.<sup>11</sup> The fact that their ratio is superior to 1 means that the output of these sectors does not reach final consumer directly but is used by other industries as intermediate goods.

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<sup>5</sup> Augmented by de Sousa (2012).

<sup>6</sup> Variables descriptions are provided in appendix 2.

<sup>7</sup> Countries and sectors are listed in the appendix.

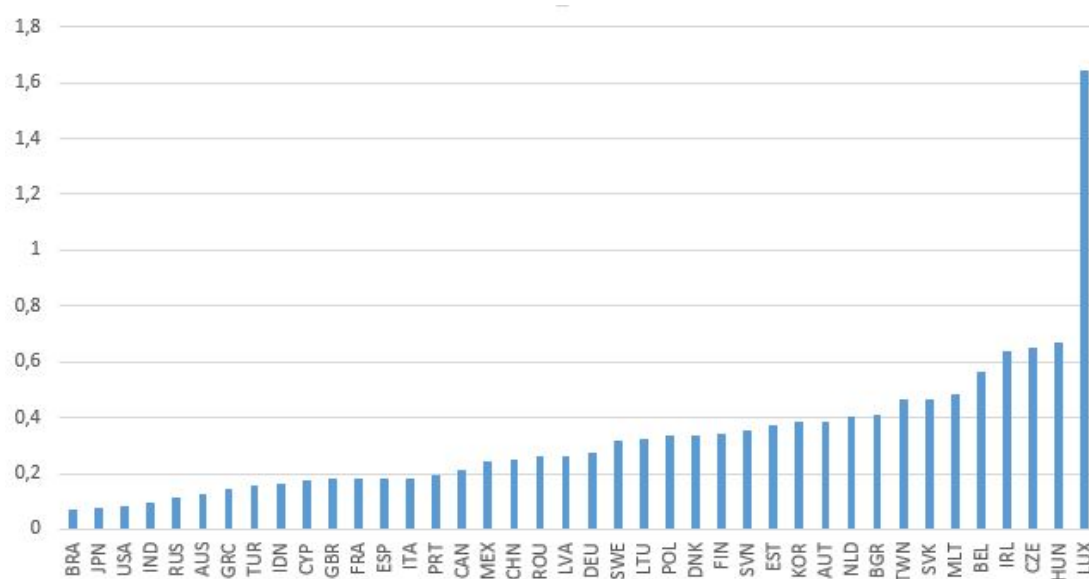
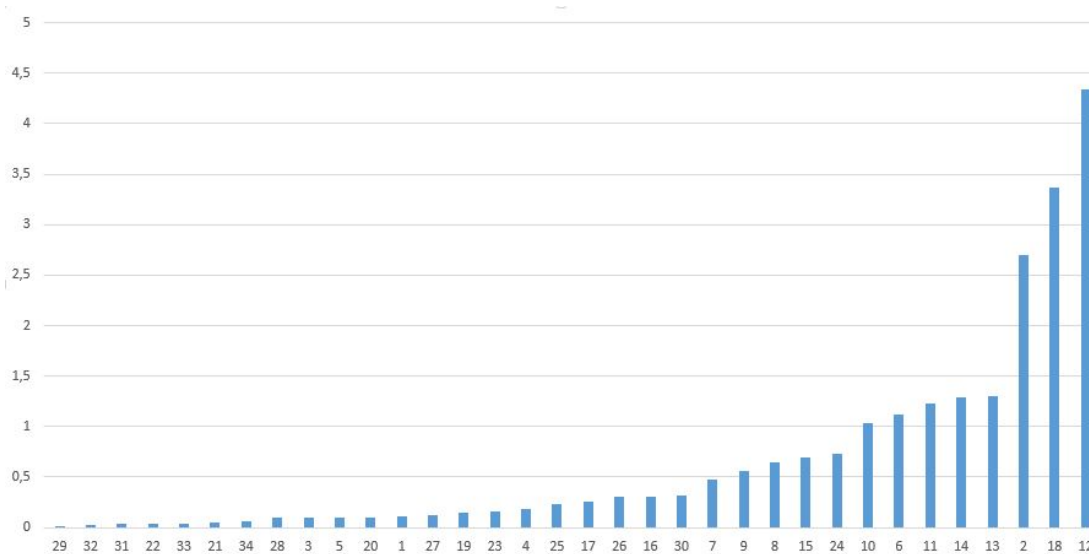
<sup>8</sup> Imbs *et al.* (2005).

