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Three Essays on the Relation between Trade and Business Cycle Synchronization

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Résume en français

Trois essais sur la relation entre le commerce et la synchronisation des cycles économiques

Depuis plusieurs décennies, la globalisation et l'intégration économique semblent renforcer la convergence des cycles économiques des pays (Kose et al., 2008, Ductor and Leiva-Leon, 2016). La synchronisation des cycles économiques constitue ainsi un sujet important de la macroéconomie internationale. Plusieurs travaux de recherche ont testé l'existence d'un cycle global unique (Otto et al., 2001, Stock et Watson, 2005, Kose et al., 2008, Flood et Rose, 2010, Grigoraş et Stanciu, 2016, parmi d'autres). D'autres papiers ont porté leur attention sur la mondialisation et l'européanisation des cycles économiques (Crowley, 2008, Papageorgiou et al., 2010, Ferreira-Lopes et Pina, 2011, Pentecôte et Huchet-Bourdon, 2012, Ahlborn et Wortmann, 2018, parmi d'autres). D'autres auteurs ont évalué la transmission des cycles économiques en analysant la contagion des fluctuations des variables macroéconomiques entre les pays et entre les régions (Sayek et Selover, 2002, Osborn et al., 2005, Chen, 2009, Carstensen et Salzmann, 2017, Levchenko et Pandalai-Nayar, 2018, Lange, 2018, parmi d'autres). L'identification des déterminantes de la synchronisation des cycles est un défi essentiel en macroéconomie internationale. La littérature met en évidence plusieurs facteurs : l'intégration commerciale, l'intégration financière, la spécialisation industrielle, la coordination des politiques monétaires et fiscales, les investissements directs à l'étranger, les régimes de change (Frankel et Rose, 1998, Clark et Van Wincoop, 2001, Fidrmuc, 2004, Imbs, 2004, Baxter et Kouparitsas, 2005, Inklaar et al., 2008, Abbott et al., 2008, Dées et Zorell, 2011, Pentecote et al., 2015, parmi d'autres). Comme les volumes des échanges internationaux ont fortement augmenté pendant les dernières années (de 17% du PIB mondial en 1960 à environ de 50% en 2017), les effets du commerce bilatéral sur l'harmonisation des PIB ont attiré beaucoup d'attention des chercheurs. Cette thèse vise ainsi à étudier empiriquement cet effet. Nous nous concentrons sur trois questions qui ont reçu une attention limitée, voire nulle, dans la

littérature existante : i) la propagation du choc de demande via le canal commerciale au sein d'une zone monétaire et entre différentes zones monétaires, ii) le rôle de la marge extensive du commerce dans la résolution du puzzle de commerce-synchronisation et iii) la transmission des chocs de nouvelle de la productivité globale des facteurs (PGF) via le commerce bilatéral. Les trois chapitres de cette thèse apportent des éléments de réponse à ces questions.

Premièrement, la recherche se concentre sur la relation entre l'intégration commerciale et les interdépendances macroéconomiques au sein de l'Union Européenne. Il s'agit de mettre en évidence (i) le caractère endogène de l'intégration commerciale avec l'élargissement de l'UE aux Pays de l'Europe Central et Orientale (PECO) et (ii) comment cette intégration commerciale a eu des effets différents sur les interdépendances macroéconomiques des PECO selon leur adoption ou non de l'euro. Pour répondre à ces questions, nous utilisons dans le chapitre 1 un modèle quasi-VAR pour estimer des changements dans les réponses de sept PECO[1] aux chocs économiques qui viennent de douze membres de la zone euro[2] avant et après l'année 2004. Nos résultats empiriques estimés sur la période 1990-2015 indiquent que les PECO sont affectés plus fortement par les économies membres de la zone Euro pendant la période d'après 2004 qu'avant (3,3 fois plus grande en moyenne). Les effets de contagion sont principalement expliqués par trois économies les plus grandes de la zone euro qui sont l'Allemagne, la France et l'Italie. En plus, les réponses des trois PECO qui ont rapidement adopté l'euro comme monnaie nationale (Slovénie, Slovaquie et Estonie) sont plus élevées que celles des autres pays (4,9 contre 2,1) tandis que ses intensités commerciales avec la zone euro n'ont pas augmenté (1,07 contre 1,12). L'adhésion à l'UE et l'adoption de l'euro permettent donc à ces pays

[1] Sept PECO comprennent de République Tchèque, Estonie, Hongrie, Lituanie, Pologne, Slovaquie et Slovénie.
[2] Douze membres de la zone euro comprennent d'Autriche, Belgique, Finlande, France, Allemagne, Grèce, Irlande, Luxembourg, Pays-Bas, Italie, Portugal et Espagne.

d'amplifier les effets du commerce sur l'interdépendance macroéconomique et de s'intégrer plus rapidement à la zone euro.

Le chapitre 2 va se concentrer sur les deux autres canaux par lesquels le commerce augmente la synchronisation des cycles : *la transmission de technologie* et *les effets des termes de l'échange*. Le principal apport du chapitre 2 est de distinguer les effets liés à la marge extensive du commerce (nouveaux produits exportés) de la marge intensive du commerce (produits déjà exportés). Kose et Yi (2006) a souligné le puzzle de commerce-synchronisation selon lequel les modèles théoriques sont incapables de reproduire des effets du commerce sur les corrélations du cycle économique aussi forts que ceux estimés par des études empiriques. Comme Juvenal et Santos-Monteiro (2017), ce chapitre explique la synchronisation des cycles économiques par trois facteurs: la corrélation de la PGF entre deux pays, la corrélation de la part des dépenses en biens domestiques entre deux pays et la corrélation entre la PGF d'un pays et la part des dépenses en biens domestiques de son partenaire commercial. Ensuite, pour chaque facteur, les effets commerciaux sont décomposés en deux parties : l'effet de la marge intensive et celui de la marge extensive. En utilisant des données concernant 40 pays[3] sur une période 1990-2015, nous trouvons premièrement que la synchronisation des cycles économiques s'explique principalement par la corrélation de la PGF et la corrélation de la part des dépenses en biens domestiques. Deuxièmement, la marge extensive augmente non seulement la corrélation de la PGF entre les partenaires commerciaux (Liao et Santacreu, 2015), mais aussi la corrélation entre les parts de dépenses en biens domestiques. Le dernier effet est de 0.079 contre 0.074 qui sont l'effet du commerce total (marge extensive et marge intensive) estimé par Juvenal et Santos-Monteiro (2017). Ce résultat souligne que les nouveaux produits exportés

[3] L'échantillon comprend de vingt-quatre pays développés (Australie, Autriche, Canada, Danemark, Finlande, France, Allemagne, Grèce, Hongrie, Islande, Irlande, Italie, Japon, Corée du Sud, Pays-Bas, Nouvelle-Zélande, Norvège, Pologne, Portugal, Espagne, États-Unis, Suède, Suisse et Royaume-Uni) et seize pays émergents (Chili, Chine, Indonésie, Inde, Malaisie, Philippines, Argentine, Brésil, Mexique, Turquie, Costa Rica, Roumanie, Thaïlande, Uruguay, Bulgarie et Tunisie).

transmettent les chocs de la PGF (la transmission de technologie) et ne détériorent pas, voire améliorent, les termes de l'échange (les effets des termes de l'échange). Nous suggérons donc qu'afin de résoudre le puzzle du commerce-synchronisation, il faut que les modèles théoriques intègrent la marge extensive du commerce. Au niveau de politiques économiques, pour augmenter la synchronisation des cycles, il faut que les pays créent un environnement qui encourage les exports des nouveaux produits.

Troisièmement, le type de choc peut être une source du puzzle de commerce-synchronisation. Dans les modèles DSGE, les fluctuations macroéconomiques sont souvent générées à partir de chocs contemporains de la PGF. Néanmoins, plusieurs recherches récentes ont démontré que les chocs de nouvelle de la PGF sont la source des cycles économiques (Barsky et Sims, 2011, Beaudry et al., 2011b, Fujiwara et al., 2011, Nam et Wang, 2015, Kamber et al., 2017, parmi d'autres). Le chapitre 3 étudie donc la transmission des cycles économiques générée par ce type de chocs. Nous développons un modèle VAR structurel et la méthodologie d'identification des chocs de nouvelles retenue est celle de Barsky et Sims (2011 & 2017). La modélisation permet ainsi d'étudier les réponses de l'Australie, du Canada, de la Nouvelle-Zélande et du Royaume-Uni aux chocs aux États-Unis. Deux types de chocs sont évalués et comparés: i) un choc de nouvelles et ii) un choc contemporain. L'exécution du modèle sur les données de la période post-Bretton Woods (1973Q1-2016Q4) nous permet d'obtenir des résultats principaux. Premièrement, les chocs de nouvelles de la PGF génèrent des cycles économiques aux États-Unis (le PIB et l'emploi augmentent de 0,3% sur l'impact, l'investissement 1,5% et la consommation 0,2%) alors que ce n'est pas le cas pour le choc contemporain. Deuxièmement, les effets des chocs de nouvelles sur le taux de change réel, les termes de l'échange, les exportations et importations bilatérales entre les petites économies ouvertes et les États-Unis sont différents de ceux des chocs contemporains. Dans le cas d'un choc de nouvelles, les réponses du taux de change réel et des termes de l'échange sont en forme de courbe en J. En revanche, elles sont en forme de « U inversé » dans le cas d'un choc contemporain de la PGF. Face à un choc favorable de la PTF aux États-Unis, les exportations des petits pays ouverts vers les

États-Unis augmentent de façon permanente (les exportations du Canada et du Royaume-Uni vers les États-Unis ont augmenté de 0,4% et de 0,3% sur l'impact, respectivement; les exportations de l'Australie et de la Nouvelle-Zélande ont augmenté de 1,5% après le 5ème trimestre et le 12ème trimestre, respectivement) alors que les importations enregistrent une très légère augmentation dès le début et puis reviennent à zéro. Dans le cas d'un choc contemporain de la PGF, les exportations augmentent puis reviennent rapidement à leur niveau initial après quelques trimestres. Nous ne trouvons aucun effet de ce type de choc sur les importations bilatérales. Troisièmement, les petites économies ouvertes sont affectées par les cycles économiques aux États-Unis générées par les chocs de nouvelles. Après l'augmentation des exportations vers Etats-Unis, le PIB, la consommation, l'emploi et l'investissement des petits pays augmentent. En revanche, les réponses de ces économies ne sont pas significatives dans le cas d'un choc contemporain de la PGF. Ainsi, le troisième chapitre de cette thèse démontre que les chocs de nouvelle, en combinaison avec le commerce bilatéral, peuvent être une source importante du cycle économique international. Il faut que les économies augmentent les échanges avec les pays innovateurs (comme les Etats-Unis) pour profiter les expansions économiques générées par les chocs de nouvelle de la PGF.

La contribution principale de cette thèse est de fournir de preuves empiriques sur la relation entre le commerce et la synchronisation des cycles. Les trois essais nous aident à comprendre plus clairement comment le commerce bilatéral améliore la corrélation des cycles économiques dans les cadres théoriques différents et pourquoi les modèles théoriques ne parviennent pas à reproduire pleinement cette corrélation positive. Cette compréhension est importante pour les implications politiques, notamment dans une zone monétaire où les échanges commerciaux sont fortement encouragés, et le niveau élevé de synchronisation des cycles économiques assure l'efficacité des politiques économiques communes.

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GENERAL INTRODUCTION

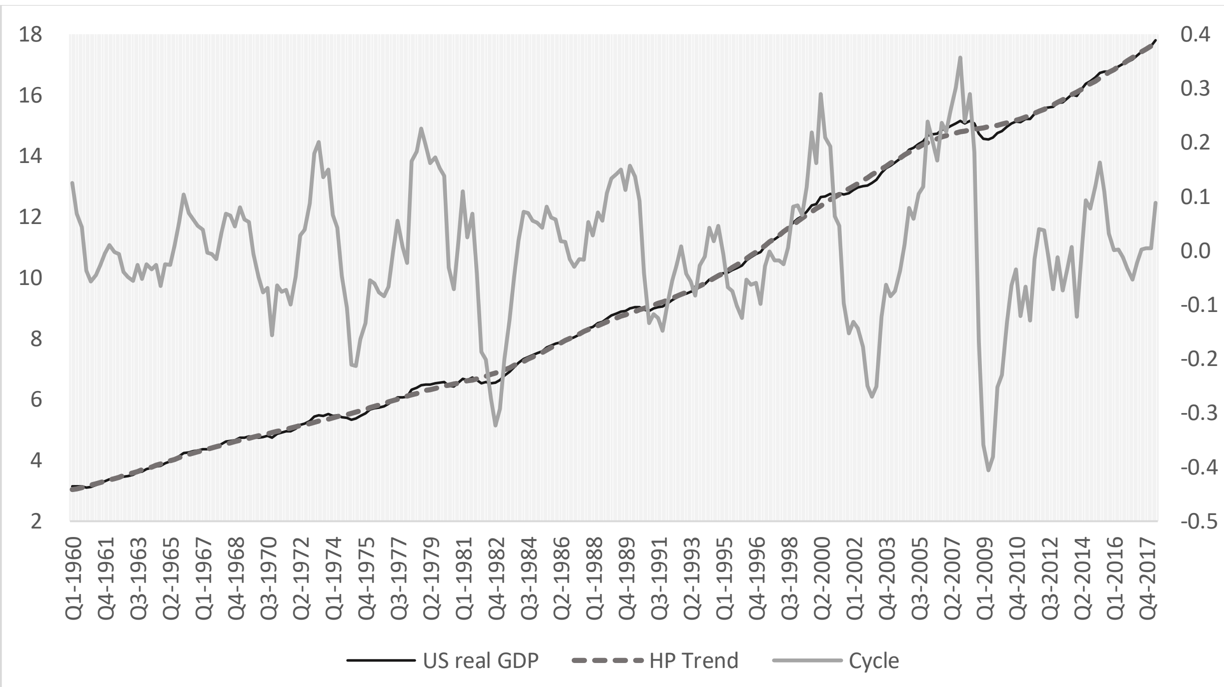
BUSINESS CYCLE SYNCHRONIZATION AND TRADE IN A GLOBALIZING WORLD

In a globalizing world with rapidly increasing trade and financial integration, economies becoming more integrated. While emerging countries could benefit from the economic growth of industrial countries, they could also suffer from the collapses in these economies. A small open economy such as Canada may fluctuate together with its giant neighbor, the United States. A productivity shock in the euro area may influence the employment rate in Central and Eastern European countries (CEECs). Moreover, when China sneezes, others Asian economies catch a cold. The first decade of this century has seen the Great Recession, which affected most countries around the world. The world is increasingly "flat," and many countries' business cycles are converging (Kose et al., 2008, Ductor and Leiva-Leon, 2016).

In macroeconomics, the *business cycle* of an economy is defined as the rises and falls in gross domestic product (GDP) around its long-term trend. More specifically, it describes the series of expansion and contraction periods. These fluctuations originate from uncertainty shocks: policy shock, productivity shock, customer confidence shock, and other demand and supply shocks. Business cycles are usually measured as the *cyclical components* of real output. Figure 0.1 depicts the United States' business cycles and its long-term trend between 1960–2018. The figure clearly indicates the recession periods of the United States' economy over last decades: 1969–1970, 1973–1975, 1980–1982, 1990–1991, 2001–2002 and 2007–2009. These periods are identified as recession time by the Business Cycle Dating Committee (NBER). The *business cycles synchronization* (business cycle comovement) describes the harmonization of real activity fluctuations across countries resulting from the economic integration. In the literature, it is usually measured as the *correlation coefficient* between cyclical components of the real GDP of economies.

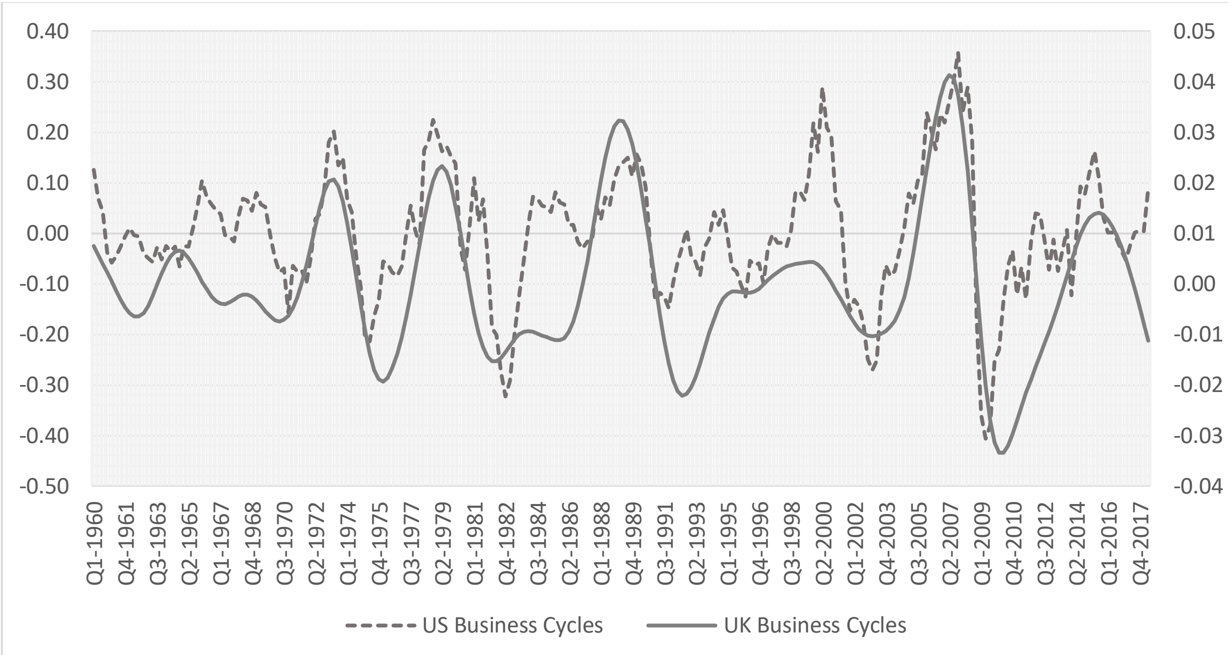
For example, business cycle comovement is illustrated in Figure 0.2, which depicts business cycles of the United States and United Kingdom from 1960–2018. The figure highlights that the United Kingdom's economy went down when the United States' economy experienced recessions. In fact, the output correlation coefficient between these two economies is approximately 0.70 over the considered period.

Figure 0.1 The United States' business cycles, 1960–2018



Notes: Source: Author's calculation based on data extracted from the OECD database. The Hodrick-Prescott (HP) filter is used to detrend the GDP series. Unit: thousands of trillion US 2010 dollars. Axis: The United States real GDP and HP trend correspond to left axis; the United States business cycles corresponds to the right axis.

Figure 0.2 Business cycles of the United States and the United Kingdom, 1960–2018



Notes: Source: Author's calculation based on data extracted from OECD database. The HP filter is used to detrend the GDP series. Unit: thousands of trillion US 2010 dollars. Axis: the United States business cycles correspond to left axis; the United Kingdom business cycles corresponds to right axis.

Business cycle synchronization is an important contemporary subject in international macroeconomics. It has attracted interest from researchers because of its policy implications. For example, when member countries in a common currency area exhibit high levels of GDP comovement, common economic policies have more symmetric impacts and therefore, more success (Mundell, 1961). By understanding the business cycle comovement, one may forecast the extent to which a shock in one country propagates to others. Thus, theorists focus on explaining business cycle comovement. Empirical research has sought evidence on business cycle convergence. For instance, authors such as Otto et al. (2001), Stock and Watson (2005), Kose et al., (2008), Flood and Rose (2010), and Grigoraş and Stanciu (2016), among others, have studied the existence of a *global business cycle*. An international business cycle requires the convergence of macro fluctuations across countries. In other words, output and other macroeconomic aggregates across countries move in the same rhythm. There is evidence that national fluctuations around the world are increasingly correlated, and therefore, an international business cycle may exist (Kose et al. 2008, Ductor and Leiva-Leon, 2016). However, there is also evidence that suggests a decrease in the correlation of cycle components of outputs, or the single business cycle, does not exist (Camacho et al., 2006, Grigoraş and Stanciu, 2016). The existence of a global business cycle is still being debated, although to some extent, economies are moving together.