<sup>9</sup> Luxemburg ratio is superior to 1, which means either that it sells most of its final goods in its own market or it exports its output as intermediate goods.

<sup>10</sup> Not surprising considering the size of the countries and the fact that Japan is an island. They can more easily keep all the production stages within country.

<sup>11</sup> The sector codings and titles are presented in the appendix 2.

Figure C1: Vertical specialization by country in 2011

Figure C2: Vertical specialization by sector<sup>11</sup> in 2011

### 3.A.3 Methodology

The main idea in the empirical part is to highlight the interaction between vertical trade intensity and intermediate and final good trade synchronization. To do that, I use a methodology that is close to that used in papers studying the links between (direct) trade intensity and business

cycle synchronization.<sup>12</sup> To my knowledge, this methodology has not previously been applied to vertical trade.

I define the sector business cycle correlation ( $corrSectorBusinessCycle_{ijsrt}$ ) as the correlation between the intermediate good trade and the final good trade. More precisely, I compute the correlation<sup>13</sup> between the cyclical component of intermediate goods exported by sector  $s$  of country  $i$  and the cyclical component of final goods trade exported by sector  $r$ <sup>14</sup> of country  $j$ .<sup>15</sup> The cyclical component of trade is obtained by detrending my trade data using the Hodrick-Prescott (HP) filter.<sup>16</sup>

I define the intermediate good trade intensity ( $intensityIntermediateTrade_{ijsrt}$ ) as the ratio between intermediate good imported from sector  $s$  of country  $i$  to sector  $r$  of country  $j$  and the final goods exported by sectors  $r$  and  $s$ ,

$$intensityIntermediateTrade_{ijsrt} = \frac{\text{intermediate goods imported by sector } r \text{ country } j \text{ from sector } s \text{ country } i}{\text{final goods exported by sectors } r \text{ and } s} \quad (3.37)$$

My equation is different from Hummels, Ishii and Yi (2001) since I use a different denominator. I am interested in comparing  $intensityIntermediateTrade_{ijsrt}$  and  $intensityFinalTrade_{ijsrt}$ , which is why I use the same denominator for both. I plan to test alternative measure of vertical integrations.

I define the final good trade intensity ( $intensityFinalTrade_{ijsrt}$ ) as the ratio between final good traded from country  $i$  sector  $r$  to country  $j$  and the final goods exported by sectors  $r$  and  $s$ ,

$$intensityFinalTrade_{ijsrt} = \frac{\text{final goods imported by country } j \text{ from sector } s \text{ country } i}{\text{final goods exported by sectors } r \text{ and } s} \quad (3.38)$$

In order to test the impact of vertical trade integration on intermediate and final goods trade synchronization, I run the following regression, my main interest lying on the sign and magnitude of the slope coefficient  $\beta_1$ :

$$corrSectorBusinessCycle_{ijsrt} = \beta_1 intensityIntermediateTrade_{ijsrt} + \beta_2 intensityFinalTrade_{ijsrt} + \lambda_{1ijsr} + \lambda_{2ist} + \lambda_{3jrt} + \epsilon_{ijt}, \quad (3.39)$$

where  $corrSectorBusinessCycle_{ijsrt}$  is the correlation between detrended intermediate good trade from country  $i$  sector  $s$  to country  $j$  sector  $s$  and the detrended final good trade from country  $j$  sector  $r$  exported to final consumer everywhere in the world at time  $t$ .  $intensityIntermediateTrade_{ijsrt}$  is the ratio between intermediate good from country  $i$  sector  $s$  used by sector  $r$  of country  $j$  at time  $t$  and the final goods exported by sectors  $r$  and  $s$  at time  $t$ .  $intensityFinalTrade_{ijsrt}$  is the ratio between final good traded from country  $i$  sector  $r$  to country  $j$  at time  $t$  and the final goods exported by sectors  $r$  and  $s$  at time  $t$  (this way, I control for direct trade).  $\lambda_{1ijsr}$ ,  $\lambda_{2ist}$  and  $\lambda_{3jrt}$  are pair-sector-fixed effects, exporter-sector-time fixed effects and importer-sector-time

<sup>12</sup>Frankel and Rose (1997, 1999), Calderón *et al.* (2007), Inklaar *et al.* (2008).

<sup>13</sup>I divide my 12 years period in two to be able to add time fixed effects.

<sup>14</sup> $s$  and  $r$  can be equal.

<sup>15</sup> $i \neq j$

<sup>16</sup>I plan to test alternative detrend methods.

fixed effect,<sup>17</sup> this way I control for time-invariant country pair-specific variables which may have an impact on vertical trade synchronization, and I control for general increase of trade over time. I plan to also test a specification without exporter-sector-time fixed effects and importer-sector-time fixed effects together, and adding additional control variables, to take into account if the case where a shock hits the two sectors simultaneously. I plan to add other control variables, as fixed exchange rate regime dummies, or financial integration proxies.

My fixed effects in part handle the endogeneity problems but do not get rid of them completely. I tried two instruments. The first instrument, following Frankel and Romer (1999) contains distance, GDP per capita, GDP, colonial links, common language, common border, FTA, currency union, land surface, population size, island, landlocked. A test for overidentifying restrictions rejects it.<sup>18</sup> The second instrument contains WTO, FTA and currency union only. An F-test rejects it since it does not have strong predictive power for trade. Currently, I am searching for a new instrument.

### 3.A.4 Results at sector level

In my most favored specification (OLS), the effect of vertical trade on sectors' business cycle synchronisation is positive but not significant. Direct trade increases significantly business cycle synchronisation which is in line with the literature. Free trade agreements and currency unions favor a correlation between the sectors' business cycle. WTO does not increase business cycle synchronisation which is not surprising since it includes a wide range of countries.

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<sup>17</sup>Pol, Fort and Tintelnot (2017) show the importance of importer fixed effect, as the size of the country is related to the size of the firms outsourcing, itself being linked to the number of countries they can import from.

<sup>18</sup>Indeed, Gruben, Koo and Millis (2002) argue that it is correlate not onlyd with the outcome variable but also to the dependent variable.

Table C1: Different specifications, my favorite being the OLS

	(1)	(2)	(3)
corr Sector Business Cycle	IV All control	IV WTO	OLS
Intensity Intermediate Trade	-107.3 (101.5)	-173.6 (184.9)	0.352 (0.645)
Intensity Final Trade	0.418*** (0.0658)	0.433*** (0.0722)	0.411*** (0.0623)
FTA		0.0528*** (0.00499)	0.0557*** (0.00307)
Currency Union		0.0671*** (0.00344)	0.0652*** (0.00251)
WTO			0.00653 (0.00524)
Observations	678,610	678,610	678,610
R-squared	0.850	0.837	0.858
Pair-country-sector FE	YES	YES	YES
Exporter-sector-time FE	YES	YES	YES
Importer-sector-time FE	YES	YES	YES

*Note:* Column 1: IV contains distance, GDP per capita, GDP, colonial links, common language, common border, FTA, currency union, surface of the land, population size, island, landlocke. Column 2: IV contains WTO, FTA and currency union. Column 3: no IV. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ )

I then check the effect of vertical trade on the synchronisation of sector  $r$  of country  $j$  with its sector trading partners. Table C2 shows the results of this specification, for the sectors using global value chains the most intensively. The results for all the sectors are provided in appendix 3 (tables C4, C5, C6 and C7).