Several papers have focused on the *globalization* or, notably, the *Europeanization* of the business cycle. These studies have exploited a core-periphery framework to evaluate the convergence of business cycle of peripheries toward core economies. This strand of research includes the works of Crowley (2008), Papageorgiou et al. (2010), Ferreira-Lopes and Pina (2011), Pentecôte and Huchet-Bourdon (2012), and Ahlborn and Wortmann (2018), among others. There is evidence that members of regions around the world experience core-periphery patterns wherein the periphery business cycle converges to the systematic core. However, the definition of "core" remains debated. For example, most studies have used Germany as the proxy for business cycles of the euro area. Other studies have assumed that the main members of this region exhibit a unified business cycle and that the macro aggregates of periphery countries converge accordingly. However, there is limited empirical verification of this assumption.

Another line of research, including studies conducted by Sayek and Selover (2002), Osborn et al. (2005), Chen (2009), Carstensen and Salzmann (2017), Levchenko and Pandalai-Nayar (2018), and Lange (2018), among others, has evaluated the transmission of business cycles by investigating *spillovers* from a specific country or region to another. In these cases, there is evidence that the transmission of business cycle from one economy to others is significant. For instance, Lange (2018) has illustrated that 55% to 70% of a shock to the United States' output gap is transmitted to Canada within the first year after the shock. Using a larger sample, Carstensen and Salzmann (2017) have indicated that 10% to 25%

variance of the G7 countries' output growth is effected by the non-G7-countries' business cycle.

Thus, the transmission and convergence of the business cycles of economies has been well documented in the literature. As such, an important question is, what forces the real output comovement? Frankel and Rose (1998), Clark and Van Wincoop (2001), Fidrmuc (2004), Imbs (2004), Baxter and Kouparitsas (2005), Inklaar et al., (2008), Abbott et al. (2008), Dées and Zorell (2012), and Pentecôte et al. (2015), among others, have addressed this problem. These studies have documented that *trade integration* is one of the most important determinants of business cycle comovement. Moreover, financial integration, industrial specialization, international coordination of monetary and fiscal policy, (horizontal and vertical) foreign direct investment, firm-level linkages, and exchange rate regimes, etc., are also sources of macro aggregates' comovement across countries.

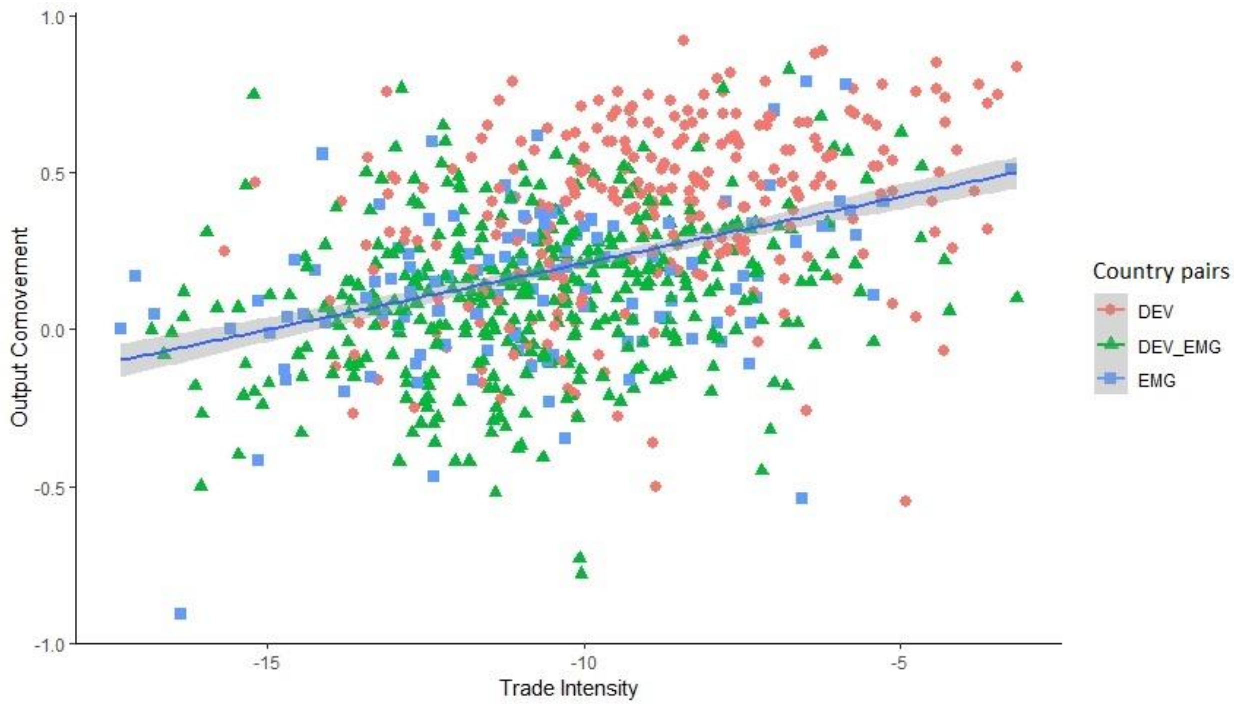
This dissertation focuses on the impacts of bilateral trade on business cycle synchronization. According to World Bank data, world total trade has increased from 17% in 1960 to approximately half of the world GDP in 2017. With this impressive increase over recent decades, the role of trade with respect to economic integration between countries is incontrovertible. Figure 0.3 visualizes the trade-comovement relationship. In fact, the figure summarizes 780 observations from a sample of twenty-four developed countries and sixteen developing countries between 1990 and 2015[4]. As the figure

[4] Data is extracted from OECD, IMF and World Bank databases and concerns 40 countries, including twenty-four developed countries (Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States) and sixteen developing countries (Chile, China, Indonesia, India, Malaysia, Philippines, Argentina, Brazil, Mexico, Turkey, Costa Rica, Romania, Thailand, Uruguay, Bulgaria and Tunisia). Output comovement is measured as the first-differenced correlation of real GDP between two countries. Trade intensity in logarithm is calculated as follows:

$Log(TradeIntensity_{ij}) = Log(\frac{IM_{ij}}{TotalIM_j}) + Log(\frac{IM_{ji}}{TotalIM_i})$ where IM_{ij} denotes import from *i* to *j*, IM_{ji} is import from *j* to *i*, $TotalIM_i$ and $TotalIM_j$ are total import of country *i* and country *j*, respectively.

indicates, there is a positive association between bilateral trade and business cycle comovement. The figure also reveals that developed country pairs (represented by red circles) exhibit higher trade intensity and output comovement than other country pairs (developing country pairs are represented by blue squares and developed-developing country pairs represented by green triangles).

Figure 0.3 Trade intensity and business cycle synchronization for country pair groups, from 1990–2015



Notes: DEV: Developed country pair, DEV_EMG: Developed-Developing country pair, EMG: Developing country pair. Source: Author's calculations based on data extracted from OECD, IMF, World Bank databases. The HP filter is used to detrend the GDP series.

We add to the existing literature by producing empirical evidence regarding how bilateral trade enhances output correlation and why theoretical models fail to fully replicate this relationship. In particular, we focus on three research questions that have received limited or no attention in the existing literature: trade spillover within the same currency area and between different currencies zone, the role of the extensive margin of trade in solving the trade-comovement puzzle, and the transmission of news TFP shocks via trade channels. The first and the last questions relate to the demand-supply spillover channel of trade. The second question addresses the technology transmission channel of trade and the terms-of-trade effect. Therefore, this dissertation studies three mechanisms through which bilateral trade enhances the business cycle synchronization, as documented in the existing literature (Liao and Santacreu, 2015).

The chapters of this dissertation address the aforementioned questions. First, *Chapter 1* focuses on the effects of trade on contagion in the European Union. Twenty years have passed since the creation of the euro area on January 1, 1999. During this time, seven potential candidates have adopted the euro (Greece, 2001, Slovenia, 2007, Cyrus, 2008, Malta, 2008, Estonia, 2011, Latvia, 2014, Lithuania, 2015). It is interesting to study trade spillover effects in a common currency area, especially for new members. It is also interesting to review the endogeneity of the Optimum Currency Areas documented by Frankel and Rose (1998), who have suggested that a common currency increases trade *ex-post* and so, the synchronization of business cycle between members. However, the differences in effects of trade within the same currency area and between different currency zones should also be addressed. As such, Chapter 1 sheds some light on these problems by investigating the *trade spillover effects* and *business cycle interdependences* in the European Union. In particular, we estimate the trade spillover effects of twelve founding members of the euro area on seven CEECs. By running a near-VAR model that captures direct and indirect effects of trade between 1996 and 2015, we determine three main results: the primary economies of the euro area (Germany, France and Italy) diffuse spillover effects on CEECs; CEECs respond more strongly to output shocks in the euro area after becoming members of the European Union in 2004; and, most importantly, the adoption of the euro significantly enhances macro interdependences but without higher trade intensity. Trade intensity increases business cycle synchronization within the same currency area, but the effects are negative for CEECs without the euro. These results reveal that a common currency amplifies trade effects for business cycle interdependences but does not increase trade intensity, especially for periphery members of the common currency area.

Chapter 1 adds to the literature by producing empirical evidence regarding the *demand-supply spillover channel* through which trade enhances output comovement. The demand-supply spillover channel presented in the standard model (Backus et al., 1995) indicates that economies with higher trade intensity are more synchronized because trade increases the demand for foreign (intermediate) goods. More specifically, a positive demand (supply) shock induces an increase in domestic GDP and its demand for import. Therefore, foreign GDP also increases after the shock due to the increase in its export. Hence, the real activity fluctuations in an open economy are transmitted to trading partners. To demonstrate this relationship, Ng (2010) has presented a simple example: suppose that country X exports intermediate goods to country Y. In Country Y, these imported intermediate goods are combined with domestic intermediate goods in processes of production of final goods, which are consumed domestically or exported to country X or a third country, Z. Intermediate goods from country X are complements to country Y's intermediate and final goods. A demand shock occurring in country X, Y or Z requires an increase in final good production, thereby increasing demand for intermediate goods from countries X and Y. The real outputs of countries X and Y will thus increase together and co-move. If country Y experiences a supply shock, the demand for country X's intermediate goods will increase because these goods are also necessary for final goods production. In this case, the real outputs of countries X and Y also increase together. As a result, the demand-supply spillover is a mechanism through which trade positively influences real activity comovement. However, the existing literature has also documented other mechanisms through which bilateral trade enhances output correlation, such as technology transmission and terms-of-trade effect (Liao and Santacreu, 2015). The next chapter explores these two channels to provide more insight into the trade-comovement puzzle (Kose and Yi, 2006).

The second question concerns the *trade-comovement puzzle*. The positive association between trade and output correlation is empirically well-documented. Theoretical models have attempted to replicate this relationship. The trade-comovement puzzle (Kose and Yi, 2006) existing in the literature describes that models are unable to generate trade effects on business cycle synchronization as strong as those observed from the data. Many researchers have tackled the puzzle by employing different methods (Kose and Yi, 2006, Kugler and Verhoogen, 2009, Goldberg et al., 2009, 2010, Johnson, 2014, Liao and Santacreu, 2015, and Juvenal and Santos-Monteiro, 2017, among others). However, they have not been successful in fully producing the theoretical trade effect on output comovement. The puzzle demonstrates that the relation between trade and the real output correlation has yet to be understood. Therefore, *Chapter 2* contributes to understanding the puzzle more deeply by focusing on the *structure of trade*.

Several studies, such as those conducted by Fidrmuc (2004), Shin and Wang (2004, 2005), Cortinhas (2007), Pentecôte et al. (2015), Liao and Santacreu (2015), Duval et al. (2016), and Li (2017), among others, have investigated the effects of trade on business cycle synchronization by examining the structure of bilateral trade. Some articles have decomposed the trade intensity according to its nature and have investigated the effects of each component on comovement. In such cases, the research questions ask: what are the effects of extensive margin and intensive margin of trade on the output correlations? Is trade conducted in gross value or value-added matters? What are the differences in the effects of inter-industry and intra-industry trade on business cycle comovement? For instance, Duval et al. (2016) have re-estimated the relation between trade and output correlation by measuring trade intensity through value-added instead of gross value. They have argued that using the gross value of trade is an inadequate solution due to the growing importance of global supply chains such that countries progressively specialize in stages of production process. Using value-added trade helps net out the intermediate goods trade between countries and also accounts for the third-party effects. Their results, which were obtained from a sample of 63 countries between 1995–2013, have suggested a robust effect of value added of trade on business cycle synchronization. Moreover, this effect increases with the degree of value added intra-industry trade. Pentecôte et al. (2015) have questioned the effect of trading new products between countries. They have exploited approximately

5,000 bilateral trade flows between ten member states of the Economic and Monetary Union (EMU) between 1995–2007, revealing a negative effect of new trade flows on output correlation. However, Liao and Santacreu (2015) have argued that through transmitting knowledge and technology across countries, extensive margin of trade increases the correlation among the trading partner's aggregate productivity and therefore, favors output comovement. Most recently, Li (2017) has re-investigated the difference between the effects of intra-industry and inter-industry trade. The author has proposed that while high inter-industry trade leads to increased industrial specialization, and therefore decreases comovement, higher intra-industry trade induces a higher business cycle synchronization. These results are in line with the findings of Shin and Wang (2005), which have indicated that for European economies, trade integration synchronizes business cycles through intra-industry trade.

Nonetheless, Chapter 2 differs from the existing literature by investigating the effects of extensive and intensive margins of trade on business cycle factor structure. Juvenal and Santos-Monteiros (2017) have suggested that output correlation may be decomposed into three factors: correlation of productivity, correlation of share of expenditure on domestic goods, and correlation between these two factors. However, their model has generated a counter-factual effect of trade on the second factor and therefore, is not completely successful in solving the puzzle. This courter-factual effect of trade comes from the countercyclical terms-of-trade. Liao and Santacreu (2015) have concluded that the extensive margin enhances business cycle synchronization by increasing the correlation of aggregate productivity between trading partners. In this chapter, we question whether trading at the extensive margin generates procyclical terms-of-trade, thereby increasing the correlation of share of expenditure on domestic goods and therefore, business cycle synchronization. Our empirical results, which have been obtained from regressions on a sample of 40 countries over the period 1990–2015, suggest that the extensive margin of trade significantly increases the correlation of expenditure share on domestic goods.

Moreover, the intensive margin of trade has ambiguous effects. These results are robust over various model specifications and may help solve the trade-comovement puzzle.

The trade-comovement puzzle may originate from the sources of business cycle in theoretical models. In other words, the existing literature on the trade spillovers has only focused on traditional shocks, such as demand shock, preference shock or unanticipated productivity shock. Thus, the next chapter brings to the literature an empirical evidence regarding the transmission of news Total Factor Productivity (TFP) shock via trade channel.

The third question concerns the transmission of different *types of shock* via trade channels. The existing literature has documented the empirical evidence on the international transmission of unanticipated TFP shocks (surprise TFP shocks). The transmission mechanism of news about future productivity has not attracted much attention. However, recent developments of the literature on news shock (Beaudry and Portier, 2006, Barsky and Sims, 2011, Nam and Wang, 2015, Levchenko and Pandalai-Nayar, 2018, among others) have added a new viewpoint about the cross-border transmission of business cycle via trade channel. *Chapter 3* sheds light on the differences in trade-based transmissions of the news and surprise TFP shocks. This chapter analyzes trade spillovers of a news TFP shock from the United States, an influential economy, to its four trading partners, Australia, Canada, New Zealand and the United Kingdom. More specifically, we evaluate the responses of macro aggregates of these economies to news and surprise TFP shocks in the United States. The results reveal that the economic booms in the United States generated by news TFP shocks are transmitted to open countries by increasing their exports to the United States. Responses to the surprise TFP shocks are not significant. Two factors that cause the increase of exports from other countries to the United States are increase in the demand of foreign goods in the United States after a positive news TFP shock, and decreased relative price due to the effects of news TFP shock on the terms-of-trade and the real exchange rate. These results suggest that news TFP shock, instead of surprise TFP shock, is a source for the international business cycle.

With an impressive increase in recent decades, the role of bilateral trade on economic integration and business cycle convergence is not negligible. In fact, it has been the subject of large and growing body of literature. Frankel and Rose (1998), who have produced pioneering work on the relationship between trade and output correlation, have documented a positive impact of trade on output correlation. This result have paved the way for a great numbers of studies to investigate the effects of trade on business cycle comovement and how trade integration closes the gap between economies. Some studies have evaluated the direct and indirect trade linkages (Çakır and Kabundi, 2013, Saldarriaga and Winkelried, 2013, Dungey et al., 2018, among others). Meanwhile, others have focused on trade structure and measurement (Fidrmuc, 2004, Shin and Wang, 2004, 2005, Cortinhas, 2007, Pentecôte et al., 2015, Liao and Santacreu, 2015, Duval et al., 2016, Li, 2017, among others). Several researchers have investigated how production fragmentation and trade in intermediate goods increase business cycle comovement (Burstein et al., 2008, Arkolakis and Ramanarayanan, 2009, Giovanni and Levchenko, 2010, Ng, 2010, Takeuchi, 2011, Wong and Eng, 2013, Johnson, 2014, Zlate, 2016, among others). Others have analyzed the relation between trade and the comovement by focusing on the components and measurement of synchronization as well as other approaches (Blonigen et al., 2014, Juvenal and Santos-Monteiro, 2017, Boehm et al., 2014, Cravino and Levchenko, 2015, Kleinert et al., 2015, Giovanni et al., 2016, among others). Most of these studies have highlighted that country pairs that have higher trade intensity also have higher output comovement. This dissertation brings to the existing literature three empirical essays on this relationship. While the first chapter adds to the literature evidence on trade spillover in a common currency area, Chapter 2 adds insight into the trade-comovement puzzle by focusing on trade structure. The final chapter studies trade-based transmission of news TFP shock and highlights the role of this type of shock on business cycle convergence.

Therefore, the main contributions of this thesis include a more clear understanding of the positive impacts of trade on business cycle comovement, which constitutes important policy implications for contemporary international macroeconomics. First, potential candidate countries that have not yet adopted the euro should do it as soon as possible. With a common currency, trade will significantly synchronize their business cycles with the macro fluctuations of existing members. This synchronization will enhance the efficiency of common economic policies and benefits the countries. Without common currency, trade negatively affects comovement. As a result, these countries are de-synchronized from the euro area. Second, since the extensive margin is largely responsible for the positive effects of trade on business cycle comovement, countries should create an environment that encourages firms to exchange more *new products* (decrease the import duties and remove trade barriers for these products, for example) in order to enhance synchronization. Third, countries should increase their trade with *innovation countries* (United States, for example) to benefit from the economic booms generated by the *news productivity shocks*. In a world where information and communication technologies are well developed, news shocks have important effects on the domestic economy and international business cycle convergence.

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CHAPTER 1

THE TRANSMISSION OF BUSINESS CYCLES: LESSONS FROM THE 2004 ENLARGEMENT AND THE EURO ADOPTION

(Paper version of this chapter is accepted for publication in *Economics of Transition and Institutional Change*, forthcoming)

Highlights

This chapter evaluates macroeconomic interdependencies of seven Central and Eastern European Countries (CEECs) with the euro area (EA) through trade relationship. We investigate the demand-supply spillover channel of trade by running a near-VAR model and simulating responses of activity in those CEECs to output shocks for twelve former members of the EA before and after the 2004 enlargement of the European Union (EU). During both periods, empirical results show that spillover effects come through the main economies of the EA: Germany, France and Italy. Furthermore, CEECs are more responsive to output shocks in the EA after 2004 than before (3.3 times larger on average). Increases in spillover effects are larger for the three CEECs that adopted the Euro early (Slovenia, Slovakia, and Estonia) than the other CEECs (4.9 versus 2.1) but without higher trade intensity with the EA (1.07 versus 1.12). Our results show that trade effects are positive inside the same currency area but negative for the CEECs without the euro.

JEL Classifications: F13, F15, F45

Keywords: Trade Spillovers, Enlargement, European Union, Euro, Near-VAR, OCA

1.1. Introduction

Business cycle transmission is a key issue specifically in the context of monetary integration. Large spillover effects can dampen asymmetric shocks and increase business cycle synchronization. This is a particular issue for CEECs after the Treaty of Accession[5] with the European Union (EU), on 1 May 2004. Some of these new member states have since adopted the Euro: Slovenia (2007), Cyprus and Malta (2008), Slovakia (2009), Estonia (2011), Latvia (2014) and Lithuania (2015), while their neighbors did not yet. One may thus ask whether these divergent attitudes towards European monetary integration had any impact on their ability to limit output losses from excessive business fluctuations.

As stated by the Optimum Currency Area theory (OCA, Mundell, 1961) countries with a high degree of business cycle comovement may benefit from adoption of a common currency. In this case, the costs of monetary integration are lower than the benefits. For McKinnon (1963) and Kenen, (1969), trade integration reduces exposure of countries to asymmetric shocks, and so reduces costs of currency unification. A large literature confirms the positive effects of trade on business cycle synchronization (Clark and van Wincoop, 2001, Imbs, 2004, Baxter and Kouparitsas, 2003, 2005, Dées and Zorell, 2012, Gouveia and Correia, 2013, among others). Even if trade integration is not large enough before monetary integration, an endogeneity effect of OCA can occur: the monetary unification increases trade *ex post* and so synchronization (Frankel and Rose, 1998). However, for Krugman (1993), trade integration should increase sectoral specialization and asymmetric shocks.

This chapter focuses on business cycle transmission from the euro area (EA) to the CEECs. We evaluate the responses of CEECs (CEECs-7) to an industrial production shock originating from the twelve initial members of the EA (EA-12) and we investigate how CEECs that have adopted the euro react differently to EA shocks than the other CEECs

[5] This included eight Central and Eastern European countries (the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia), and two Mediterranean countries (Malta and Cyprus).

countries. We relate these responses to changes of trade intensity with the EA. Two main contributions emerge from this study: first, we find that Slovenia, Slovakia and Estonia, three CEECs using the euro, react more strongly to the output shock from the EA economies. Second, those changes in economic integration are not correlated with trade intensity with the EA. CEECs using the euro are more sensitive to the EU shocks even if changes of their trade intensity to the EA are the same as the other CEECs. In other words, adopting the euro does not increase trade intensity but magnifies the effects of trade spillover. Spillover effects of trade are positive within the same currency area (from the EA to Slovenia, Slovakia and Estonia) but not between two currency areas (from the EA to the Czech Republic, Hungary, Lithuania, and Poland).

The chapter is structured as follows. The next section reviews the main studies concerning integration of the CEECs into the EU. The third section describes the econometric methodology, and the required data. The fourth section describes and assesses the empirical results: *i)* the effects of the 2004 Enlargement on spillovers, *ii)* the origins of the spillovers, and *iii)* the effects of the Euro on spillovers. The final section presents the conclusion.

1.2. Literature Review

Beginning in the late 1990s, several studies tried to evaluate the degree of business cycle synchronization between CEECs and the EA (see Fidrmuc and Korhonen, 2006, for a survey). Most of those studies found a different level of integration between CEECs. Boone and Maurel (1999) found that CEECs' economic cycles were close enough to those of the EU for a monetary union. And this was particularly the case for Hungary, Poland and Slovakia. For Fidrmuc and Korhonen (2003), only Hungary exhibits a high degree of business cycle correlations with EA. Korhonen (2003) showed that EU shocks could explain a large part of business cycles in Hungary and in Slovenia. But smaller CEECs are less sensitive to EA shocks. For Fidrmuc and Korhonen (2006), "*Many new EU member states have achieved a relatively high degree of business cycle correlation with the euro* *area. This seems to be especially true for Hungary, Poland and Slovenia*". After the 2004 enlargement, Artis et al. (2008) found that the business cycles of Hungary, Slovenia and Poland run parallel to the business cycle of the euro. Jimenez-Rodriguez et al. (2010) use a near-VAR model to investigate the impact of interest rate, commodity price and industrial production shocks on macroeconomic variables for ten CEECs over the period from the early 1990s to 2009. They suggest that some countries (Slovakia and Slovenia) – already euro area members – react more strongly to foreign activity shocks than other economies. In another study (Jimenez-Rodriguez et al., 2013), these authors find the same result: Slovakia and Slovenia exhibit a high degree of concordance with the European business cycle. The degree of concordance is similar to that of the Netherlands or Spain. Siedschlag (2010) analysed a sample of 171 pairs of countries of the Eurozone and CEECs over the period 1990-2003. Her empirical findings suggest that bilateral trade increases the similarity of business cycles. The IMF's spillover report (2012, p.6) indicated a positive relationship between real output in the EA and GDP fluctuations in Central, Eastern and South-eastern Europe regions via trade channels. Stanisic (2013) studied co-movements of the CEECs' GDPs and showed that there is no common business cycle between CEECs, although a synchronization trend is obvious with the EA. Keppel and Prettner (2015) developed a theoretical framework based on the structural vector error correction model to evaluate the effects of shocks to some variables (output, interest rates and exchange rate) on the EA and CEECs. Their results show strong spillovers of output shocks across regions. Recently, Di Giorgio (2016), using a Markov switching auto-regressive model, has rejected the hypothesis of the independence of CEECs' cycles from the EA cycle.

1.3. Model Specification and Data

A near-VAR model is exploited to take into account the degree of trade integration (the econometric strategy is similar to Abeysinghe and Forbes, 2005, and Dungey et al., 2018). This near-VAR model allows us to capture both the direct and indirect spillover effects of trade.

Considering a sample with n economies, which interact through bilateral trade relationships, the output of a country i can be decomposed in the following way:

$$Y_i = A_i + \sum_{j=1}^{n-1} X_{ij} - M_i \text{ with } (j \neq i) \qquad (1.1)$$

whith Y_i denoting output of country i, A_i being domestic demand, M_i referring to import of country i and X_{ij} to export from country i to country j.

Let us assume that domestic demand and imports depend on domestic output ($A_i = A_i(Y_i)$ and $M_i = M_i(Y_i)$ where $0 < \frac{\partial A_i}{\partial Y_i} < 1$ and $0 < \frac{\partial M_i}{\partial Y_i} < 1$), and that exports from country i to country j in the short run depend on country j's output ($X_{ij} = X_{ij}(Y_j)$ where $\frac{\partial X_{ij}}{\partial Y_j} \geq 0$). Then equation (1.1) can be expressed in terms of growth rates as:

$$\frac{\Delta Y_i}{Y_i} = a_i \varepsilon_{Y_i}^{A_i} \frac{\Delta Y_i}{Y_i} + \sum_{j=1}^{n} \theta_{ij} x_i \varepsilon_{Y_j}^{X_{ij}} \frac{\Delta Y_j}{Y_j} - m_i \varepsilon_{Y_i}^{M_i} \frac{\Delta Y_i}{Y_i} \qquad (1.2)$$

where $a_i = \frac{A_i}{Y_i}$, $\theta_{ij} = \frac{X_{ij}}{X_i}$, $x_i = \frac{X_i}{Y_i}$, $m_i = \frac{M_i}{Y_i}$ and ε_H^G refers to the elasticity of variable G with respect to H.

Assuming also that each country i has the same elasticity of exports with respect to foreign activities for all countries j, we have $\varepsilon_{Y_j}^{X_{ij}} = \varepsilon_{Y_i^e}^{X_i}$ where Y_i^e is the international demand of country i's goods. Under these assumptions, equation (1.2) can be re-written as follows:

$$\frac{\Delta Y_i}{Y_i} = a_i \varepsilon_{Y_i}^{A_i} \frac{\Delta Y_i}{Y_i} + \sum_{j=1}^{n} \theta_{ij} x_i \varepsilon_{Y_i^e}^{X_i} \frac{\Delta Y_j}{Y_j} - m_i \varepsilon_{Y_i}^{M_i} \frac{\Delta Y_i}{Y_i}$$

Finally, using small letters for growth rates:

$$y_i = \beta_i y_i^e \qquad (1.3)$$

where $y_i = \frac{\Delta Y_i}{Y_i}$, $\beta_i = \frac{x_i \varepsilon_{Y_i^e}^{X_i}}{1 - a_i \varepsilon_{Y_i}^{A_i} + m_i \varepsilon_{Y_i}^{M_i}}$ and $y_i^e = \sum_{j=1}^{n} \theta_{ij} y_j$ ($j \neq i$).

Equation (1.3) constitutes a theoretical framework that will provide the bases for the development of a constrained VAR model to estimate the transmission of shocks.

Our model (1.3) is rewritten as a dynamic equation capturing both the adjustment of domestic GDP of country *i* and the response of exports from country *i* to country *j* to fluctuations in the country *j*'s output:

$$g_i(L)y_{i,t} = h_i(L)y_{i,t}^e + u_{i,t} \quad (1.4)$$

where, $g_i(L) = 1 - g_{i,1}L - \cdots - g_{i,P_i}L^{P_i}$, $h_i(L) = h_{i,0} + h_{i,1}L + \cdots + h_{i,q_i}L^{q_i}$, $i=1,\ldots n$ and $u_{i,t}$ is a residual term.

Using a matrix form including equations for all countries, the model can be written as follows:

$$G(L)Y_t = H(L)Y_t^e + U_t = H(L)\Theta Y_t + U_t \quad (1.5)$$

where $G(L) = \begin{bmatrix} g_1(L) & 0 & 0 \\ 0 & \ldots & 0 \\ 0 & 0 & g_n(L) \end{bmatrix}$, $\quad H(L) = \begin{bmatrix} h_1(L) & 0 & 0 \\ 0 & \ldots & 0 \\ 0 & 0 & h_n(L) \end{bmatrix}$,

$$\Theta = \begin{bmatrix} \theta_{11} & . & . & . & \theta_{1n} \\ . & . & . & . & . \\ . & . & . & . & . \\ . & . & . & . & . \\ \theta_{n1} & . & . & . & \theta_{nn} \end{bmatrix}$$

$Y_t = \left(y_{1,t}, \ldots, y_{n,t}\right)'$, $Y_t^e = (y_{1,t}^e, \ldots, y_{n,t}^e)'$ and $U_t = (u_{1,t}, \ldots, u_{n,t})'$.

The constrained VAR model is finally determined by imposing *n(n-2)* restrictions on each coefficient matrix of the VAR model:

$$\emptyset(L)Y_t = U_t$$

where $\emptyset(L) = G(L) - H(L)\Theta$, $\emptyset(L) = \emptyset_0 - \emptyset_1 L - \ldots - \emptyset_p L^p$, and $p = \max(p^i, q^i)$. Entries of the matrix $\emptyset(L)$ are given by $\phi_{ij}(L) = -h_i(L)\theta_{ij}$ for $i, j = 1,2, \ldots, n$ and $i \neq j$ and by $\phi_{ii}(L) = g_i(L)$ for $i = 1, \ldots, n$.

The impulse response functions are computed from the VMA form of the model:

$$Y_t = \emptyset^{-1}(L)U_t = \Psi(L)U_t \quad (1.6)$$

where $\Psi(L) = \Psi_0 + \Psi_1 L + \ldots$ and $\Psi_{k,(i,j)} = \frac{\partial y_{i,t+k}}{\partial u_{j,t}}$.

The matrix of cumulative multiplier effects over h periods in response to an innovation of output is then obtained by:

$$Mh = \sum_{s=1}^{h} \Psi_s \qquad (1.7)$$

From this model, we evaluate responses of seven CEECs to output shocks in the twelve initial members of the euro area. We use the cumulative multiplier effects given by equation (1.7) to evaluate how CEECs are exposed to output fluctuations in the euro area. This model includes all bilateral trade relationships between members of the euro area and CEECs and therefore captures the direct and indirect transmissions of shocks. For example, an output shock to Germany not only impacts the GDP of Poland via direct bilateral trade between these two countries, but also spills over to Poland by influencing the economic activity elsewhere via bilateral trade between Germany and these third countries.

The sample consists of seven CEECs - the Czech Republic, Estonia, Hungary, Lithuania, Poland, Slovakia and Slovenia (CEECs-7) and the twelve founding members of the euro area - Austria, Belgium, Finland, France, Germany, Greece, Ireland, Luxembourg, the Netherlands, Italy, Portugal, and Spain (EA-12) - from January 1996 to September 2015. The choice of the sample is based on data availability. The monthly industrial production index (IPI) is used as a proxy for economic activity (data come from the OECD database and DataStream). The growth rate is given by the first difference of the logarithm of the IPI. Dickey-Fuller tests indicate that these series are stationary. The bilateral export share is the average of annual data over the studied period, and exports are extracted from the World Integrated Trade Solution database. To capture economic fluctuations in the rest of the world, we also introduce an exogenous variable computed as the export share-weighted output of the main economies: China, Japan, South Korea and India in Asia; United States, Canada, Brazil and Mexico in America and Russia, Denmark, Norway, Sweden and United Kingdom in Europe. This is done for each equation of the model. In this way, we capture from 75% (Slovenia) to 91% (Slovakia) of the total exports of the CEECs-7 economies.

Lag length selection is based on Akaike's Information Criterion (AIC) for each specific variable in the model. Lags cannot exceed twelve months.[6] The Jarque-Berra tests and Ljung-Box tests are run to check for the normality and the non-autocorrelation of residuals, respectively. Lag lengths are then adjusted to correct for the residual auto-correlation issue. Because lag lengths in each equation of the system are different and because exogenous variables are given by output variables weighted by trade shares, the model is estimated by the Seemingly Unrelated Regressions (SUR) method rather than Ordinary Least Squares (OLS).

We first begin by estimating the model over the period from January 1996 to September 2015. While the assumption of non-autocorrelation of residuals is satisfied for all countries, residuals are normally distributed only in the equations of Germany, the Netherlands, Portugal and Italy (see Table 1.A.1 in the Appendix).

We then perform Chow tests in order to determine whether structural breaks of coefficients exist in May 2004. The trade spillover effects from the euro area to CEECs are expected to change after the largest enlargement of the European Union. As shown in Table 1.A.2 (Appendix), only the estimated coefficients for Estonia and Poland are not significantly constant over time. However, Jiménez-Rodríguez et al. (2010), using the method proposed by Wang and Zivot (2000) to detect structural breaks in industrial production of CEECs from 1990 to 2009, find significant breaks around 2004 (in August 2005 for Poland, in February 2002 for Estonia, in November 2003 for the Czech Republic, in January 2004 for Slovakia and in August 2001 for Slovenia). These results support our intuition that the model should be estimated on two sub-periods: pre- and post-accession. Furthermore, we perform many Chow tests for the introduction of the euro: January 2001

[6] We also tried to estimate the model based on the Bayesian Information Criterion (BIC) with fixed or varying lags of specific variables. However, these models seem to be less efficient according to our data.

for Greece and January 1999 for other founding members of the euro area; the dates that Slovenia, Slovakia, and Estonia switched to the euro in January 2007, January 2009, and January 2011, respectively; September to December 2008 for the Global Financial Crisis in 2008-09; and finally the sovereign debt crisis in Europe in September 2012. Results in Table 1.A.2 reveal that the null hypothesis of no structural break cannot be rejected for all tested dates (except for Italy in 2008).

We therefore estimate the near-VAR model over two sub-periods: from January 1996 to April 2004 and from May 2004 to September 2015. All of the series of residuals are not auto-correlated according to the Ljung-Box test. The normal distribution assumption is not statistically rejected in most of those economies. One of the most important tests in the VAR model is the cross-correlation of residuals test. The matrix of cross-correlations of residuals is presented in Table 1.A.3 (Appendix). Only 4% of correlations are greater than 30% in the pre-accession model. This number shrinks to 2.3% during the post-accession period.

The hypothesis of non-correlation of residuals is tested by the Breusch-Pagan procedure: $\lambda = n\sum_{k=1}^{n}\rho_k$ where ρ_k are correlations in ascending order, λ follows a Chi-squared distribution and $1 \leq n \leq 171$ (since the maximum number of correlations in a model using 19 dependent variables is 171). Results of the performed tests for all values of n indicate that only 11% of correlations are significantly different from zero for both pre- and post-accession models.

1.4. Empirical Results

1.4.1. Effects of the 2004 Enlargement on Spillovers

Running estimation of the near-VAR model on the two sub-periods, before and after the accession, allows us to compare the impulse responses of seven CEECs when facing an output shock of one standard error in the twelve initial members of the euro area. We calculate the multiplier effects as cumulative impulse responses over 24 months (M24, see equ.1.7) and report these in Table 1.A.4.

Two conclusions can be drawn from these results. Firstly, all impulse responses of CEECs are positive in both periods. This result indicates that the model captures the transmission of *demand shocks*. During the pre-accession period, we obtain a maximum multiplier effect of 1.71% when Lithuania adjusts to an output shock in Germany and a minimum of 0.03% when the Czech Republic reacts to a shock in Finland. Furthermore, whereas variations in growth of industrial production of CEECs converge to zero after 8 to 10 months during the pre-accession period, reactions are more persistent following the enlargement. Effects remain significant, on average, up to 20 to 24 months during this period.

Secondly, multiplier effects increase in the period following the enlargement of the European Union and are consistently correlated with trade intensity. Table 1.1 reports the changes in multiplier effects and in trade intensities: R_{M24} denotes the ratio of estimated multiplier effects during the post-accession period over multiplier effects during the pre-accession period, or more formally:

$$R_{M24} = \frac{M24(post - accession)}{M24(pre - accession)}$$

Trade intensity is calculated as:

$$TI_{ij} = \frac{EX_{ij} + IM_{ij}}{Y_i}$$

where EX_{ij} is the average of exports of country *i* to country *j* over the sample period, IM_{ij} is the average of imports of country *i* from country *j*, and Y_i is the average of output of country *i*. This trade intensity variable represents the share of bilateral trade with country *j* in output and measures the degree of trade integration of country *i* with country *j*. Similar to R_{M24}, R_{TI} in Table 1.1 measures changes in trade intensity between each CEEC with the euro area members after/before the enlargement.

Table 1.1 Multiplier effects and trade intensity after/before 2004

	CZE		EST		HUN		POL		SVK		SVN		LTU		Correlations
	R_{M24}	R_{TI}	R_{M24}	R_{TI}	R_{M24}	R_{TI}	R_{M24}	R_{TI}	R_{M24}	R_{TI}	R_{M24}	R_{TI}	R_{M24}	R_{TI}	(R_{M24};R_{TI})
AUT	2.53	0.98	*4.08*	*0.98*	0.71	0.82	2.26	1.39	4.57	1.12	2.58	1.27	0.79	1.11	0.16
BEL	2.86	1.22	4.24	1.07	0.87	0.90	2.46	1.18	5.21	1.19	2.85	1.32	0.78	1.57	-0.18
FIN	7.94	1.07	10.38	*0.64*	2.39	0.62	6.84	1.00	14.44	1.21	7.80	1.02	*2.77*	*0.98*	0.45
FRA	3.52	1.36	5.12	1.07	1.09	1.14	3.05	1.29	6.41	2.15	*3.40*	*0.88*	0.94	1.05	0.64
DEU	6.29	1.10	*9.57*	*0.92*	1.97	1.05	5.51	1.24	11.54	1.32	6.19	1.00	*1.78*	*0.90*	0.46
IRL	2.41	1.05	*3.49*	*0.60*	0.74	0.72	2.17	1.52	4.59	1.53	2.47	1.19	0.66	0.78	0.47
ITA	3.52	1.19	*5.20*	*0.81*	*1.10*	*0.90*	3.08	1.13	6.38	1.10	3.39	1.05	0.97	1.14	-0.10
LUX	2.09	1.22	3.04	1.84	0.66	1.26	1.85	1.63	3.91	1.44	2.15	1.37	0.59	1.02	0.62
NLD	4.78	1.39	*7.14*	*0.78*	1.46	1.20	4.12	1.31	8.89	1.59	4.77	1.31	1.31	1.45	-0.06
PRT	2.64	1.89	*3.82*	*0.69*	0.81	0.99	2.26	1.23	4.82	2.56	2.63	2.11	*0.72*	1.34	0.46
ESP	4.47	1.64	6.52	1.24	1.41	1.46	3.93	1.55	8.32	1.90	4.41	1.43	1.22	1.54	0.33
GRC	2.48	1.03	3.59	1.13	0.79	1.38	2.18	1.58	4.61	2.13	2.50	1.54	0.68	0.54	0.65
EA-12	3.41	1.15	5.14	0.78	1.05	1.02	2.97	1.25	6.23	1.36	3.33	1.07	0.95	1.07	0.18

Notes: (i) AUT-Austria, BEL-Belgium, FIN-Finland, FRA-France, DEU-Germany, GRC-Greece, IRL-Ireland, ITA-Italy, LUX-Luxembourg, NLD-Netherlands, PRT-Portugal, SPA-Spain, EST-Estonia, HUN-Hungary, LTU-Lithuania, POL-Poland, CZE- Czech Republic, SVK-Slovakia, SVN, Slovenia.