Table C2: OLS: Effect of vertical trade on the synchronisation of each sector

corr Sector Business Cycle	(1) S12 Metal	(2) S18 Construction	(3) S2 Mining	(4) S13 Machinery	(5) S14 Electronics	(6) S11 Mineral
Intensity Intermediate Trade	5.061*** (0.821)	-0.525 (0.477)	7.776** (3.646)	8.247*** (1.671)	1.852** (0.778)	6.072** (2.733)
Intensity Final Trade	1.037 (1.396)	0.306 (0.682)	0.460** (0.221)	-1.359 (0.837)	2.588*** (0.276)	-12.11*** (1.985)
FTA	0.0692*** (0.00980)	0.0878*** (0.00962)	-0.0856*** (0.0105)	-0.00781 (0.0135)	0.0533*** (0.0129)	-0.0491*** (0.0142)
Currency Union	0.0998*** (0.00988)	0.112*** (0.00968)	0.0439*** (0.0107)	0.113*** (0.0121)	0.126*** (0.0128)	0.103*** (0.0129)
WTO	-0.0509*** (0.0183)	0.103*** (0.0178)	-0.0829*** (0.0229)	0.0430* (0.0257)	0.0372 (0.0248)	0.00762 (0.0282)
Observations	65,142	71,914	57,211	47,679	48,447	44,203
R-squared	0.591	0.601	0.679	0.571	0.648	0.618
Pair-country FE	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES

Note: Sectors with the highest vertical specialization. S12: Basic metals and fabricated metal; S18: Construction; S2: Mining and quarrying; S13: Machinery, nec; S14: Electrical and optical equipment; S11: Other non-metallic mineral. Standard errors in parentheses (\*\*\*) p<0.01, \*\* p<0.05, \* p<0.1)

For almost all of the sectors using vertical trade intensively, the coefficient is positive and significant.

I also plan to test other predictions of the model, concerning for example the exchange rate.

## 3.B Appendix: Database

### 3.B.1 Countries

List of the countries in the database: Australia (AUS), Austria (AUT), Belgium (BEL), Bulgaria (BGR), Brazil (BRA), Canada (CAN), China (CHN), Cyprus (CYP), Czech Republic (CZE), Germany (DEU), Denmark (DNK), Spain (ESP), Estonia (EST), Finland (FIN), France (FRA), Great Britain (GBR), Greece (GRC), Hungary (HUN), Indonesia (IDN), India (IND), Ireland (IRL), Italy (ITA), Japan (JPN), Korea (KOR), Latvia (LVA), Lithuania (LTU), Luxembourg (LUX), Mexico (MEX), Malta (MLT), Netherlands (NLD), Poland (POL), Portugal (PRT), Romania (ROU), Russia (RUS), Slovakia (SVK), Slovenia (SVN), Sweden (SWE), Turkey (TUR), Taiwan (TWN), USA (USA)

### 3.B.2 Variables

In this appendix, I describe in detail the variables used and give their sources.

- *corrSectorBusinessCycle* : correlation calculated on a 6 year period (I have 12 years of data) between detrended intermediate good output from country  $i$  sector  $s$  and the detrended final good output from country  $j$  sector  $r$  exported to final consumer everywhere in the world, flows being expressed in millions of US dollars (WIOD database) (1995-2011)
- *intensityIntermediateTrade* : average ratio by period, between intermediate good input from country  $i$  sector  $s$  used by sector  $r$  of country  $j$  and the sum of the two sectors  $r$  and  $s$  final output, flows being expressed in millions of US dollars (WIOD database) (1995-2011)
- *intensityFinalTrade* : average ratio by period, between final good traded from country  $i$  sector  $r$  to country  $j$  and the sum of the two sectors  $r$  and  $s$  final output, flows being expressed in millions of US dollars (WIOD database) (1995-2011)
- *CurrencyUnion* : dummy for both countries being in currency union together (and dollarized economies) during more than 50% of the period
- *FTAdummy* : dummy for two countries being in a Free Trade Agreements during more than 50% of the period (Design of International Trade Agreements database) (1948-2015)
- *GDP* : average of GDP by period, in current US dollar (World Development Indicators from the World Bank) (1960-2015)
- *GDPperCapita* : average GDP per capita by period in constant 2005 US dollar (World Development Indicators from the World Bank) (1960-2015)
- *Distance* : simple distance (most populated cities, km) (CEPII database "GeoDist")
- *CommonBorder* : dummy for common frontier (CEPII database "GeoDist")
- *CommonLanguage* : dummy, 1 if a language is spoken by at least 9% of the population in both countries (CEPII database "GeoDist")
- *Colony* : dummy, 1 for pairs ever in colonial relationship (CEPII database "GeoDist")
- *CurrentColony* : dummy, 1 for pairs currently in colonial relationship (CEPII database "GeoDist")