(ii) R_{M24} represents the ratio of IRFs after/before 2004 enlargement for the country in column to a shock of the country in row.

(iii) R_{TI} represents variation (after/before 2004 enlargement) of trade openness between the country in column and the country in row.

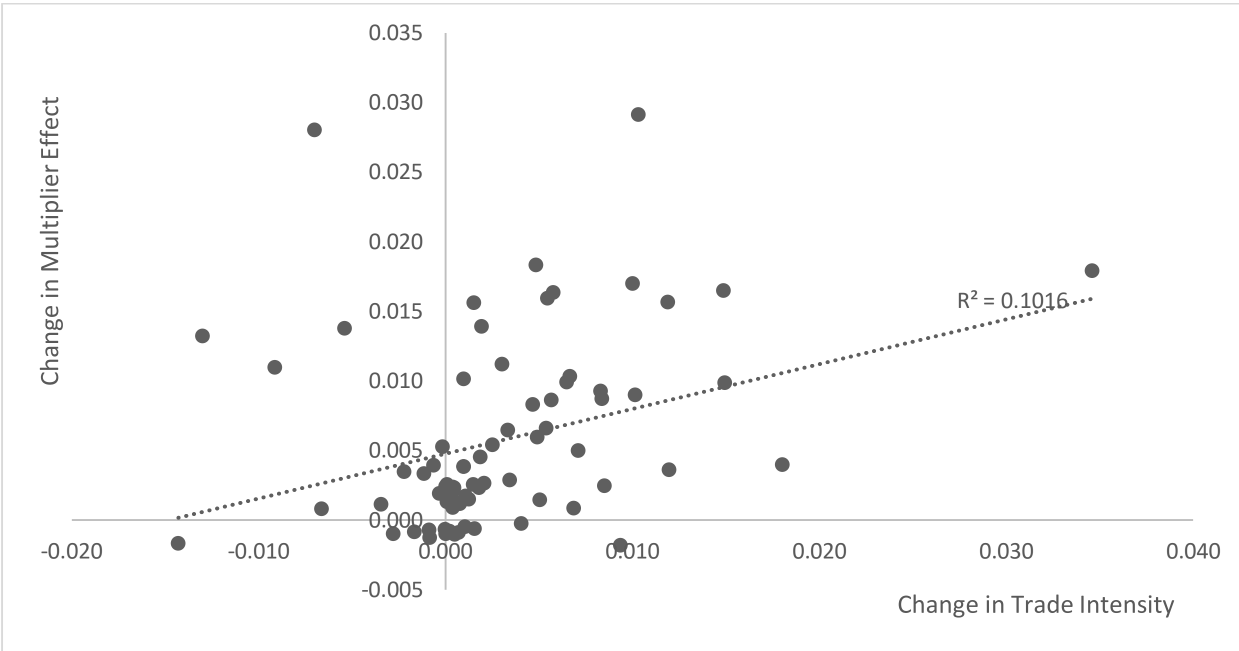
(iv) In italics, R_{M24} higher than 1 and a R_{TI} value lower than 1.

In comparison with the pre-accession period, the Czech Republic, Estonia, Poland, Slovakia, and Slovenia significantly enhance their macroeconomic integration with the euro area. These economies react more strongly and persistently to the economic fluctuations in the monetary union after becoming European Union members than before. All R_{M24} of these countries are greater than 1. The biggest rise is 14.44 fold and concerns the 24-month ahead cumulated responses of Slovakia to an output shock in Finland. Lithuania responds more strongly to an output shock in Germany, the Netherlands, Spain and Finland. However, trade spillover effects from France to this economy did not change. Moreover, multiplier effects decrease when facing a shock in other EA-12 members. Also, Hungary reacts more strongly to a shock to the major countries in the euro area such as Germany, the Netherlands, Spain, France, Italia and Finland. Multiplier effects decrease when output shocks occur in other EA-12 economies.

The results in Table 1.1 also reveal that most of the changes in multiplier effects are correlated with changes in trade intensity. Less than 24% of pairs (reported in italics) combine a value of R_{M24} higher than one and a R_{TI} value lower than one. These cases mainly occur for Estonia and Lithuania and could be explained by larger indirect trade contagion than direct trade contagion. According to Table 1.1, it seems that the increase in trade intensity after the accession in European Union significantly increases trade spillover effects. The last column of Table 1.1 presents correlations between changes in the multiplier effect and changes in trade intensity. Except for shocks in Belgium, Italy and the Netherlands, correlations are positive and range from 0.16 to 0.65. These results indicate that the CEECs-7 are generally more affected by the EA-12 countries' shocks since 2004 and this greater responsiveness is correlated with the increase in trade openness.

Figure 1.1 presents the relation between the changes in trade intensity and that of multiplier effects. The changes are now defined as the differences in trade intensity and in multiplier effects between two periods. Since most of points locate in the first quadrant of the Figure, trade intensity between the CEECs-7 and the EA-12 as well as the multiplier effect mostly increase following the enlargement. The Figure also shows a positive relation between these two variables. The changes in trade intensity explain about 10% the changes in multiplier effects. That supports the conclusion above.

Figure 1.1 Change in multiplier effect and change in trade intensity

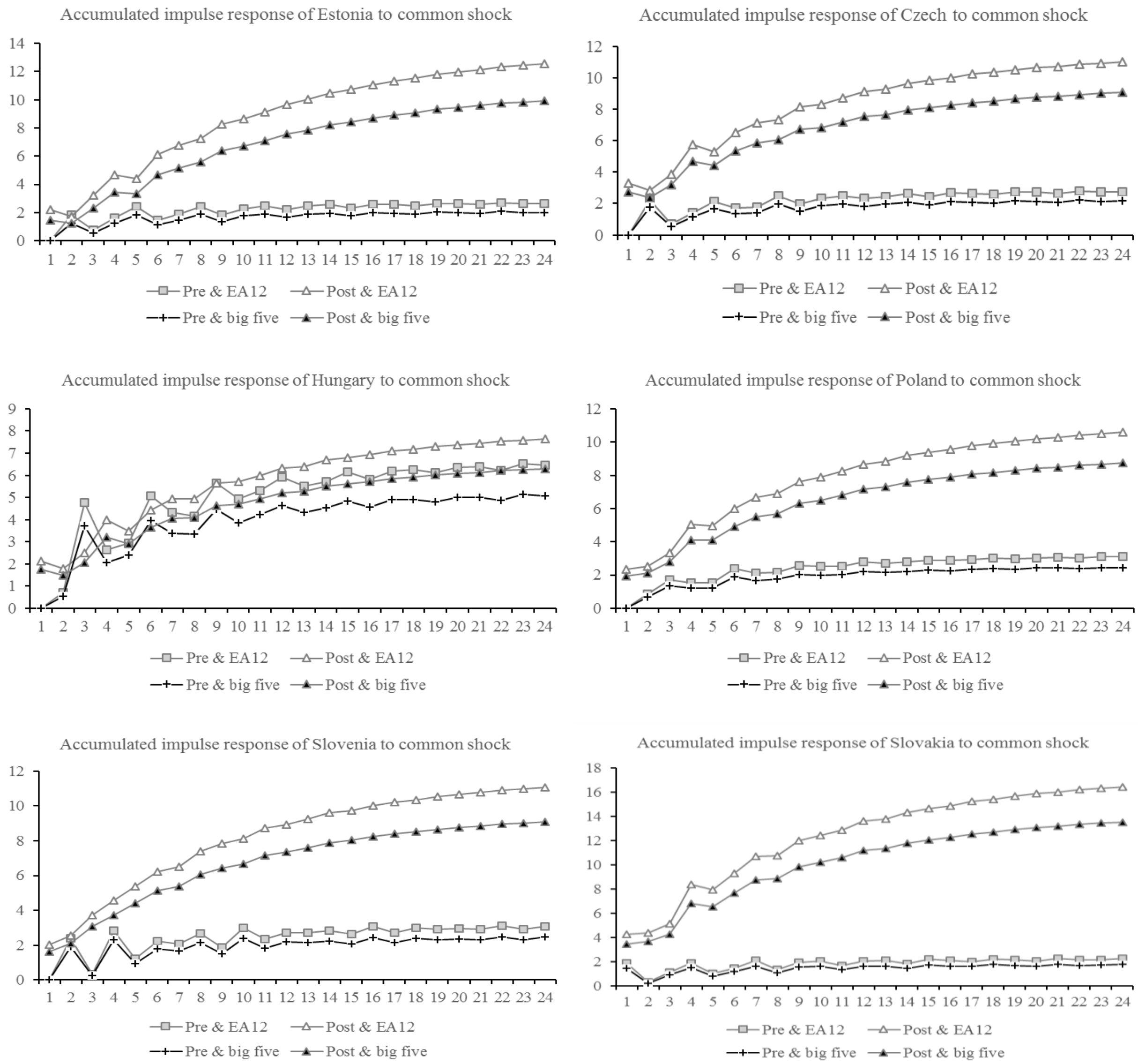


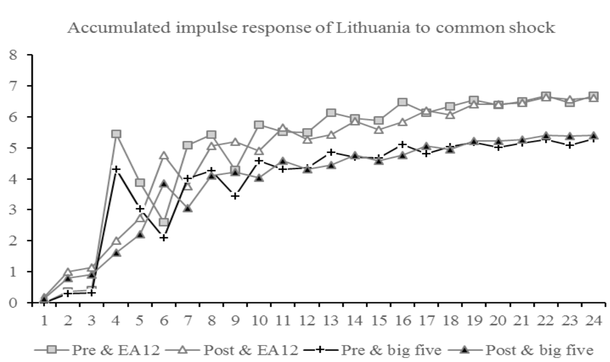
Counter-factual shocks

To see how CEECs react to a common shock occurring to all twelve founding members of the euro area, we perform a counterfactual exercise wherein shocks simultaneously occur to these countries (EA-12 shock). We also simulate a counterfactual exercise that five biggest economies in terms of GDP including Germany, France, Netherland, Italy and Spain diffuse positive shocks at the same time (big-five shock). The cumulative responses of CEECs in both two periods before and after 2004 are presented in Figure 1.2. Estonia, Czech Republic, Poland, Slovakia and Slovenia respond strongly to the EA-12 shock in the period after the enlargement. In the same period (before or after 2004), the responses of these countries to the EA-12 shock are logically more important than their responses to the big-five shock. However, the role of five biggest members of the euro area become more important following the enlargement. The responses of industrial production of five CEECs to the big-five shock after 2004 are more significant than their responses to the EA-12 shock before 2004.

The cumulative responses of Hungary and Lithuania tell a different story. For these countries, differences between the responses to the EA-12 common shock and that to the big-five common shock are not large. In other words, the influences of small economies in the euro area on these countries are negligible. This finding is discussed in more detail in the following section. The responses of Hungary to both common shocks are more important following the enlargement. In the case of Lithuania, the responses to the EA-12 common shock and to the big-five common shock seem to have not differences between two periods. In sum, the common demand shocks to the EA-12 and the five biggest economies of the euro area are transmitted to the CEECs and generate positive reaction of the industrial production in these economies. The reactions are different for each CEEC and for each case the shock is stimulated.

Figure 1.2 Responses of CEECs to common shocks





Notes: *Pre & EA12*: Responses to common shock to the EA12 before 2004; *Post & EA12*: Responses to common shock to the EA12 after 2004; *Pre & big five*: Responses to common shock to five biggest members of the euro area before 2004; *Post & big five*: Responses to common shock to five biggest members of the euro area after 2004.

1.4.2. The Origins of the Spillovers

In this section, we question which economies from the EA-12 most significantly influence CEECs in both the pre-accession and post-accession period. To this end, we compute a GDP-weighted multiplier effect as follows:

$$\widetilde{R_{M24_J}} = \frac{\widetilde{WM24_J}}{WM24_j}$$

where $WM24 = \sum_{i=1}^{7} M24_i * GDP_i$ and $\widetilde{WM24} = \sum_{i=1}^{7} \widetilde{M24_i} * GDP_i$. $M24_i$ represents the cumulative impulse response of CEE country *i* over 24 months to a common shock occurring in the euro area and GDP_i is the GDP share. $\widetilde{WM24_i}$ is equal to the 24-month ahead cumulative impulse response of CEE country *i* to a common shock occurring in the euro area when exports of the founding member *j* are set to 0. The lower $\widetilde{R_{M24_J}}$ is, the higher the contribution of country *j* is in explaining contagion effects of EA shocks. Results are presented in Table 1.2.

According to Table 1.2, the main economies in terms of GDP in the euro area explain a large part of these macroeconomic interdependencies. Germany, France, Italy and Spain considerably impact the CEECs over the period 2004-2015. Excluding the bilateral trade of Germany from the model induces a decrease in the average of multiplier effects of CEECs to a common shock in the EA by 88% and 89% over the pre-2004 and post-2004 periods, respectively. These numbers shrink to 69% and 71% (respectively) if we impose the bilateral trade of France to be zero. We also find that the Netherlands and Belgium play an important role in propagating output shocks to CEECs before 2004. Excluding bilateral trade of these two countries leads to a decrease of 75% and 44% in trade spillover effects for Belgium and 53% and 40% in the Netherlands. The smallest economies in the euro area, such as Luxembourg, Greece, Ireland and Finland have negligible impacts.

To sum up, the Czech Republic, Estonia, Poland, Slovakia, and Slovenia are more and more integrated into the EA since their accession to the European Union in 2004. The responses of Lithuania and Hungary, however, only increase when output shocks come from the largest economies in EA-12. The latter economies of the EA have a high degree of diffusion of output shocks to CEECs, especially after the enlargement of the European Union in 2004.

Table 1.2 Degree of shock diffusion and Ranking

	$\widetilde{R_{M24j}}$		Rank	
	Pre-2004	Post-2004	Pre-2004	Post-2004
GER	0.12	0.11	1	1
FRA	0.31	0.29	3	2
ITA	0.57	0.31	6	3
SPA	0.52	0.47	5	4
BEL	0.25	0.56	2	5
NLD	0.47	0.60	4	6
AUT	0.57	0.67	7	7
PRT	0.88	0.81	10	8
FIN	0.84	0.83	9	9
GRC	0.89	0.93	11	10
LUX	1.00	0.94	12	11
IRL	0.64	0.98	8	12

Note: AUT: Austria, BEL: Belgium, FIN: Finland, FRA: France, GER: Germany, GRC: Greece, IRL: Ireland, ITA: Italia, LUX: Luxembourg, NLD: the Netherlands, PRT: Portugal, SPA: Spain

1.4.3. Effects of the Euro on Spillovers

We determine which CEECs are significantly impacted by output shocks in EA-12 members and if adopting the euro matters for trade spillover effects. To show evidence on the average impulse response of CEECs-7 to EA-12, we use the following index:

$$W2M24_i = \sum_{j=1}^{12} M24_{ij} * GDP_j$$

where GDP_j is the GDP share of country j in the EA-12 region, and $M24_{ij}$ is the multiplier effect of the CEE country i of an output shock in country j. Results are reported in Table 1.3.

We note that responses of CEECs are different between the two sub-periods: before the accession to the European Union, Lithuania, Poland and Hungary are more significantly impacted by EA shocks whereas the smaller economies respond more significantly during the post-accession period. The main result is that the ranking is totally reversed: Lithuania, Hungary and Poland are the top 3 countries before 2004 while the top 3 group is composed of Slovenia, Slovakia and Estonia after 2004. The cumulative impulse responses of these economies are 0.36%, 0.40% and 0.49%, respectively, during the pre-2004 period compared to 3.27%, 2.98% and 2.37% during the subsequent period. Those three countries adopted the Euro in 2007 (Slovenia), 2009 (Slovakia) and 2011 (Estonia). These empirical results provide evidence that euro adoption significantly increased the macroeconomic interdependencies of CEECs with the initial members of the EA.

Herwartz and Weber (2013) point out that trade between Eurozone countries increased compared to European countries outside the EA. This rise in trade intensity results in stronger trade spillovers. Jiménez-Rodríguez et al. (2010) also highlight that Slovakia and Slovenia react more strongly to foreign industrial production shocks than other economies. Estonia exhibits a decrease in trade integration with the EA but an increase in the multiplier effect, as indicated in Table 1.2. Our results also show that whereas Lithuania reacts strongly before, this economy integrates slowly into the EA after accession to European Union.

According to Frankel and Rose (1998) and Rose (2000), trade patterns and international business cycle correlations are correlated and Optimum Currency Areas are endogenous. Our results show that CEECs that have adopted the Euro benefit from more spillover effects without increasing bilateral trade with the EA. Our results are in line with those of Gonçalves et al. (2009). Using a differences-in-differences approach, they find a positive effect of the Euro adoption on synchronization but a negative effect of trade. In the next, we estimate the effects of trade, of the Euro and other variables on spillovers from the EA to the CEECs.

Table 1.3 Effect of adopting the euro

	W2M24		Rank		EA
Country	Pre-2004	Post-2004	Pre-2004	Post-2004	member since
SVK	0.36	3.27	7	1	2009
EST	0.40	2.98	6	2	2011
SVN	0.49	2.37	4	3	2007
CZE	0.43	2.16	5	4	
POL	0.49	2.13	3	5	
HUN	1.02	1.58	2	6	
LTU	1.05	1.45	1	7	2015

Note: CZE: Republic Czech, EST: Estonia, HUN: Hungary, LTU: Lithuania, POL: Poland, SVK: Slovakia, SVN: Slovenia.

Table 1.4 Mean of Ratios of Multiplier effects and Trade intensity (CEECs' responses for a shock in EA-12)

	R_{M24}	R_{TI}
All countries	3.3	1.1
EST+SVK+SVN	4.9	1.07
CZE+HUN+POL+LTU	2.1	1.12

Note: CZE: Republic Czech, EST: Estonia, HUN: Hungary, LTU: Lithuania, POL: Poland, SVK: Slovakia, SVN: Slovenia.

Dynamic multipliers and the Euro effect

In this section, the empirical methodology is divided in two parts. First, we use moving-window estimations to evaluate changes in interdependencies of CEECs-7 with respect to EA-12. Cumulative multipliers *M24* (estimated from the equation 1.7) are simulated from 1996:01-2004:02 to 2007:06-2015:02.

$$MM24_{i,[t,t+138]} = \sum_{s=1}^{24} \Psi_{s,[t;t+138]} \qquad \text{for t=1996:01 to 2007:06} \quad (8)$$

In the second part, we identify drivers of such interdependencies. According to the literature (Imbs, 2004, Inklaar et al., 2008, Dées and Zorell, 2012, among others), different factors are considered: trade, industrial specialization, financial integration, and a Euro adoption dummy.

We consider two traditional measures of bilateral trade intensity, the first one is calculated using only bilateral trade data:

$$TRI1_{it} = \frac{X_{ijt} + M_{ijt}}{X_{it} + M_{it} + X_{jt} + M_{jt}}$$

where $X_{ij,t}$ and $M_{ij,t}$ refer to the bilateral export and import between country *i* and *j* during the year *t* in current dollars. X_{it}, M_{it}, X_{jt} and M_{jt} denote the total export and total import of country *i* and *j*, respectively, in the year *t*. Country i is one of the CEECs-7 countries and *j* is the EA-12.

The second indicator is defined as:

$$TRI2_{it} = \frac{X_{ijt} + M_{ijt}}{Y_{it} + Y_{jt}}$$

Following Imbs (2004), specialization is computed as the sum of absolute differences in the GDP share of an industry in two countries,

$$SPE_{i,t} = \sum_{s} \left| V_{is} - V_{js} \right|$$

The data on twenty-seven industrial sectors are extracted from the OECD database.

Financial integration is defined as standard deviation of monthly real interest rate differentials $(IFI1_{ij,t})$. We use nominal three-month interest rates and consumer price indices to calculate real interest rate. The OECD data are used.

$$IFI_{i,t} = \ln(\sigma(r_{i,t} - r_{j,t}))$$

We add a dummy variable (*Euro*) with the value 1 when the CEE country starts to use the Euro. We use quarterly data (2002:02 - 2015:02) and we calculate quarterly average for *MM24*. Results are shown in the Table 1.5. From equations 1 to 4, trade intensity (*TRI*) is not significant for three estimations. In line with Imbs (2004), industrial specialization has a negative impact on interdependencies and financial integration has a mitigate effect on spillovers effect: negative with fixed effect estimations and not significant with random effect estimations[7]. The Euro dummy variable has always a significant and positive effect.

In order to investigate this Euro effect, we replicate estimations including an interaction term: trade intensity for CEECs using the Euro (*TRI1*Euro* and *TRI2*Euro*). According to the results shown in the Table 1.5 (equations 5 to 8), trade intensity magnifies economic spillovers from the euro area to CEECs only for the countries using the Euro. Otherwise, trade dampens spillovers or at least has no effect on contagion. This opposite effects of trade can be justified by different theoretical arguments. First, between two currency areas, spillovers can be limited according to the adjustment of the real exchange rate. According to the relative purchasing power parity (PPP), an increase in the domestic inflation rate (after a positive domestic demand shock) leads to a real depreciation of the domestic currency. This depreciation reduces imports and so contagion to the foreign countries. Furthermore, currency unions coupled with trade integration could facilitate cross-border transmission of price movements and so convergence in inflation rates. In this case, the monetary policy is identical and less counter-cyclical (Robert et al., 2007). Even with controlling for real exchange rate volatility, monetary unions facilitate transmission of prices shock via the trade channel.

From the supply side, if trade changes take the form of intra-industry trade inside currency unions, common shocks and contagion are more frequent inside currency unions than with the other partners (the "European Commission view", De Grauwe, 1997). According to De Grauwe and Ji (2016), spillovers generated by "animal spirits" are higher inside currency unions than with other partners. A wave of optimism in a country leads to more output and imports in that country and spill over to the foreign country. They show that this contagion of optimism is higher inside the currency area and triggered by trade.

[7] The Hausman test rejects the null hypothesis (random estimation) at 5% for all equations.

Table 1.5 Panel Estimations for moving-window coefficients MM24 (2004:02-2015:02)

MM24	FE	FE	RE	RE	FE	FE	RE	RE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TRI1	-0.233**		-0.027		-0.428***		-0.178**	
	-0.114		-0.087		-0.097		-0.073	
TRI2		-0.184		0.5		-0.485		0.103
		-0.473		-0.305		-0.429		-0.271
SPE	-0.021***	-0.020***	-0.007***	-0.007***	-0.015***	-0.016***	-0.002	-0.004*
	-0.003	-0.003	-0.003	-0.002	-0.003	-0.003	-0.002	-0.002
IFI	-0.055***	-0.050***	-0.016	-0.013	-0.034**	-0.036**	-0.005	-0.006
	-0.017	-0.018	-0.014	-0.014	-0.015	-0.016	-0.013	-0.013
Euro	0.001***	0.002***	0.003***	0.002***	-0.002***	-0.001***	-0.001	-0.00004
	-0.0003	-0.0003	-0.0002	-0.0002	-0.0004	-0.0004	-0.0004	-0.0004
TRI1*Euro					0.801***		0.799***	
					-0.076		-0.082	
TRI2*Euro						3.538***		3.740***
						-0.459		-0.478
Constant			0.005***	0.005***			0.006***	0.005***
			-0.001	-0.001			-0.001	-0.001
Obs.	315	315	315	315	315	315	315	315
R^2	0.35	0.34	0.339	0.345	0.514	0.456	0.492	0.452
Adjusted R^2	0.215	0.203	0.33	0.336	0.413	0.343	0.486	0.445
F Statistic	34.972***	33.437***	39.738***	40.780***	68.686***	54.546***	75.097***	63.815***

Notes: (i) Standard errors under parenthesis. *p<0.1; **p<0.05; ***p<0.01.
(ii) All estimations include individual and time effects.
(iii) FE for fixed effects estimation and RE for random estimation.
(iv) All equations include individual and time effects.
(v) The Hausman test rejects the null hypothesis (random estimation) at 5% for all equations.

1.5. Conclusion

Since the enlargement of the European Union in 2004, the degree of integration of the CEECs has been at the center of many debates. Even if Stanisic (2013) rejects the hypothesis of a common business cycle between CEECs, their fluctuations seem to have become closer and closer to those of the EA (Di Giorgio, 2016). Some CEECs have already adopted the euro while others are still candidates. Thus, it was important to determine if entering the EU and adopting the euro lead to a high degree of interdependency.

Relying on a near-VAR model to capture macroeconomic relationships for seven CEECs and twelve EA countries, our empirical results indicate that *i)* CEECs countries are more affected by EA shocks after the enlargement in 2004 than before. This result could explain the path of convergence of CEE national business cycles toward those of the EA observed by Stanisic (2013).

Furthermore, we also find *ii)* that Germany, France and Italy explain a large part of economic disturbances in the CEECs-7 resulting from the EA-12. Germany, France and Italy explain up to 89%, 71% and 69%, respectively, of direct and indirect diffusion of a shock in the EA. This result is in line with Aguiar-Conraria and Soares (2011) and Belke et al. (2016): they find that France and Germany, the core of the EA, are the most synchronized countries with the rest of Europe.

Finally, *iii)* after the enlargement in 2004, the degree of economic integration increased more for CEECs that have adopted the euro than the other CEECs. Multiplier effects of CEECs from EA-12 disturbances have been multiplied by 9.0 and 7.4 after 2004 for Slovakia and Estonia (which have adopted the euro in 2009 and 2011 respectively) and only by 1.4 and 1.5 for Lithuania and Hungary, for example. Our results are in line with Frankel and Rose (1998), Rose (2000), Koopman and Azevedo (2008), and Furceri and Karras (2008): the euro contributes positively to business cycle synchronization. To test for this “euro effect”, we have simulated moving-window multiplier effects (*MM24*) and we have explained those coefficients by trade intensity, industrial specialization, financial integration, a euro dummy and an interaction term (trade intensity and euro). Results confirm the negative effect of specialization and financial integration but show positive effects of trade only in the context of the euro adoption. The lack of exchange rate volatility, development of intra-industry trade and contagion of “animal spirit” constitute arguments in favor of positive effects of trade inside a currency area. These results suggest that, macro-economically, countries that have not been adopted the euro yet should do it as soon as possible and do not wait for a higher level of business cycle synchronization. For further research, it mays be interesting to consider the role played by the structure of trade (intra- and inter-industry) within and outside the EA in this opposite effect of trade.

This chapter focuses on the demand-supply spillover channel (Backus et al., 1995) through which bilateral trade increases the business cycle interdependences. This channel indicates that trade intensity has positive impacts on the business cycle synchronization. Following a positive shock, domestic economy (founding members of the euro area in this chapter) demands more (intermediate) goods from foreign economies (CEE countries). The positive shock is thereby transmitted to trading partners and the business cycles are more synchronized. The existing literature also documents other trade channels of macro fluctuation transmission: *resource-shifting, technology transmission and the terms-of-trade effects*. Resource-shifting mechanism is documented in Backus et al., (1992) and predict a negative impact of trade. When domestic economy experiences a positive productivity shock, it becomes more productive than its trading partners and therefore attracts the resources from both itself and foreign countries. This reallocation effect increases domestic production, decreases foreign production and thereby dampens the synchronization. Technology transmission channel is highlighted in Liao and Santacreu (2015). According to the authors, bilateral trade enhances the business cycle comovement through increasing the productivity comovement. They find that the extensive margin of trade transmits the technology and knowledge across countries. In addition to these channels, another effect of trade on business cycle synchronization discussed in the existing literature, as noted in Liao and Santacreu (2015), is the terms-of-trade effect. Following a positive productivity shock, domestic goods are cheaper and thus more competitive in the international markets. That decreases the output of trading partner and therefore dampens the comovement. However, the synchronization may be enhanced because trading partners also benefit from cheaper imported goods to increase their production. This terms-of-trade effect thus has an ambiguous sign. Thus, the positive impacts of trade on output correlation may be explained by the demand-supply spillover, technology transmission and the terms-of-trade mechanisms. The next chapter contributes to understand more deeply the *trade-comovement puzzle* by focusing on two later mechanisms of trade.

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Appendix

Table 1.A.1 Model specification tests

Country	Jan 1996-Sep 2015				Pre-accession model				Post-accession model			
	LAGs	**LB**	**JB**	**AIC**	**LAGs**	**LB**	**JB**	**AIC**	**LAGs**	**LB**	**JB**	**AIC**
CZE	(2,2,7)	0.36	**0.03**	-463.10	(1,2,2)	0.46	0.18	-238.36	(3,1,11)	0.19	0.82	-363.61
EST	(2,2,7)	0.38	**0.03**	-396.00	(1,1,1)	0.11	0.90	-221.80	(8,3,5)	0.93	**0.02**	-299.65
HUN	(2,3,8)	0.94	**0.00**	-502.82	(2,3,1)	0.06	0.41	-271.76	(2,1,7)	0.43	**0.00**	-372.33
POL	(1,1,1)	0.08	**0.00**	-571.99	(2,3,3)	0.55	0.28	-277.70	(2,1,7)	0.42	0.55	-468.57
SVK	(1,1,1)	0.71	**0.00**	-350.76	(3,1,5)	0.27	0.22	-256.14	(2,1,7)	0.17	**0.02**	-258.18
SVN	(8,5,11)	0.05	**0.00**	-542.21	(3,3,1)	0.42	**0.00**	-306.86	(2,2,5)	0.53	**0.00**	-397.06
LTU	(7,1,1)	0.99	**0.00**	-87.65	(3,4,1)	0.29	0.87	-60.52	(10,6,1)	0.74	**0.00**	-164.00
AUT	(5,5,11)	0.50	**0.00**	-669.48	(12,3,3)	0.60	**0.01**	-320.20	(2,2,9)	0.74	0.96	-472.35
BEL	(4,3,4)	0.87	**0.00**	-576.11	(2,3,7)	0.71	**0.00**	-340.90	(3,4,7)	0.39	0.93	-399.44
FIN	(2,3,8)	0.11	**0.00**	-612.06	(6,6,3)	0.42	0.48	-350.13	(2,1,7)	0.66	**0.00**	-399.34
FRA	(3,3,12)	0.59	**0.02**	-826.19	(6,2,1)	0.53	**0.00**	-431.70	(2,2,9)	0.39	0.23	-537.94
DEU	(2,3,8)	0.74	0.77	-751.54	(4,1,5)	0.05	0.62	-416.51	(1,3,1)	0.32	0.12	-475.01
IRL	(3,1,10)	0.14	**0.00**	-105.91	(3,2,10)	0.55	0.44	-149.49	(3,5,7)	0.21	**0.00**	-109.49
ITA	(2,3,8)	0.44	0.39	-822.26	(1,3,2)	0.83	0.07	-463.94	(3,3,2)	0.20	0.44	-531.01
LUX	(3,2,11)	0.25	**0.00**	-304.83	(6,2,5)	0.60	**0.00**	-187.54	(2,2,9)	0.56	**0.00**	-245.11
NLD	(3,3,12)	0.16	0.16	-541.36	(3,4,12)	0.74	0.46	-317.86	(1,1,1)	0.13	0.81	-368.08
PRT	(3,3,12)	0.78	0.98	-529.89	(2,2,5)	0.95	0.06	-308.49	(2,1,3)	0.19	0.76	-398.43
GRC	(10,4,1)	0.06	**0.00**	-477.86	(2,2,5)	0.62	**0.00**	-285.99	(4,0,1)	0.11	0.39	-358.25
ESP	(6,3,8)	0.11	**0.00**	-720.66	(2,2,5)	0.55	**0.01**	-410.04	(1,1,2)	0.08	0.38	-524.90

Notes: (i) LB, JB denote p-value of Ljung-Box test and Jarque-Berra test, respectively.
(ii) LAGs represent lags of national output (y), international output (ye) and rest of the word's output.
(iii) AIC refers to Akaike Information Criterion.
(iv) Country code: AUT: Austria, BEL: Belgium, FIN: Finland, FRA: France, GER: Germany, GRC: Greece, IRL: Ireland, ITA: Italia, LUX: Luxembourg, NLD: Netherlands, PRT: Portugal, SPA: Spain, EST: Estonia, HUN: Hungary, LTU: Lithuania, POL: Poland, CZE: Republic Czech, SVK: Slovakia, SVN: Slovenia.

Table 1.A.2 Chow tests (P-values) for breaks in near-VAR models

Country	Chow test's p-value										
	1996-2004		1996-2015	2004-2015							
	Dec-98	Dec-00	May-04	Jan-11	Jan-09	Jan-07	Sep-08	Oct-08	Nov-08	Dec-08	Sep-12
CZE			0.67				0.78	0.78	0.82	0.82	0.63
EST			**0.03**	0.99			0.72	0.71	0.59	0.94	0.99
HUN			0.44				0.97	0.97	0.97	0.95	0.31
POL			**0.03**				0.10	0.10	0.34	0.16	0.50
SVK			0.90		0.46		0.72	0.73	0.67	0.66	0.56
SVN			0.41			0.87	0.94	0.94	0.78	0.73	0.65
LTU			0.92				0.93	0.93	0.90	0.84	0.97
AUT	1.00		0.50				0.98	0.98	0.99	0.89	0.90
BEL	0.80		0.06				0.85	0.83	0.83	0.83	0.71
FIN	0.90		0.40				0.36	0.37	0.35	0.35	0.98
FRA	0.34		0.83				0.26	0.26	0.27	0.44	0.74
DEU	0.68		0.29				0.44	0.45	0.39	0.57	0.99
IRL	1.00		0.27				0.90	0.89	0.91	0.85	0.09
ITA	0.64		0.14				0.08	**0.05**	**0.05**	**0.05**	0.65
LUX	0.70		0.23				0.91	0.91	0.87	0.80	0.99
NLD	1.00		0.90				0.97	0.99	0.96	0.96	0.96
PRT	0.64		0.48				0.27	0.29	0.36	0.42	0.91
GRC		0.10	0.89				0.63	0.66	0.81	0.74	0.86
ESP	0.17		0.85				0.83	0.70	0.44	0.22	0.88

Notes: (i) Country code: AUT-Austria, BEL-Belgium, FIN-Finland, FRA-France, DEU-Germany, GRC-Greece, IRL-Ireland, ITA-Italy, LUX-Luxembourg, NLD-Netherlands, PRT-Portugal, ESP-Spain, EST-Estonia, HUN-Hungary, LTU-Lithuania, POL-Poland, CZE- Czech Republic, SVK-Slovakia, SVN, Slovenia.
(ii) In bold, significant breaks at 5%.

Table 1.A.3 Residual analysis

	CZE	EST	HUN	POL	SVK	SVN	LTU	AUT	BEL	FIN
CZE		-0.01	0.21	**0.38**	-0.05	0.15	0.06	0.06	-0.19	0.07
EST	0.01		-0.03	-0.02	0.05	0.18	0.29	0.00	-0.20	-0.25
HUN	0.03	0.05		0.19	0.11	0.12	0.18	-0.04	-0.14	-0.13
POL	-0.01	0.07	0.27		-0.06	0.21	0.01	-0.09	-0.02	-0.09
SVK	0.03	-0.09	-0.17	0.13		0.26	0.08	-0.17	-0.06	-0.05
SVN	-0.08	-0.19	0.06	-0.06	0.05		0.01	-0.13	-0.20	-0.16
LTU	0.12	-0.12	0.01	-0.23	-0.05	0.04		-0.09	0.02	-0.09
AUT	-0.02	0.01	0.09	0.16	0.06	-0.06	-0.01		0.11	-0.06
BEL	-0.19	0.09	0.03	0.16	-0.04	-0.24	-0.02	-0.01		-0.01
FIN	0.11	**-0.37**	-0.04	0.06	0.27	0.10	-0.06	-0.21	-0.08	
FRA	0.29	0.13	-0.09	-0.13	-0.01	0.09	0.23	0.03	-0.11	-0.07
DEU	**-0.32**	0.12	-0.05	-0.21	**-0.35**	0.15	-0.06	-0.12	-0.11	-0.14
IRL	0.02	-0.07	0.11	-0.04	-0.09	0.02	0.08	-0.13	-0.18	0.07
ITA	-0.09	0.15	-0.01	0.22	-0.04	-0.13	-0.08	-0.05	0.06	0.05
LUX	-0.04	-0.01	0.01	-0.13	0.08	0.25	0.00	-0.14	-0.25	0.08
NLD	0.06	0.06	0.03	-0.13	0.08	0.08	0.15	-0.02	-0.10	0.05
PRT	-0.12	0.08	-0.01	0.10	0.13	0.08	-0.10	-0.06	0.04	-0.07
GRC	0.13	-0.08	-0.04	0.08	0.16	-0.08	-0.11	0.08	-0.17	0.05
ESP	-0.03	-0.13	0.04	-0.05	0.12	0.04	0.11	0.01	0.01	0.07

	FRA	DEU	IRL	ITA	LUX	NLD	PRT	GRC	ESP
CZE	-0.13	-0.10	0.07	0.18	0.21	0.18	0.17	-0.11	0.01
EST	0.22	-0.21	-0.13	-0.05	0.04	0.17	0.11	0.22	0.05
HUN	-0.14	0.10	-0.12	0.10	-0.17	-0.19	-0.04	0.07	0.07
POL	-0.18	-0.01	-0.13	0.13	0.24	0.04	0.00	-0.05	-0.13
SVK	-0.11	**0.32**	-0.29	-0.14	0.04	-0.23	-0.01	-0.20	0.18
SVN	0.09	0.15	-0.04	0.01	0.08	0.17	-0.08	-0.08	0.08
LTU	0.13	-0.18	-0.04	-0.08	-0.03	0.15	-0.03	0.00	-0.07
AUT	0.20	**-0.47**	-0.02	0.08	0.14	0.26	0.08	-0.01	-0.30
BEL	**-0.34**	-0.15	-0.09	-0.01	-0.04	-0.19	-0.05	-0.13	-0.07
FIN	-0.04	0.08	0.05	-0.13	0.01	0.16	0.24	-0.12	-0.03
FRA		**-0.33**	0.01	-0.13	0.03	**0.39**	0.00	-0.14	-0.21
DEU	-0.24		-0.01	-0.26	-0.23	-0.27	-0.13	-0.23	0.20
IRL	-0.01	0.01		-0.04	0.11	0.12	-0.12	0.10	-0.03
ITA	-0.19	-0.18	-0.10		0.12	0.03	-0.07	0.01	**-0.31**
LUX	0.07	0.04	0.06	-0.05		0.14	-0.03	-0.12	-0.21
NLD	**0.37**	-0.09	0.06	-0.06	0.10		0.02	-0.12	-0.24
PRT	-0.21	0.11	0.12	0.07	-0.13	-0.23		-0.24	-0.04
GRC	-0.04	-0.29	0.08	-0.02	0.20	0.02	-0.25		0.15
ESP	0.10	-0.08	0.20	-0.22	0.14	0.13	-0.12	0.15	

Notes: Lower triangular matrix consists of correlations of residuals from the post-accession model. Upper triangular matrix consists of correlations of residuals from the pre-accession model. Country code: AUT: Austria, BEL: Belgium, FIN: Finland, FRA: France, DEU: Germany, GRC: Greece, IRL: Ireland, ITA: Italia, LUX: Luxembourg, NLD: Netherlands, PRT: Portugal, ESP: Spain, EST: Estonia, HUN: Hungary, LTU: Lithuania, POL: Poland, CZE: Republic Czech, SVK: Slovakia, SVN: Slovenia. In bold, correlations larger than 0.30.