- *Population* : average of total population by period (World Development Indicators from the World Bank) (1960-2014)
- *Surface* : Land area in square kilometer (World Development Indicators from the World Bank)(1960-2014)
- *Landlocked* : dummy, if one of the two countries is landlocked (CEPII database "GeoDist")
- *BothLandlocked* : dummy, if the two countries are landlocked (CEPII database "GeoDist")
- *Island* : dummy, if one of the two countries is an island (CEPII database "GeoDist")
- *BothIsland* : dummy, if the two countries are islands (CEPII database "GeoDist")

**3.B.3 Sector classification**

description	code
Agriculture, hunting, forestry and fishing	1
Mining and quarrying	2
Food , beverages and tobacco	3
Textiles and textile	4
Leather, leather and footwear	5
Wood and of wood and cork	6
Pulp, paper, paper , printing and publishing	7
Coke, refined petroleum and nuclear fuel	8
Chemicals and chemical	9
Rubber and plastics	10
Other non-metallic mineral	11
Basic metals and fabricated metal	12
Machinery, nec	13
Electrical and optical equipment	14
Transport equipment	15
Manufacturing nec; recycling	16
Electricity, gas and water supply	17
Construction	18
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	19
Wholesale trade and commission trade, except of motor vehicles and motorcycles	20
Retail trade, except of motor vehicles and motorcycles; repair of household goods	21
Hotels and restaurants	22
Other inland transport	23
Other water transport	24
Other air transport	25
Other supporting and auxiliary transport activities; activities of travel agencies	26
Post and telecommunications	27
Financial intermediation	28
Real estate activities	29
Renting of meq and other business activities	30
Public admin and defence; compulsory social security	31
Education	32
Health and social work	33
Other community, social and personal services	34

Table C3: List of sectors in my database

### 3.C Appendix: Additionnal estimations

Table C4: OLS: effect of vertical trade on business cycle synchronisation - sector 1 to 9

corr Sector Business Cycle	(1) S1	(2) S2	(3) S3	(4) S4	(5) S5	(6) S6	(7) S7	(8) S8	(9) S9
Intensity Vertical Trade	21.26*** (4.546)	7.776** (3.646)	17.49*** (4.146)	-3.830* (2.024)	-5.597* (3.209)	5.772*** (2.133)	8.468*** (1.371)	2.221*** (0.705)	4.339*** (1.428)
Intensity Direct Trade	0.177 (1.049)	0.460** (0.221)	-0.524 (1.422)	1.731*** (0.347)	-3.260*** (0.689)	-10.66*** (1.640)	0.670 (1.420)	0.141 (0.113)	-0.0718 (0.507)
FTA	0.0722 (0.0463)	-0.0856*** (0.0105)	0.0798 (0.0622)	0.263*** (0.0330)	0.263*** (0.0490)	0.0566*** (0.0125)	0.156*** (0.0183)	-0.102*** (0.0272)	-0.0283 (0.0173)
Currency Union	0.0394 (0.0304)	0.0439*** (0.0107)	0.0685 (0.0621)	-0.132*** (0.0256)	0.444*** (0.0430)	0.0350*** (0.0122)	0.0433*** (0.0160)	0.00894 (0.0237)	0.0739*** (0.0170)
WTO	0.324*** (0.0597)	-0.0829*** (0.0229)	1.245 (7.822e+07)	0.114* (0.0680)	-4.250 (5.637e+07)	0.0135 (0.0241)	-0.143*** (0.0260)	-0.0819*** (0.0237)	-0.00594 (0.0278)
Observations	14,272	57,211	8,256	19,858	12,586	49,140	35,075	18,965	31,867
R-squared	0.547	0.679	0.607	0.700	0.742	0.611	0.554	0.676	0.585
Pair-country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: In each column, the sector of interest is the one importing intermediate goods and exporting final goods to the final consumer. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table C5: OLS: effect of vertical trade on business cycle synchronisation - sector 10 to 18

corr Sector Business Cycle	(1) S10	(2) S11	(3) S12	(4) S13	(5) S14	(6) S15	(7) S16	(8) S17	(9) S18
Intensity Vertical Trade	7.512*** (1.801)	6.072** (2.733)	5.061*** (0.821)	8.247*** (1.671)	1.852** (0.778)	2.663* (1.506)	4.916* (2.697)	7.675*** (1.934)	-0.525 (0.477)
Intensity Direct Trade	13.59*** (0.953)	-12.11*** (1.985)	1.037 (1.396)	-1.359 (0.837)	2.588*** (0.276)	0.979*** (0.236)	-1.173** (0.548)	2.835 (3.620)	0.306 (0.682)
FTA	0.139*** (0.0135)	-0.0491*** (0.0142)	0.0692*** (0.00980)	-0.00781 (0.0135)	0.0533*** (0.0129)	0.145*** (0.0179)	0.196*** (0.0306)	0.0308 (0.0301)	0.0878*** (0.00962)
Currency Union	0.0813*** (0.0135)	0.103*** (0.0129)	0.0998*** (0.00988)	0.113*** (0.0121)	0.126*** (0.0128)	0.0181 (0.0153)	0.0744*** (0.0254)	-0.0553** (0.0269)	0.112*** (0.00968)
WTO	0.184*** (0.0233)	0.00762 (0.0282)	-0.0509*** (0.0183)	0.0430* (0.0257)	0.0372 (0.0248)	-0.0898** (0.0365)	0.121* (0.0684)	0.00575 (0.0306)	0.103*** (0.0178)
Observations	42,773	44,203	65,142	47,679	48,447	35,919	19,853	14,726	71,914
R-squared	0.535	0.618	0.591	0.571	0.648	0.639	0.688	0.573	0.601
Pair-country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Note:* In each column, the sector of interest is the one importing intermediate goods and exporting final goods to the final consumer. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table C6: OLS: effect of vertical trade on business cycle synchronisation - sector 19 to 27

corr Sector Business Cycle	(1) S19	(2) S20	(3) S21	(4) S22	(5) S23	(6) S24	(7) S25	(8) S26	(9) S27
Intensity Vertical Trade	3.045 (4.411)	0.475 (3.827)	-23.50 (14.81)	20.97*** (7.925)	0.0551 (2.453)	-2.120** (0.967)	-0.485 (2.878)	-5.406*** (1.957)	1.842 (12.15)
Intensity Direct Trade	-76.05 (60.79)	-4.500 (3.888)	29.44 (27.27)	18.39 (24.33)	2.119 (3.901)	1.894 (1.640)	4.279** (1.899)	-8.203*** (2.231)	22.12*** (7.370)
FTA	0.0586 (0.0556)	0.351*** (0.0713)	-41.32 (6.537e+07)	-0.131 (1.036)	0.107** (0.0448)	-0.0496** (0.0240)	0.267*** (0.0291)	0.0152 (0.0341)	-0.0267 (0.0715)
Currency Union	0.00835 (0.0287)	0.0897*** (0.0316)	-0.0490 (0.0441)	-0.00877 (0.0958)	0.0616** (0.0281)	0.0174 (0.0173)	0.0265 (0.0201)	-0.0304 (0.0207)	0.118*** (0.0339)
WTO	1.821 (8.670e+07)	2.091 (7.616e+07)	1.265 (4.656e+07)	1.468 (9.182e+07)	0.138*** (0.0458)	-0.0640* (0.0347)	0.165*** (0.0406)	0.155*** (0.0326)	-0.338* (0.175)
Observations	13,796	13,719	7,912	3,772	16,101	30,344	24,707	21,687	12,760
R-squared	0.547	0.496	0.507	0.521	0.518	0.507	0.543	0.513	0.603
Pair-country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Note:* In each column, the sector of interest is the one importing intermediate goods and exporting final goods to the final consumer. Standard errors in parentheses (\*\*\*)  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