Table 1.A.4 Multiplier effects before and after the accession (in percent)

	CZE		EST		HUN		POL	
	Pre-2004	Post-2004	Pre-2004	Post-2004	Pre-2004	Post-2004	Pre-2004	Post-2004
AUT	0.22	0.55	0.17	0.70	0.57	0.41	0.23	0.52
BEL	0.32	0.92	0.31	1.33	0.76	0.67	0.37	0.91
FIN	0.03	0.27	0.14	1.45	0.08	0.20	0.04	0.28
FRA	0.39	1.38	0.38	1.94	0.93	1.01	0.45	1.38
DEU	0.73	4.60	0.65	6.19	1.70	3.35	0.82	4.52
IRL	0.14	0.33	0.14	0.49	0.32	0.24	0.15	0.33
ITA	0.35	1.22	0.33	1.71	0.82	0.91	0.40	1.23
LUX	0.10	0.21	0.09	0.28	0.23	0.15	0.11	0.20
NLD	0.45	2.15	0.46	3.26	1.08	1.57	0.52	2.16
PRT	0.14	0.38	0.14	0.53	0.34	0.28	0.17	0.38
ESP	0.26	1.16	0.25	1.65	0.61	0.86	0.30	1.16
GRC	0.09	0.22	0.09	0.32	0.21	0.17	0.10	0.22

	SVK		SVN		LTU	
	Pre-2004	Post-2004	Pre-2004	Post-2004	Pre-2004	Post-2004
AUT	0.19	0.85	0.25	0.65	0.43	0.34
BEL	0.27	1.39	0.35	1.00	0.82	0.64
FIN	0.03	0.42	0.04	0.29	0.11	0.30
FRA	0.33	2.12	0.46	1.56	1.01	0.95
DEU	0.6	6.92	0.8	4.95	1.71	3.03
IRL	0.11	0.49	0.14	0.36	0.36	0.24
ITA	0.3	1.89	0.43	1.47	0.86	0.83
LUX	0.08	0.31	0.11	0.23	0.24	0.14
NLD	0.37	3.28	0.49	2.32	1.16	1.53
PRT	0.12	0.58	0.16	0.42	0.36	0.26
ESP	0.21	1.78	0.29	1.29	0.66	0.80
GRC	0.07	0.34	0.1	0.25	0.22	0.15

Notes: This table presents the cumulative impulse response in 24 months ahead of country in column to a shock originated in country in row. Country code: AUT: Austria, BEL: Belgium, FIN: Finland, FRA: France, DEU: Germany, GRC: Greece, IRL: Ireland, ITA: Italia, LUX: Luxembourg, NLD: Netherlands, PRT: Portugal, ESP: Spain, EST: Estonia, HUN: Hungary, LTU: Lithuania, POL: Poland, CZE: Republic Czech, SVK: Slovakia, SVN: Slovenia.

CHAPTER 2

EXTENSIVE MARGIN AND TRADE-COMOVEMENT PUZZLE

Highlights

The trade-comovement puzzle has been highlighted by Kose and Yi (2006), who have suggested that theoretical models find weak effects of trade on business cycle correlations. To explain this puzzle, Juvenal and Santos-Monteiro (2017) have divided output comovement into three factors: correlation between each country's TFP, correlation between each country's share of expenditure on domestic goods, and correlation between each country's TFP and the partner's share of expenditure on domestic goods. From this decomposition, they have revealed that the trade-comovement puzzle arises mainly from the second factor. As such, in their theoretical model, trade decreases the correlation between each country's share of expenditure on domestic goods because the model generates a countercyclical terms-of-trade. To investigate this counterfactual effect, we decompose trade intensity into intensive and extensive margins. We then study the effects of each margin on three component factors of output comovement. Using data for 40 countries (24 developed countries and 16 developing countries) over the period 1990-2015, we find that the effects of the intensive margin on comovements are ambiguous. However, the extensive margin increases not only the correlation of TFP between trading partners (first factor) but also the correlation between each country's shares of domestic goods (second factor). This result emphasizes that new exported products transmit TFP shocks and do not deteriorate but instead improve the terms-of-trade. The extensive margin of trade should be integrated into theoretical model to solve the puzzle.

JEL Classifications: F14, F41, F44, E32

Keywords: Business cycle comovement, Trade-comovement puzzle, Trade Margins

2.1. Introduction and Literature Review

Although substantial empirical evidence has suggested that bilateral trade contributes positively to output comovement (Frankel and Rose, 1998; Clark and Wincoop, 2001; Imbs, 2004, Baxter and Kouparitsas, 2005, among others), theoretical models fail to fully replicate this relationship. International business cycle models are unable to generate trade effects on business cycles synchronization as strong as those observed from the data.

Kose and Yi (2006) have developed an international business cycle model and simulated the effects of increased trade integration on business cycle correlations. Their model implies an increase in output correlation for pairs of countries with stronger trade linkages. However, this theoretical correlation accounts for approximately one tenth of the empirically detected effect. They have named this fact the *trade-comovement puzzle* in the standard international real business cycle model. The authors have also highlighted that when allowing for higher TFP shock comovement, the model performance improves in reducing the gap between empirical findings and theoretical predictions.

To solve this trade-comovement puzzle, Arkolakis and Ramanarayanan (2009) have used an international business cycle model with two stages of production. Bilateral trade varies with trade barriers. The results have suggested that vertical specialization fails to solve the trade-comovement puzzle with perfect competition but has helped solve the puzzle with imperfect competition. Di Giovanni and Levchenko (2010), using firm-level data and input-output matrix, have indicated a higher comovement for sectors that trade more with each other, in terms of volume and frequency. They have noted that vertical production linkages are responsible for 30 percent of total trade effect. Wong and Eng (2013) have developed a model with three production stages, which allow for vertical trade (importing intermediates for re-exporting as intermediates) and processing trade (importing intermediates for re-exporting as final goods). The authors have demonstrated that their model can solve the puzzle. Johnson (2014) has included input-output linkages across sectors into international real business cycle model. Their results have indicated that the puzzle cannot solved by input trade: "*the model yields high trade-comovement correlations* *for goods, but near-zero correlations for services and thus low aggregate correlations.*"

For Liao and Santacreu (2015), theoretical effects of trade on business cycle comovement can be increased if TFP correlation is considered. Distinguishing between intensive and extensive margins of trade, Liao and Santacreu (2015) have revealed that the extensive margin of trade increases correlation between the trading partner's aggregate productivity and therefore drives the observed output comovement. In addition, business cycles between countries that trade a wider variety should be highly correlated. Zlate (2016) has examined the effect of offshoring through vertical foreign direct investments on business cycle correlation. His model has distinguished between intensive and extensive margins of offshoring, indicating that offshoring and its extensive margin raise output comovement across countries. More recently, Drozd et al. (2017) have studied the dynamic properties of trade elasticity. They have argued that models will be more consistent with dynamic instead of static trade elasticity.

According to Juvenal and Santos-Monteiro (2017), business cycle comovement could be explained by three factors in most theoretical models: correlation between each country's TFP, correlation between each country's share of expenditure on domestic goods and correlation between each country's TFP and its trading partner's share of expenditure on domestic goods. Juvenal and Santos-Monteiro (2017) have illustrated that the trade-comovement puzzle is explained by the second factor. This counterfactual effect results from the fact that TFP shocks induce a deterioration of the domestic terms-of-trade and that the second factor responds more strongly to terms-of-trade variations when countries are more trade-integrated.

In this chapter, we evaluate the effects of the extensive margin and the intensive margin of trade on the three aforementioned component factors. While Juvenal and Santos-Monteiro (2017) have examined the effects of total trade, we focus on the effects of margins of trade on component factors. Our hypothesis holds that extensive margin has a positive impact on TFP correlations (first factor) and also has a positive effect on the correlation between each country's shares of domestic goods (second factor). In the last case, the terms-of-trade are procyclical if we consider the extensive margin of trade.

By using a sample that covers 40 countries, we first follow the work of Juvenal and Santos-Monteiro (2017) and acknowledge that business comovements are mainly explained by correlations of TFP and shares of expenditure on domestic goods, whereas the effect of the third factor is ambiguous. Second, our results reveal that the extensive margin of trade not only increases the correlation of TFP between trading partners (Liao and Santacreu, 2015) but also increases the correlation between each country's shares of domestic goods. In contrast, the effects of the intensive margin are negative or insignificant. These results emphasize that new exported products transmit TFP shocks via embedded technology information, and more importantly, they do not deteriorate the terms-of-trade. The higher level of the extensive margin of trade between two countries is, the more the TFP, the share of expenditure on domestic goods and therefore the output between these countries commove. Thus, to solve the trade-comovement puzzle, theoretical models should integrate the extensive margin of trade.

The remainder of this chapter is divided into four sections. Section 2.2 presents the methodology, data and measurements. Next, section 2.3 describes the results. Lastly, section 2.4 presents robustness checks, while section 2.5 concludes the chapter.

2.2. Methodology, Data and Measurement

First, we explain the correlation of output fluctuations by addressing the three component factors proposed by Juvenal and Santos-Monteiro (2017):

$$corr\left(\tilde{y}_i, \tilde{y}_j\right) = b_{01} + b_{11}\, corr\left(\tilde{A}_i, \tilde{A}_j\right) + b_{21}\, corr\left(\tilde{\lambda}_i, \tilde{\lambda}_j\right) + b_{31}\, corr\left(\tilde{\lambda}_i, \tilde{A}_j\right) + \varepsilon_{ij1} \quad (2.1)$$

where $corr\left(\tilde{y}_i, \tilde{y}_j\right)$ denotes the correlation between each country's output, $corr\left(\tilde{A}_i, \tilde{A}_j\right)$ is the correlation between each country's TFP, $corr\left(\tilde{\lambda}_i, \tilde{\lambda}_j\right)$ refers to the correlation between each country's share of expenditure on domestic goods, and $corr\left(\tilde{\lambda}_i, \tilde{A}_j\right)$ is the correlation between each country's TFP and the trading partner's share of expenditure on domestic goods.

The data concern 40 countries, including 24 developed countries and 16 developing countries, over the period 1990-2015. The developed countries are Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States. The developing countries consist of Chile, China, Indonesia, India, Malaysia, Philippines, Argentina, Brazil, Mexico, Turkey, Costa Rica, Romania, Thailand, Uruguay, Bulgaria and Tunisia. This sample accounts for 78% of world trade and 86% of world GDP. The data have been extracted from various databases, as detailed below.

Business cycle comovement is defined as the correlation of the cyclical components of real GDP (in millions, local currencies) from 1990 to 2015. The series are detrended by the Hodrick-Prescott (HP) filter. For the OECD countries, the data come from the OECD database, and for the non-OECD countries, the nominal output in local currency is extracted from the World Bank database and is then deflated by the GDP deflator (base year 2010), which has been obtained from the International Financial Statistics (IMF).

The correlation between each country's TFP is calculated from the series of TFP, which are also detrended by the HP filter. We follow Liao and Santacreu (2015) in estimating the productivity aggregate of country *i* in year *t*:

$$Log(TFP_{it}) = Log(Y_{it}) - \alpha Log(L_{it}) - (1-\alpha) Log(K_{it})$$

where Y_{it} denotes real GDP in local currency, K_{it} is the physical capital stock and L_{it} is the total employment. The employment data comes from the IMF and World Bank databases, while the series of physical capital stock are constructed using the perpetual inventory method. We assume an annual depreciation of 10%, and the initial capital stock is zero. In addition, following the literature, α is set to 0.64 for all countries. The data of real gross fixed capital formation is extracted from the Word Bank database. This method is similar to the one used by Liao and Santacreu (2015).

The share of expenditure on domestic goods corresponds to the share of domestic intermediate goods used to produce final goods. As in the work of Juvenal and Santos-

Monteiro (2017), share of expenditure on domestic goods is defined as one minus the import penetration ratio, or

$$\lambda_i = 1 - \frac{M_i}{GDP_i - X_i + M_i} = \frac{GDP_i - X_i}{GDP_i - X_i + M_i}$$

where X_i and M_i denote the total exports and imports, respectively, of country i. The total export and total import data is extracted from the Direction of Trade Statistics (IMF) database. The GDP_i is the nominal output, in US dollars, that comes from the OECD database for OECD countries and the World Bank and IMF databases for non-OECD countries. We use nominal output in US dollars because the value of exports and imports are in US current dollar. The series of lambda are then de-trended by the HP filter. The correlation between each country's share of expenditure on domestic goods is calculated from the cyclical components over the period 1990–2015.

The third factor identified by Juvenal and Santos-Monteiro (2017) is the sum of the correlation between cyclical components of TFP of country *i* and lambda of country *j* and the correlation between cyclical components of TFP of country *j* and lambda of country *i*.

After examining the component factor structure of output comovement, we revisit the impacts of trade intensity on business cycle synchronization and its effects on each component factor by estimating the following equations:

$$corr(\tilde{y}_i, \tilde{y}_j) = b_{02} + b_{12} \log(bilateraltrade)_{ij} + \varepsilon_{ij2} \quad (2.2)$$

$$corr(\tilde{A}_i, \tilde{A}_j) = b_{03} + b_{13} \log(bilateraltrade)_{ij} + \varepsilon_{ij3} \quad (2.3)$$

$$corr(\tilde{\lambda}_i, \tilde{\lambda}_j) = b_{04} + b_{14} \log(bilateraltrade)_{ij} + \varepsilon_{ij4} \quad (2.4)$$

$$corr(\tilde{\lambda}_i, \tilde{A}_j) = b_{05} + b_{15} \log(bilateraltrade)_{ij} + \varepsilon_{ij5} \quad (2.5)$$

We consider two traditional measures of bilateral trade intensity. The first indicator is calculated using only bilateral export and import data:

$$trade1_{ij} = \frac{1}{T} \sum_{t=1}^{T} \frac{X_{ij,t} + M_{ij,t}}{X_{it} + X_{jt} + M_{it} + M_{jt}}$$

where X_{ijt} and M_{ijt} refer to the bilateral export and import between country i and j during the year t, in current US dollars. Thus, X_{it}, M_{it}, X_{jt} and M_{jt} denote the total exports and imports of countries i and j, respectively, in year t. The second indicator is defined:

$$trade1_{ij} = \frac{1}{T}\sum_{t=1}^{T}\frac{X_{ij,t}+M_{ij,t}}{Y_{it}+Y_{jt}}$$

where Y_{it} and Y_{jt} are the nominal GDP in current US dollars of countries i and j.

The bilateral trade data is exploited from DOTS (IMF). The series of nominal output come from the OECD, World Bank and IFS (IMF) databases.

Then, the trade effects are decomposed into the intensive margin *IM* and the extensive margin *EM*:

$$corr(\tilde{y}_i, \tilde{y}_j) = b_{06} + b_{16}\,log(EM)_{ij} + b_{26}\,log(IM)_{ij} + \varepsilon_{ij6} \qquad (2.6)$$

$$corr(\tilde{A}_i, \tilde{A}_j) = b_{07} + b_{17}\,log(EM)_{ij} + b_{27}\,log(IM)_{ij} + \varepsilon_{ij7} \qquad (2.7)$$

$$corr(\tilde{\lambda}_i, \tilde{\lambda}_j) = b_{08} + b_{18}\,log(EM)_{ij} + b_{28}\,log(IM)_{ij} + \varepsilon_{ij8} \qquad (2.8)$$

$$corr(\tilde{\lambda}_i, \tilde{A}_j) = b_{09} + b_{19}\,log(EM)_{ij} + b_{29}\,log(IM)_{ij} + \varepsilon_{ij9} \qquad (2.9)$$

Intensive and extensive margins of trade are obtained from the export decomposition using the methodology proposed by Hummels and Klenow (2005). The extensive margin of trade is defined as the ratio of country k's exports to j in I_{ij} and country k's exports to j in I, where I_{ij} is the set of observable goods in which country i has positive export to country j and I is the set of all goods:

$$EM_{ij} = \frac{\sum_{m \in I_{ij}} Export_{kjm}}{\sum_{m \in I} Export_{kjm}}$$

The wider the variety of goods that country i exports to country j, the higher the EM_{ij}.
The intensive margin of trade compares nominal exports for country i and k in a common set of varieties. It is constructed as the ratio of country i's nominal shipments to country j

to country k's nominal shipments to country j in the same set of goods. IM_{ij} is higher when country i exports higher quantities of each product category to j.

$$IM_{ij} = \frac{\sum_{m \in I_{ij}} Export_{ijm}}{\sum_{m \in I_{ij}} Export_{kjm}}$$

Margins of trade between countries i and j are then computed as the sum of the natural logarithm of the margins of export of country i to j and those of country j to i:

$$Log(EM_{ij}) = Log(EM_{ij}) + Log(EM_{ji})$$

$$Log(IM_{ij}) = Log(IM_{ij}) + Log(IM_{ji})$$

We also consider an alternative measure of the overall bilateral trade intensity from the calculation of margins:

$$Log(OT_{ij}) = Log(EM_{ij}) + Log(IM_{ji})$$

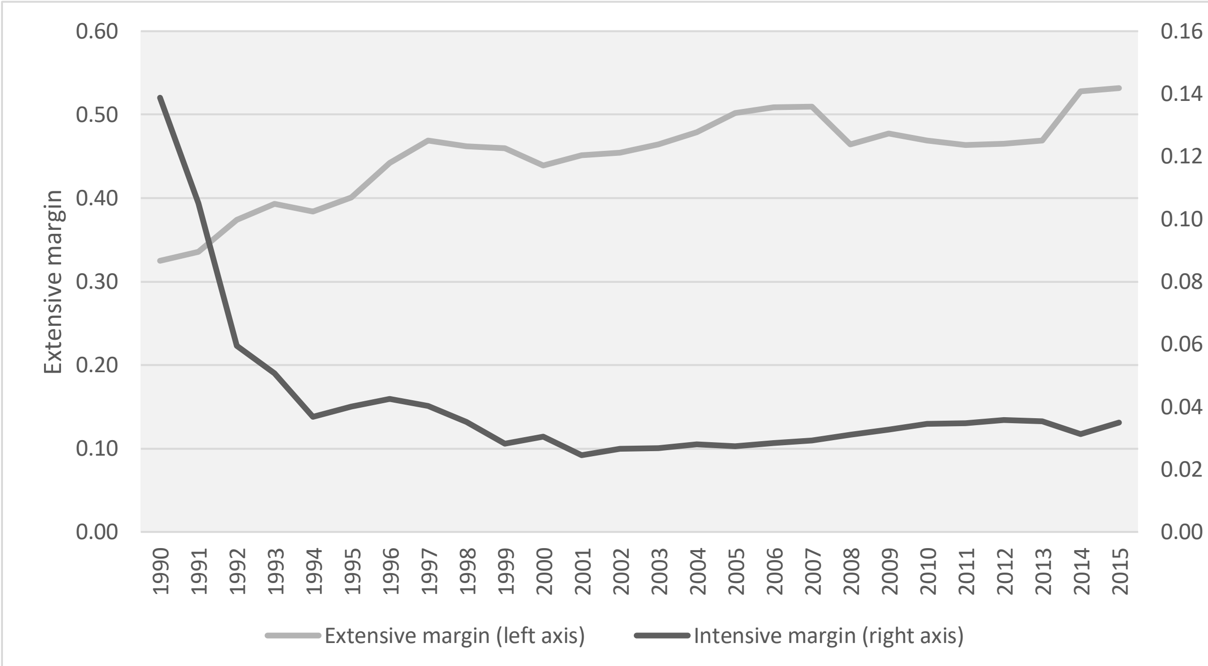
The BACI database, which consists of 5,017 six-digit U.N HS product codes from CEPII (Gaulier and Zignago, 2010), is exploited to calculate the extensive and intensive margins of trade. We compute *EM* and *IM* for each year and then take the average over the period 1990–2015. The specifications are estimated by the OLS and two-stage least squares (2SLS) methods. In line with Liao and Santacreu (2015), the distance and the regulation entry cost are used as instruments to deal with the measurement errors and omitted variables problem. These authors have argued that the transport cost has a significant impact on the intensive margin, whereas the extensive margin is affected by the entry cost that firms must pay to entry into a new market. The distance data is obtained from CEPII, and the data of regulation entry cost is constructed by Djankov et al. (2002). This variable is measured by the amount of time and money lost for legal procedures to start operating a business. Since the bilateral extensive margin is calculated as the sum of the extensive margins for two countries, we take the sum of regulation entry cost of two countries for each country pair.

2.3. Empirical Results

2.3.1 Stylized Facts

To begin, we examine the evolution of the extensive and intensive margins of trade over the considered period. Figure 2.1 indicates the averages of the margins of trade of all country pairs from 1990 to 2015. The extensive margin and intensive margin of trade seem to move in opposite directions until 1996, at which point they do not produce many fluctuations. In general, while the intensive margin decreased sharply from 1990 to 1994 and tended to be stable during the remaining period, the extensive margin showed an increasing trend over the studied period. In fact, the extensive margin of trade temporarily declined from 2008 to 2013 due to the global crisis and raised again in 2014 and 2015. Dutt et al. (2013) have used data on exports for 150 countries from 1962–1999 and have indicated that the growth in overall trade is mainly due to the increase of trade in new products, or the extensive margin of trade. In fact, two factors over recent decades explain these movements: technological development helps enterprises create new products and economic integration in a globalized world helps firms find new exporting markets. Naknoi (2015) has suggested that the extensive margin of export negatively correlates with the intensive margin of export for 90% of countries that trade with the US.

Figure 2.1 Extensive and intensive margins of trade



Note: The extensive and intensive margins are computed as the average of all pairs of countries.