Table C7: OLS: effect of vertical trade on business cycle synchronisation - sector 28 to 34

corr Sector Business Cycle	(1) S28	(2) S29	(3) S30	(4) S31	(5) S32	(6) S33	(7) S34
Intensity Vertical Trade	0.488 (1.997)	-10.46 (26.86)	-2.840 (4.274)	-25.21 (18.28)	-14.72 (63.35)	-1.092 (8.032)	-3.103 (10.50)
Intensity Direct Trade	3.583 (5.490)	-1.981e+06*** (574,814)	-10.05*** (3.505)	-32.03 (77.51)	-	-22.90 (44.94)	-1.760 (17.86)
FTA	-0.568*** (0.0854)	-1.874 (7.264e+07)	0.135*** (0.0223)	-1.352 (2.762e+08)	-	0.349*** (0.0981)	-0.195* (0.115)
Currency Union	-0.0782* (0.0462)	-	-0.0230 (0.0171)	0.189 (0.155)	-	0.229** (0.110)	-0.0194 (0.0617)
WTO	-31,914 (1.806e+08)	-	-0.222*** (0.0364)	-	-	-194,951 (5.648e+08)	-3,650 (1.508e+08)
Observations	9,580	2,784	32,778	3,195	612	4,454	6,079
R-squared	0.490	0.788	0.550	0.493	0.522	0.485	0.532
Pair-country FE	YES	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES	YES

*Note:* In each column, the sector of interest is the one importing intermediate goods and exporting final goods to the final consumer. Standard errors in parentheses (\*\*\* p<0.01, \*\* p<0.05, \* p<0.1)





# Conclusion

## Overall message

In this thesis, I show the importance of certainty for trade. Indeed, currency union by guaranteeing an irrevocable fixed exchange rate promotes trade, both in normal times and during economics crisis. The credibility of a peg, and therefore the level of certainty of the future rate (used by the firms when they take the decision to export) depends on the lenght of time without devaluation, and the type of commitment. Fixed exchange rate regimes have an effect on trade only after 15 years, when the credibility of the peg is sufficient. By entering an extremely binding commitment, currency unions do not need to wait 15 years to become credible, they have an effect on trade from the first year. Indeed, the cost of exit is very uncertain, and potentially very high, preventing countries with economic difficulties from leaving in order to make a competing devaluation. Looking at historical examples, it is rare for a country to leave a currency union for economic reasons; it is usually but for political reasons.

## Original results

In the first chapter, I found that currency union increases trade more than peg one-to-one, both being positive and significant. I found no effect of classical fixed exchange rate regimes compared to floating exchange rate regimes. Currency unions have very strong effects from the outset, pegs one-to-one have small effects and classical fixed exchange rates have no effect. At steady state, the effects of currency unions (that remain stable over time) and pegs one-to-one tend to converge. Classical fixed exchange rate regimes have small effects only after 15 years which is also predicted by my model. However, correcting for endogeneity issues, peg one-to-one

effects turn insignificant.

In the second chapter, I found that during the economic crisis, the euro had a positive and significant effect on aggregate trade, not only during the drop, but also during the rebound and in the long run. My results are robust to many robustness checks (changing the control group and the time period, excluding countries, etc.). During the crisis, exchange rate volatility increased everywhere in the world except in the Eurozone where by nature it remained fixed. Therefore, the euro provides a premium for exchange rate stability during economic crises.

In chapter 3, I found that global value chains make economies much more linked than in Corsetti and Pesenti's (2009) model. Indeed, an intermediate good productivity shock is transmitted by two channels instead of one, so shock transmission is much greater. The business cycles of these countries are also more correlated since the shocks are transmitted symmetrically in the two economies. In addition, the exchange rate is less volatile than in the original model. My model recommends that monetary policies respond in the same way whether the shock comes from home or abroad. There is no gain from coordination.

## Limits and Perspectives

In the first chapter, my model makes a lot of ad-hoc hypotheses, which limit the scope of the predictions obtained. I therefore will have to make them endogenous. In addition, I use a very particular utility function for the firms; I will need instead to introduce a hedging cost and see whether my predictions remain the same. Finally, my model is micro-founded, and therefore the empirical part calls for firm-level data to test all the predictions. Currently, I am searching for data which will allow me to check whether the size distribution of the exporting firms changes when the country enters a currency union. I have these data for European firms for years 2014 and 2015, but to identify my effect, I need a switch otherwise my fixed effects absorb the differences between firms exporting outside the Eurozone and the others.

In chapter 2, I need to control for institutional changes in the Eurozone which are confounded by the presence of a single currency. I therefore cannot disentangle the effects of the euro from

the effects of the reforms implemented only by Eurozone members. Furthermore, since I conclude is that the channel through which the euro had a positive effect on trade during the crisis lacks of volatility, the next logical step would be to replicate this for all currency unions during crisis since this would constitute a characteristic common to all of them. It would help me to know whether I have identified the right channel.

In the third chapter, the scope of my model is not wide as all the final goods consumed by users come from vertical trade; however, in reality this is not the case. The new transmission paths highlighted by my model therefore do not represent very significant paths for the transmission of shocks. One extension to the model could be to add another tradable sector in each country. This would provide a more realistic view since most trade is not vertical. In addition, in my model, the forward-looking nature of inflation is neglected. My model presents a link between employment and inflation, a sort of original form Phillips curve. However, this equation is too simplistic because the agents anticipate inflation, which does not appear in my model.

**Titre :** Trois études portant sur les unions monétaires et le commerce

**Mots clés :** Union monétaire, taux de change fixe, commerce, euro, crise, effondrement du commerce

**Résumé :** Cette thèse relève du commerce international, des politiques monétaires et de macroéconomie internationale. Le premier chapitre étudie les différentes caractéristiques des différents régimes de change fixe et évalue les effets de chacune de ces caractéristiques sur le commerce international. Il apparaît que la transparence des prix et les coûts de transaction liés au changement de monnaie n'ont pas d'effet significatif sur le commerce, seule la crédibilité du régime de change fixe (liée à l'absence de possibilité de dévaluation) augmente significativement le commerce. Cela explique pourquoi seule l'union monétaire augmente le commerce entre ses membres dès les premières années du régime de change.

Le second chapitre s'intéresse aux effets de l'euro sur le commerce pendant la crise financière de 2008-2009. Il apparaît que l'euro amortit la chute du commerce observée partout dans le monde, grâce à l'absence de volatilité du taux de change entre ses membres. Le troisième chapitre présente un modèle théorique permettant d'étudier la transmission des chocs dans une économie spécialisée verticalement, et propose une politique monétaire optimale pour stabiliser l'économie. Le modèle promeut des politiques monétaires symétriques entre les deux pays partageant un mode de production basé sur les chaînes globales de valeur.

**Title :** Three Essays on Currency Union and Trade

**Keywords :** Currency union, Fixed exchange rate, trade, euro, crisis, great trade collapse

**Abstract :** This thesis studies international trade, monetary policy and international macroeconomics. Chapter 1 examines the different characteristics of different fixed exchange rate regimes and assesses the effects of each of these characteristics on international trade. It appears that price transparency and transaction costs linked to the currency changes do not have a significant effect on trade; only the credibility of the fixed exchange rate regime (due to the absence of devaluation possibilities) increases trade significantly. This explains why only monetary union increases trade between its members from the first years of the exchange rate regime. Chapter 2 looks at the effects of the euro on trade during the 2008-2009 financial crisis.

It seems that the euro amortized the trade drop observed throughout the world, owing to the absence of exchange rate volatility among its members. Chapter 3 presents a theoretical model to study the transmission of shocks in a vertically specialized economy, and proposes an optimal monetary policy to stabilize the economy. The model promotes symmetrical monetary policies between the two countries sharing a production mode based on global value chains.