The descriptive statistics for the variables are presented in Table 2.A.1 in the appendix. The output correlation of country pairs in our sample has a mean of 0.23 and varies from -0.71 (Brazil – Ireland) to 0.90 (Austria – Netherlands). The correlation of TFP between trading partners is always positive, with a mean of 0.78, a minimum of 0.00 (Argentina – Ireland) and a maximum of 0.99 (Austria – Germany). The range of correlation of the share of expenditure on domestic goods is from -0.63 (Argentina – Ireland) to 0.89 (United States – Finland). The minimum correlation between each country's TFP and the trading partner's share of expenditure on domestic goods is -1.17 (Austria – Germany), and its maximum is 0.63 (Indonesia – Iceland). As Hummels and Klenow (2005) have noted, the extensive margin is always larger than the intensive margin, since the former, in this case, reaches a mean of 0.280. The two countries that trade the largest number of varieties are Canada and the United States. The opposite case is Iceland and Uruguay. The intensive margin reaches a maximum with the country pair Canada – United States and the minimum with Iceland – Mexico.

2.3.2 Business Cycle Comovement Factor Structure

Juvenal and Santos-Monteiro (2017) have used the data of industrial manufacturing from 24 OECD countries and have found that all three factors significantly affect output correlations. While the comovement between TFP and the shares of expenditure on domestic goods has positive effects on output correlation, the third factor contributes negatively and thus reduces the business cycle synchronization. Based upon the data for 40 countries, the results reported in Table 2.1 also indicate that the correlation between TFP and between shares of expenditure on domestic goods are the main sources of business cycle comovement. However, unlike Juvenal and Santos-Monteiro (2017) have suggested, the coefficient of the TFP correlation is larger than that of the correlation of shares of expenditure on domestic goods in all specifications. Furthermore, we find that the impact of the correlation between each country's TFP and the trading partner's share of expenditure on domestic goods is not significant. However, excluding this factor from the benchmark regression does not change other coefficients as reported in column (2). According to Juvenal and Santos-Monteiro (2017), the trade-comovement puzzle arises from the counter-factual effect of trade on the second factor. Moreover, the authors have noted that the empirical impact of trade on third factor is not significant. Thus, we focus on the effects of trade on the first two factors that drive the business cycle comovement: the comovement of productivity and the comovement of expenditure share on domestic goods comovement.

Table 2.1 Business cycle synchronization factor structure

	$Corr(y_i,y_j)$ (1)	$Corr(y_i,y_j)$ (2)
$Corr(A_i,A_j)$	0.741***	0.744***
	(0.061)	(0.061)
$Corr(\lambda_i,\lambda_j)$	0.207***	0.210***
	(0.043)	(0.042)
$Corr(\lambda_i,A_j)$	-0.019	
	(0.032)	
Constant	-0.421***	-0.421***
	(0.046)	(0.046)
R-squared	0.24	0.24
Nb. of obs.	780	780

Source: Author's calculation. The HP filter is used to detrend the raw series. Models are estimated by the Ordinary Least Squared method.

For Juvenal and Santos-Monteiro (2017), the counterfactual effect of trade intensity on the second factor explains 80% of the trade-comovement puzzle. According to these authors, shares of expenditure on domestic goods in countries that have high level of trade integration reduce business cycles synchronization. Following a productivity shock in the domestic country (home), the price of home goods becomes cheaper. The lower domestic price raises the share of expenditure on domestic goods. The TFP shock also deteriorates domestic terms-of-trade and makes home goods cheaper on the international market, therefore lowering the share of expenditure on domestic goods of trading partners. Moreover, the elasticity of expenditure share on domestic goods to changes of the terms-of-trade is higher when countries are more integrated. The counter-cyclicality of terms-of-trade causes the failure of this class of model in replicating the effect of trade on business cycle synchronization.

Liao and Santacreu (2015) have developed a model emphasizing that the extensive margin of trade drives business cycle comovement by increasing synchronization of TFP shocks. Pentecôte et al. (2015) have indicated that the volatility of terms-of-trade is reduced when trade growth occurs at the extensive margin. In the remainder of this chapter, we investigate the effects of the extensive and intensive margins of trade on three factors that have been identified by Juvenal and Santos-Monteiro (2017). We question whether the extensive margin not only transmits the technology but also generates procyclical terms-of-trade, thereby improving the correlation of share of expenditure on domestic goods and so, business cycle comovement.

2.3.3 Margins of Trade and Business Cycle Comovement Factors

We first revisit the effect of international trade on the business cycle synchronization and evaluate the effects of the intensive and extensive margins. The left-hand panel of Table 2.2 reports the results estimated by the OLS method[8]. Bilateral trade intensity has a positive effect on output correlation, an outcome which has been well documented in the literature. This effect varies with the measure of trade intensity, approximating 0.065 when trade intensity is measured as the ratio between the sum of bilateral export and import between countries *i* and *j* and the sum of total export and total import of two countries. It decreases to 0.053 when trade measure is the percentage of bilateral export and import between two countries on total GDP of two countries. Moreover, this effect is smallest (0.041) when the independent variable is computed as the overall trade by employing the sum of the intensive and extensive margins. In the fourth column, the intensive and extensive margins favor the output comovement. The coefficients are positive and significant, and the effect of the extensive margin is two times larger than that of the intensive margin.

However, the results obtained from estimations by OLS may be biased due to measurement errors of international trade and omitted variables. We thus re-estimate the specifications by using the 2SLS estimator. The geographical distance is used as an instrument for bilateral trade as well as intensive margin, as well documented in the literature (Imbs, 2004, Liao and Santacreu, 2015, among others). The entry regulation cost is exploited as an instrument for extensive margin, as in the research of Liao and Santacreu (2015). The results are presented in the right-hand panel of Table 2.2. The hypothesis of

[8] We note that R-squared in these estimations are very small, indicating that bilateral trade explain a small fraction of cross-section correlations. When we add country-specific fixed effects, as Juvenal and Santos-Monteiro (2017) have done, R-squared increase to 0.49 in average. This outcome suggests that the fixed effects capture most variation due to unobserved covariates.

weak instruments is rejected in all four estimations. Trade coefficients are almost the same (0.168 and 0.169) despite how the independent variable is measured, whether by the first or second indicator.

Table 2.2 Output comovement and bilateral trade – a revisit

	OLS				2SLS			
	$Corr(y_i,y_j)$	$Corr(y_i,y_j)$	$Corr(y_i,y_j)$	$Corr(y_i,y_j)$	$Corr(y_i,y_j)$	$Corr(y_i,y_j)$	$Corr(y_i,y_j)$	$Corr(y_i,y_j)$
LogTrade1	0.065*** (0.007)				0.168*** (0.016)			
LogTrade2		0.053*** (0.007)				0.169*** (0.016)		
LogOT			0.041*** (0.004)				0.094*** (0.008)	
LogEM				0.055*** (0.007)				0.120*** (0.041)
LogIM				0.027*** (0.007)				0.070 (0.045)
Constant	0.592*** (0.040)	0.564*** (0.044)	0.640*** (0.042)	0.560*** (0.053)	1.173*** 0.088)	1.289*** (0.103)	1.180*** (0.086)	1.036*** (0.292)
R-squared	0.1	0.07	0.12	0.12				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance	distance	distance	distance & entry cost
Cragg-Donald Wald F statistic					259.318	240.179	296.535	8.381
Stock-Yogo test (10% maximal IV size)					16.38	16.38	16.38	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

The results in the last column of Table 2.2 reveal that the coefficient of the extensive margin is significant, at a 1% confidence level, whereas the effect of the intensive margin is not significant. This finding supports those of Liao and Santacreu (2015), which have emphasized the role of extensive margin of trade.

We also note that the coefficients estimated by 2SLS are significantly larger than corresponding coefficients in OLS. A potential explanation of this result is that the measurement error of bilateral trade data biases the coefficients toward zero. Gujarati (2003) has indicated that this problem can be mitigated by the instrumental variable approach. Moreover, as the sample consists of advanced and emerging countries, the 2SLS may drive coefficients toward an average value that approximates the true value of advanced countries. When we run the estimation with GMM-IV method in the robustness check section (see Section 4) to correct the potential heteroscedasticity, the results are similar to those of our benchmark estimations.

We then investigate effects of the intensive and extensive margins on the three component factors of business cycle comovement. These results are presented in Table 2.3 and provide evidence that bilateral trade has a positive impact on the correlation of TFP. However, the extensive margin of trade is the only source of this effect. The results generated by OLS and 2SLS highlight that the intensive margin does not increase TFP comovement. This finding confirms those of Liao and Santacreu (2015). The technology embedded in new goods is transmitted through international trade, more precisely through the extensive margin. Countries that trade a wider variety of goods have more productivity synchronization and therefore, higher business cycle synchronization.

Table 2.3 Bilateral trade and TFP comovement

	OLS				2SLS			
	Corr(A_i,A_j)	Corr(A_i,A_j)	Corr(A_i,A_j)	Corr(A_i,A_j)	Corr(A_i,A_j)	Corr(A_i,A_j)	Corr(A_i,A_j)	Corr(A_i,A_j)
LogTrade1	0.023*** (0.004)				0.062*** (0.008)			
LogTrade2		0.016*** (0.004)				0.062*** (0.009)		
LogOT			0.015*** (0.002)				0.035*** (0.005)	
LogEM				0.027*** (0.004)				0.110*** (0.026)
LogIM				0.003 (0.004)				-0.036 (0.029)
Constant	0.911*** (0.023)	0.882*** (0.025)	0.931*** (0.024)	0.861*** (0.030)	1.127*** (0.047)	1.170*** (0.054)	1.130*** (0.046)	0.710*** (0.186)
R-squared	0.04	0.02	0.05	0.07				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance	distance	distance	distance & entry cost
Cragg-Donald Wald F statistic					259.318	240.179	296.535	8.381
Stock-Yogo test (10% maximal IV size)					16.38	16.38	16.38	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

The effect of bilateral trade on the correlation between each country's share of expenditure on domestic goods is presented in Table 2.4. Trade increases the second component factor. In fact, when the model is estimated by the 2SLS method, the trade effect is the same (0.062) no matter how trade intensity is measured, whether by the first or second indicator. By decomposing trade intensity into extensive and intensive margins, we reveal that the extensive margin increases the business cycle correlation not only by synchronizing TFP shocks but also by favoring the correlation between shares of expenditure on domestic goods. The effect of the extensive margin of trade is positive (0.079) and significant at a 5% confidence level. In contrast, the coefficients of intensive margin are not significant.

In the international real business cycle model, a positive technology shock in the home country increases home GDP and home expenditure share on domestic goods while depreciating the home terms-of-trade. This depreciation of terms-of-trade induces a decrease in the share of expenditure on domestic goods of the trading partner. However, we suggest that trading at the extensive margin does not induce a deterioration of the terms-of-trade. In other words, the extensive margin of trade may generate the pro-cyclical terms-of-trade. Furthermore, the technology embedded in new products raises the productivity of trading partner and therefore, the part of domestic demand satisfied by domestic goods. Juvenal and Santos-Monteiro (2017) have proved that the comovement of TFP and the share of expenditure on domestic goods are the main sources of output comovement. This productivity transmission mechanism hence may help theoretical models fully replicate the trade-comovement relationship observed in the data.

Table 2.4 Bilateral trade and share of expenditure on domestic goods comovement

	OLS				2SLS			
	Corr(λ_i,λ_j)	Corr(λ_i,λ_j)	Corr(λ_i,λ_j)	Corr(λ_i,λ_j)	Corr(λ_i,λ_j)	Corr(λ_i,λ_j)	Corr(λ_i,λ_j)	Corr(λ_i,λ_j)
LogTrade1	0.036*** (0.006)				0.074*** (0.012)			
LogTrade2		0.032*** (0.005)				0.074*** (0.012)		
LogOT			0.021*** (0.003)				0.042*** (0.006)	
LogEM				0.031*** (0.006)				0.079** (0.032)
LogIM				0.012** (0.006)				0.007 (0.035)
Constant	0.526*** (0.033)	0.523*** (0.036)	0.531*** (0.035)	0.476*** (0.044)	0.738*** (0.065)	0.789*** (0.074)	0.740*** (0.066)	0.534** (0.227)
R-squared	0.05	0.04	0.05	0.05				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance	distance	distance	distance & entry cost
Cragg-Donald Wald F statistic					259.318	240.179	296.535	8.381
Stock-Yogo test (10% maximal IV size)					16.38	16.38	16.38	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

Finally, although the third component factor has no significant effect on the output correlation, we assess the effects of trade on this factor to provide more evidence regarding the role of extensive margin in generating a procyclical terms-of-trade. The results presented in Table 2.5 reveal that total trade decreases this correlation factor. In the OLS, both the intensive and extensive margins have a negative impact on this component factor. The coefficients are significant, but near 0 (0.013 and 0.016). In the 2SLS, the effect of the extensive margin becomes positive and remains significant. As explained above, the extensive margin plays an important role in transmitting the technology across countries and does not induce the deterioration of terms-of-trade. In fact, it increases the share of expenditure on domestic goods of foreign country. As a result, it raises the correlation between home productivity and trading partner share of expenditures on domestic goods. In contrast, the intensive margin of trade deteriorates the terms-of-trade. The home's tradable goods become cheaper in the trading partner's market following a productivity shock. Hence, it decreases the share of expenditure in domestic goods of the foreign country and therefore, decreases the third component factor. As such, the overall impact of trade is negative. However, given that the effect of the third factor on output correlation is not significant, trade does not affect the business cycle comovement through this channel.

Table 2.5 Bilateral trade and the correlation between TFP and expenditure share on domestic goods

	OLS				2SLS			
	Corr(λi,Aj)	Corr(λi,Aj)	Corr(λi,Aj)	Corr(λi,Aj)	Corr(λi,Aj)	Corr(λi,Aj)	Corr(λi,Aj)	Corr(λi,Aj)
LogTrade1	-0.029*** (0.007)				-0.082*** (0.015)			
LogTrade2		-0.028*** (0.007)				-0.083*** (0.015)		
LogOT			-0.015*** (0.004)				-0.046*** (0.008)	
LogEM				-0.013* (0.007)				0.524*** (0.137)
LogIM				-0.016** (0.007)				-0.582*** (0.150)
Constant	-0.398*** (0.042)	-0.409*** (0.045)	-0.381*** (0.044)	-0.391*** (0.056)	-0.695*** (0.084)	-0.752*** (0.094)	-0.698*** (0.085)	-3.892*** (0.966)
R-squared	0.02	0.02	0.01	0.02				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance	distance	distance	distance & entry cost
Cragg-Donald Wald F statistic					259.318	240.179	296.535	8.381
Stock-Yogo test (10% maximal IV size)					16.38	16.38	16.38	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

In this section, the results highlight that extensive margin of trade favors business comovement by increasing TFP comovement (through transmitting new technology) and raising the correlation between each country's share of expenditure on domestic goods (by not deteriorating, even improving, the terms-of-trade). These findings are in line with those of Liao and Santacreu (2015) and Juvenal and Santos-Monteiro (2017) (See Appendix

2.A.2 for a comparison). The extensive margin of trade thus is a potential solution to solve the trade-comovement puzzle.

2.4. Robustness Checks

We perform a sensitivity analysis in order to determine whether the benchmark results are robust. First, we re-calculate the business cycle comovement and its component factors by using the growth rate (computed as the first-differencing of natural logarithms of the raw series). We then re-estimate the effects of the intensive and extensive margins of trade on these variables. The results presented in the right-hand panel of Table 2.6 suggest that the extensive margin drives business comovement by increasing the two first components factors while the coefficients of the intensive margin have a negative or insignificant effect. These results reveal that our benchmark results are robust to the measure of the correlations.

Table 2.6 Correlations and margins of trade using series of growth

	OLS				2SLS			
	Corr(y_i,y_j)	Corr(A_i,A_j)	Corr(λ_i,λ_j)	Corr(λ_i,A_j)	Corr(y_i,y_j)	Corr(A_i,A_j)	Corr(λ_i,λ_j)	Corr(λ_i,A_j)
LogEM	0.051*** (0.006)	0.033*** (0.003)	0.027*** (0.005)	-0.035*** (0.007)	0.098*** (0.035)	0.075*** (0.020)	0.180*** (0.042)	0.393*** (0.117)
LogIM	0.034*** (0.006)	0.006* (0.003)	0.017*** (0.005)	-0.022*** (0.007)	0.067* (0.039)	-0.005 (0.022)	-0.103** (0.047)	-0.518*** (0.128)
Constant	0.585*** (0.046)	0.861*** (0.026)	0.616*** (0.039)	-0.423*** (0.052)	0.949*** (0.249)	0.855*** (0.140)	-0.045 (0.300)	-3.578*** (0.823)
R-squared	0.16	0.13	0.07	0.06				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance & entry cost	distance & entry cost	distance & entry cost	distance & entry cost
Cragg-Donald Wald F statistic					8.381	8.381	8.381	8.381
Stock-Yogo test (10% maximal IV size)					7.03	7.03	7.03	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

Second, because our sample consists of developed and developing countries, benchmark results may be bias due the endogeneity issues and unknown form of heteroskedasticity. We follow Ng (2010) in using the GMM-IV estimator to correct for these problems. Thus, the same instruments are exploited, and the results reported in Table 2.7 are similar to those of the benchmark estimations.

Table 2.7 Correlations and margins of trade using GMM-IV

	GMM-IV			
	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)
LogEM	0.120*** (0.042)	0.110*** (0.024)	0.079*** (0.030)	0.524*** (0.129)
LogIM	0.070 (0.046)	-0.036 (0.023)	0.007 (0.033)	-0.582*** (0.130)
Constant	1.036*** (0.291)	0.710*** (0.143)	0.534*** (0.212)	-3.892*** (0.826)
Nb of obs	780	780	780	780
Instruments	distance & entry cost	distance & entry cost	distance & entry cost	distance & entry cost

Note: The HP filter is used to de-trend the series before calculating the correlations.

Third, because the extensive margin decreases temporarily between 2008 and 2013 and the output correlations between countries may be higher during this downward period, we exclude the global crisis period from the sample and estimate the specifications on the data from 1990–2006. The results presented in Table 2.8 confirm a significant and positive effect of the extensive margin and a negative or insignificant of the intensive margin.

Table 2.8 Correlations and margins of trade, 1990–2006

	OLS				2SLS			
	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)
LogEM	0.027*** (0.007)	0.020*** (0.003)	0.053*** (0.006)	-0.026*** (0.008)	0.071** (0.041)	0.103*** (0.024)	0.069** (0.034)	0.675*** (0.182)
LogIM	0.034*** (0.004)	0.007*** (0.003)	0.007 (0.007)	-0.010 (0.009)	0.077 (0.053)	-0.049 (0.030)	0.031 (0.044)	-0.865*** (0.234)
Constant	0.502*** (0.062)	0.930*** (0.027)	0.370*** 0.054)	-0.344*** (0.069)	0.935*** (0.336)	0.673*** (0.193)	0.596*** (0.281)	-5.572*** (1.489)
R-squared	0.05	0.06	0.09	0.01				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance & entry cost	distance & entry cost	distance & entry cost	distance & entry cost
Cragg-Donald Wald F statistic					7.698	7.698	7.698	7.698
Stock-Yogo test (10% maximal IV size)					7.03	7.03	7.03	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

Table 2.9 Correlations and margins of trade in capital goods

	OLS				2SLS			
	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)
LogEM	0.035*** (0.007)	0.021*** (0.004)	0.018*** (0.007)	0.004 (0.008)	0.101** (0.048)	0.111*** (0.030)	0.074*** (0.038)	0.612*** (0.131)
LogIM	0.036*** (0.006)	0.012*** (0.003)	0.017*** (0.005)	-0.03*** (0.006)	0.070*** (0.028)	-0.010 (0.017)	0.017 (0.022)	-0.349*** (0.076)
Constant	0.618*** (0.050)	0.928*** (0.028)	0.512*** (0.041)	-0.051*** (0.052)	1.03*** (0.197)	0.856*** (0.123)	0.590*** (0.154)	-2.592*** (0.536)
R-squared	0,13	0.09	0.05	0.03				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance & entry cost	distance & entry cost	distance &entry cost	distance & entry cost
Cragg-Donald Wald F statistic					12.28	12.28	12.28	12.28
Stock-Yogo test (10% maximal IV size)					7.03	7.03	7.03	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

Fourth, we decompose the bilateral trade intensity into trade in capital goods, intermediate goods and consumptions goods. The effects of trade margins of these types of goods on business cycle comovement are reported in Tables 2.9–2.11. We find that the effects are similar to those of the baseline estimations in the cases of capital goods and consumption goods. However, the instruments are weak in the case of intermediate goods. Trade in intermediate goods involves vertical trade (importing intermediates for re-exporting as intermediates) and processing trade (importing intermediates for re-exporting as final goods). As such, entry cost is may not be strong enough to account for this feature of the extensive margin of trade in intermediate goods. Thus, we use a country pair dummy variable that equals one if both countries are developed and zero otherwise since different stages in production process may be allocated based on the country's level development. Moreover, the level of country development may affect the capacity to generate new products via technological innovation. The estimated results are reported in Table 2.12. The hypothesis that instruments are weak is rejected. In fact, we find positive and significant effects of the extensive margin of trade on business cycle comovement and its determinants.

Finally, we re-estimate the specifications when the extensive and intensive margins are measured using only exports. This means that we calculate these two explicative variables using only export data from country i to country j and EM_{ij} and IM_{ij}. The results reported in Table 2.13 do not differ from the benchmark estimation.

Table 2.10 Correlations and margins of trade in consumption goods

	OLS				2SLS			
	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)
LogEM	0.050***	0.028***	0.032***	-0.007	0.153***	0.106***	0.087***	0.367***
	(0.007)	(0.004)	(0.006)	(0.008)	(0.032)	(0.019)	(0.024)	(0.064)
LogIM	0.023***	0.002	0.008*	-0.022***	0.024	-0.024*	-0.002	-0.300***
	(0.006)	(0.003)	(0.005)	(0.006)	(0.024)	(0.014)	(0.018)	(0.049)
Constant	0.517***	0.843***	0.447***	-0.444***	0.701***	0.753***	0.451***	-2.254***
	(0.049)	(0.028)	(0.041)	(0.052)	(0.167)	(0.099)	(0.127)	(0.314)
R-squared	0.11	0.07	0.06	0.03				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance & entry cost	distance & entry cost	distance & entry cost	distance & entry cost
Cragg-Donald Wald F statistic					23.28	23.28	23.28	23.28
Stock-Yogo test (10% maximal IV size)					7.03	7.03	7.03	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

Table 2.11 Correlations and margins of trade in intermediate goods

	OLS				2SLS			
	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)
LogEM	0.040***	0.020***	0.025***	0.020***	0.109	0.149	0.091	0.915
	(0.005)	(0.003)	(0.004)	(0.005)	(0.074)	(0.091)	(0.064)	(0.754)
LogIM	0.020***	-0.006*	0.003	0.009	0.042	-0.196	-0.064	-1.899
	(0.007)	(0.004)	(0.005)	(0.007)	(0.153)	(0.189)	(0.133)	(1.559)
Constant	0.495***	0.797***	0.422***	-0.230***	0.862	0.167	0.140	-11.536
	(0.049)	(0.027)	(0.040)	(0.051)	(0.870)	(1.079)	(0.760)	(8.891)
R-squared	0.10	0.07	0.05	0.02				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance & entry cost	distance & entry cost	distance & entry cost	distance & entry cost
Cragg-Donald Wald F statistic					0.76	0.76	0.76	0.76
Stock-Yogo test (10% maximal IV size)					7.03	7.03	7.03	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

Table 2.12 Correlations and margins of trade in intermediate goods with dummy instrument variable

	OLS				2SLS			
	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)
LogEM	0.040*** (0.005)	0.020*** (0.003)	0.025*** (0.004)	0.020*** (0.005)	0.191*** (0.023)	0.120*** (0.016)	0.133*** (0.019)	-0.025 (0.017)
LogIM	0.020*** (0.007)	-0.006* (0.004)	0.003 (0.005)	0.009 (0.007)	-0.117*** (0.050)	-0.139*** (0.034)	-0.147*** (0.042)	-0.075*** (0.035)
Constant	0.495*** (0.049)	0.797*** (0.027)	0.422*** (0.040)	-0.230*** (0.051)	-0.025 (0.306)	0.148 (0.211)	-0.324 (0.255)	-0.850*** (0.210)
R-squared	0.10	0.07	0.05	0.02				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance & dummy	distance & dummy	distance & dummy	distance & dummy
Cragg-Donald Wald F statistic					16.47	16.47	16.47	16.47
Stock-Yogo test (10% maximal IV size)					7.03	7.03	7.03	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

Table 2.13 Extensive and intensive margin measured only using exports

	OLS				2SLS			
	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)	Corr(yi,yj)	Corr(Ai,Aj)	Corr(λi,λj)	Corr(λi,Aj)
LogEM	0.097*** (0.013)	0.052*** (0.007)	0.055*** (0.011)	-0.031** (0.014)	0.347*** (0.050)	0.199*** (0.029)	0.181*** (0.037)	0.469*** (0.123)
LogIM	0.012 (0.009)	-0.002 (0.005)	0.002 (0.007)	0.024** (0.009)	0.026 (0.062)	-0.069** (0.036)	-0.019 (0.045)	-0.713*** (0.151)
Constant	0.380*** (0.038)	0.825*** (0.021)	0.384*** (0.031)	-0.363*** (0.039)	0.680*** (0.216)	0.700*** (0.124)	0.424*** (0.156)	-2.646*** (0.524)
R-squared	0.07	0.06	0.04	0.02				
Nb of obs	780	780	780	780	780	780	780	780
Instruments					distance & entry cost	distance & entry cost	distance & entry cost	distance & entry cost
Cragg-Donald Wald F statistic					12.44	12.44	12.44	12.44
Stock-Yogo test (10% maximal IV size)					7.03	7.03	7.03	7.03

Note: The HP filter is used to de-trend the series before calculating the correlations.

2.5. Conclusion

Theoretical models are unable to fully replicate the relation between business cycle comovement and trade observed from the data. Kose and Yi (2006) have termed this phenomenon the trade-comovement puzzle. To solve this puzzle, Juvenal and Santos-Monteiro (2017) have proved that the output correlation should be explained by three component factors: correlation between each country's TFP, correlation between each country's share of expenditure on domestic goods, and correlation between each country’s TFP and the trading partner’s share of expenditure on domestic goods. They have illustrated that most models generate a counterfactual relation between trade and the comovement of share of expenditure on domestic goods. In this chapter, we have empirically investigated the effect of extensive margin of trade on business cycle comovement and its determinants. First, we have re-examined the business comovement factor structure, determining that the first two component factors drive the business cycle synchronization. On the other hand, the effect of the third factor is not significant. By decomposing bilateral trade into extensive and intensive margins, we have observed that the extensive margin of trade not only synchronizes TFP shocks through transmitting new technology embedded in varieties of goods (Liao and Santacreu, 2015) but also favors the correlation between each country's share of expenditure on domestic goods. In fact, the effect of the intensive margin is negative or not significant. Thus, we suggest that theoretical models should allow for extensive margin of trade in order to solve the puzzle. In such models, following a productivity shock in the Home country, the productivity threshold for firms to export falls. This fall raises the number of domestic firms and number of new products in the tradable sector. The prices of domestic exported products do not change, even increase. The correlation of aggregate productivities and shares of expenditure in domestic goods increase with trade in varieties. These higher correlations induces an increase in business cycle comovement. Since the extensive margin of trade, and not the intensive margin, enhances comovement, countries should encourage the trade of new products in order to increase synchronization.

The existing literature on the trade-comovement puzzle has only focused on the unanticipated productivity shock. However, recent empirical evidence has noted important differences between the transmission of unanticipated (surprise) TFP shock and anticipated (news) TFP shock. For instance, Levchenko and Pandalai-Nayar (2018) have suggested that while the news TFP shocks occurring in the US generate Canadian business cycle in the medium term, US surprise TFP shocks have no effect on the neighboring economy. Nam and Wang (2015) have emphasized the important role of news TFP shock in comparison with the traditional surprise TFP shock on the transmission via trade channels. Thus, the trade-comovement puzzle may originate from this source of macro aggregate fluctuations. The next and final chapter adds to the literature by identifying evidence for the transmission of news TFP shock via trade channel. More specifically, the contribution brings a new viewpoint on one of the sources of the international business cycle: news TFP shock.

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Appendix

Table 2.A.1 Descriptive Statistics

Variable	Nb. of Obs.	Mean	Std. Dev.	Min	Max
Corr(y_i,y_j)	780	0.23	0.32	-0.71	0.90
Corr(A_i,A_j)	780	0.78	0.18	0.00	0.99
Corr(λ_i,λ_j)	780	0.32	0.27	-0.63	0.89
Corr(λ_i,A_j)	780	-0.23	0.32	-1.17	0.63
EM_{ij}	780	0.280	0.250	0.000	0.960
IM_{ij}	780	0.002	0.016	0.000	0.375
$Trade1_{ij}$	780	0.012	0.025	0.000	0.293
$Trade2_{ij}$	780	0.006	0.020	0.000	0.315

Table 2.A.2 Our results versus Liao and Santacreu (2015) and Juvenal and Santos-Monteiro (2017)

	OLS	2SLS			J&SM2017				L&S2015	
	$Corr(y_i,y_j)$	$Corr(y_i,y_j)$	$Corr(A_i,A_j)$	$Corr(\lambda_i,\lambda_j)$	$Corr(y_i,y_j)$	$Corr(y_i,y_j)$	$Corr(A_i,A_j)$	$Corr(\lambda_i,\lambda_j)$	$Corr(y_i,y_j)$	$Corr(A_i,A_j)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$Corr(A_i,A_j)$	0.741*** (0.061)				0.135* (0.069)					
$Corr(\lambda_i,\lambda_j)$	0.207*** (0.043)				0.320*** (0.062)					
$Corr(A_i,\lambda_j)$	-0.019 (0.032)				-0.282* (0.153)					
$Log(Trade_{ij})$						0.103*** (0.021)	0.061*** (0.021)	0.074*** (0.023)		
$Log(EM_{ij})$		0.120*** (0.041)	0.110*** (0.026)	0.079** (0.032)					0.155*** (0.029)	0.138*** (0.025)
$Log(IM_{ij})$		0.070 (0.045)	-0.036 (0.029)	0.007 (0.035)					0.016 (0.014)	-0.021 (0.012)
Constant	-0.421*** (0.046)	1.036*** (0.292)	0.710*** (0.186)	0.534** (0.227)	0.266*** (0.047)	0.963*** (0.093)	0.560*** (0.100)	0.937*** (0.099)	0.644*** (0.080)	0.215** (0.071)
R-squared	0.24				0.17	0.1	0.03	0.04		
Nb. of obs.	780	780	780	780	210	210	210	210	2610	2610
Instruments		distance & entry-cost	distance & entry-cost	distance & entry-cost					distance & entry-cost	distance & entry cost
Cragg-Donald Wald		8.381	8.381	8.381						
Stock-Yogo 10%		7.03	7.03	7.03						

Notes: Numbers in parentheses are standard errors; ***, **, * significant at 1%, 5% and 10%, respectively. HP filter is used to detrend the raw series. This Appendix resumes our estimated results and that of Liao and Santacreu (2015) and Juvenal and Santos-Monteiro (2017). Column (1) shows our updated factor structure of business cycle comovement. Columns (2) and (3) show effects of the margins of trade on output and TFP comovements. These results are in line with two studies, which is reported in columns 5, 6, 7, 9 and 10. Column (4) shows our main contribution. The coefficient of the extensive margin is significant at 5% confidence level and equals to 0.079 (compared to 0.074 of the effect of total trade in Juvenal and Santos-Monteiro, 2017, reported in column 8). The intensive margin has no significant effect. This finding emphasizes that the extensive margin is mainly responsible for the empirical positive effect of trade on the comovement of share of expenditure on domestic goods.

CHAPTER 3

NEWS TFP SHOCK, TRADE AND BUSINESS CYCLE TRANSMISSION TO SMALL OPEN ECONOMIES

Highlights

The trade-comovement puzzle may arise from sources of aggregate fluctuations. Theoretical models (Kose and Yi, 2006, Liao and Santacreu, 2015, Juvenal and Santos-Monteiro, 2017, among others) have focused on the surprise Total Factor Productivity (TFP) shock. In their models, a positive surprise TFP shock generates an increase in domestic demand. This fluctuation is then transmitted to foreign economies via the demand-supply channel of trade. However, recent empirical evidence (Levchenko and Pandalai-Nayar, 2018) has suggested that news TFP shock, and not surprise TFP shock, is responsible for the economic cycle transmission. This chapter provides more empirical evidence regarding the demand-supply mechanism of trade through investigating the cross-border transmission of news TFP shocks and thereby contributing to understanding the puzzle. We use a structural VAR model to investigate the responses of trade and macro aggregates in four advanced economies, Australia, Canada, New Zealand and the United Kingdom, to a news TFP shock occurring in the United States. The news shocks are identified as in Barsky and Sims (2011). By running the model on data over the post-Bretton Woods period (1973Q1- 2016Q4), we obtain two findings. First, real exchange rate, terms-of-trade and bilateral trade between these economies and the United States reacts to news TFP shocks in a different way than contemporaneous TFP shocks. These results are in line with those of Nam and Wang (2015). Second, the business cycles of these economies are affected by news rather than contemporaneous TFP shocks in the United States. News TFP shocks are therefore an important source of the international business cycle instead of contemporaneous TFP shocks, a proposition which has been well documented in the literature.

JEL classification: E32, F4, F41

Keywords: News-driven business cycle, News TFP shock, Business cycle transmission, Small open economy

3.1. Introduction and Literature Review

News TFP shocks (or anticipated TFP shocks) are shocks that have no immediate impact on productivity, but portend its movements in the near future. Discoveries, inventions, and technological innovations need time to enhance productivity. For example, Internet of Things technologies, 3D printing technology, self-driving cars, hyperloop train, and smart robots have not yet become popular, although we have known about them for a long time. Otherwise, contemporaneous TFP shocks (or surprise TFP shocks, unanticipated TFP shocks) are shocks that immediately affect productivity. Given the rapid development of information and communication technology over the last two decades, most productivity shocks are news shocks. In fact, recent empirical evidence has suggested that news TFP shocks generate business cycles (Barsky and Sims, 2011, Beaudry et al., 2011b, Fujiwara et al., 2011, Nam and Wang, 2015, Kamber et al., 2017, among others). In a globalizing world, when a shock causes domestic macro fluctuations, the question of transmission across countries is important. Yet, whereas transmission mechanisms of surprise TFP shocks in open economies have attracted the attention of many researchers, there is limited empirical evidence regarding news TFP shock transmission across countries. Therefore, this chapter focuses on the cross-border transmission of news TFP shocks. We empirically investigate its role on trade behavior and international business cycle convergence.

Most theoretical models have focused on the effects of news shocks on real activity. They have not addressed the transmission of this type of shock via trade channel. The first work on modeling the role of news shock in explaining business cycles is that of Beaudry and Portier (2004). In their research, the authors constructed a general equilibrium structure model to formalize the idea that difficulties encountered by forward-looking agents in forecasting the economy may induce booms and recessions. This view has had a long history since it was first elaborated by Pigou (1927). However, there has been a growing interest in explaining business cycles by the news about future total factor productivity. Fujiwara et al. (2011) have investigated whether news TFP shock can be a major source of aggregate fluctuations. They have extended a DSGE model by allowing news TFP shocks and estimating for the United States and Japan using Bayesian methods. Their three results are that news TFP play a more important role in the US than in Japan, the effects of news shock are more important with longer forecast horizon, and news TFP shocks make the overall effect of productivity on hours worked ambiguous. Schmitt-Grohé and Uribe (2012) have estimated, in the context of a DSGE model, the contributions of anticipated shocks to the post-war US business cycles by using classical maximum likelihood and Bayesian methods. They have considered several structural shocks, including shock to productivity, shock to government spending, shock to wage markup, and preference shocks. Each of these shocks consists of a news component and a surprise component. For the anticipated component, they have distinguished the anticipation horizons, which means that positive (or negative) news may be repeated several times before realization. Their findings have suggested that approximately half of predicted aggregate movements in output, consumption, investment, and employment are explained by anticipated shocks. Beaudry et al. (2011) have developed a model to simulate the way news shocks generate positive co-movements in real activity across countries. They have indicated that news TFP shocks provide a driving force of business cycles synchronization.

On the empirical front, most studies based on news TFP shock identification schemes have been proposed by Beaudry and Portier (2006) and Barsky and Sims (2011). These studies have pointed out that news TFP shocks account for a significant fraction of macroeconomic aggregates fluctuations. Beaudry and Portier (2006) have noted that news TFP shocks account for nearly half of business cycle fluctuations. These news shocks generate a boom in consumption, investment, and hours worked. These results are obtained from a news shock identification scheme in which the effect of news TFP shock is imposed as zero over the first periods. In contrast, Barsky and Sims (2011) have proposed a news TFP shock identification approach using a structural VAR framework, in which news TFP shocks are imposed to have no impact on current factors-utilization-adjusted TFP and are orthogonal to the surprise shock. They have suggested that movements in factors-utilization-adjusted TFP are fully explained by these two shocks. After running the model on the US's data from 1960 to 2007, the authors found that positive news about future productivity declines output, investment and employment but increases consumption. However, studying news TFP shocks is insufficient to understand recessions. Beaudry et al. (2013) have indicated that the two identification approaches drive similar results. Some empirical studies have addressed the transmission of news TFP shock via the trade channel. For instance, empirical evidence for the US economy, as concluded by Nam and Wang (2015), has suggested that there are distinct dynamics for bilateral trade variables (net trade, real exports, and real imports) following surprise and anticipated shocks to productivity. The responses of international relative prices (real exchange rate and terms-of-trade) are also different. In particular, whereas good news about future productivity appreciates terms-of-trade and real exchange rate, surprise shock depreciates them. The authors therefore have concluded that ignoring news components in TFP shock may induce misleading conclusions.

More specifically, two studies relate directly to our work. Levchenko and Pandalai-Nayar (2018) have recently used a SVAR model to estimate the international transmission of three types of shock, news TFP shock, surprise TFP shock and "sentiment" (non-technology) shock. They have found that for the US-Canada country pair, news TFP shock is a source of co-movement in the medium- and long-term, whereas surprise TFP innovations do not generate synchronization. In the short-term, "sentiment" shock dominates the surprise and news TFP shock in producing business cycle co-movement between the US and Canada. They have focused on the transmission of sentiment shock exclusively for the US-Canada. Given that news TFP shock may be a solution for the trade-comovement puzzle, this chapter focuses exclusively on the transmission of this type of shock. Our work is thus distinguished from their paper since we focus on the transmission of news TFP shocks to other small open countries via the trade channel. Moreover, as TFP shocks influence relative prices, we investigate the responses of the volume of trade (export and import) as well as the international prices (real exchange rate and the terms-of-trade) to news and surprise TFP shocks as in Nam and Wang (2015).

Kamber et al. (2017) have focused on the responses of aggregate macroeconomic variables in four advanced small open economies, Australia, Canada, New Zealand and the United Kingdom, following a news shock in domestic TFP (since these four economies are relatively small in terms of GDP size with respect to the US GDP, they call them advanced small open countries). By estimating four country-specific VAR models, they have discovered that expected shocks to productivity generate comovement between real output, employment, consumption and investment. Good news about future productivity in a given country also induces a decrease in its net trade. These authors have highlighted that news TFP shocks are related to the comovement between aggregate variables as well as countercyclical current account dynamics. In this chapter, we reexamine these four advanced open economies (Australia, Canada, New Zealand and United Kingdom). However, our work differs from their study as we investigate the impact of foreign news TFP shocks on these economies. In other words, while we study the transmission of news TFP shocks, they focus on impact of domestic news TFP shocks.

By studying the responses of macro aggregates and bilateral trade in four advanced small open economies following news and surprise TFP shocks experienced in the United States, this chapter examines the role of news TFP shock on the international business cycle convergence. Advanced small open economies are used as a case study to analyze these issues due to their small sizes relative to the US, which renders them more sensible to the shock. Moreover, macro fluctuations in these countries do not affect US TFP shocks. As such, we obtain two findings. First, the effects of news TFP shocks on real exchange rate, terms-of-trade and bilateral export and import between small open economies and the United States are different from that of contemporaneous TFP shocks. News TFP shocks in the US favor its import from small trading partners while surprise TFP shocks do not. The increase in US domestic demand is thereby transmitted to foreign economies through demand-supply mechanism of trade. This fact is demonstrated in the second finding: the business cycles of the small open economies are significantly affected by the economic booms in the United States generated by news TFP shocks. The TFP news shocks are thus an important source of the international business cycle and should be considered in a theoretical model in order to replicate the trade-comovement relationship.

The rest of the chapter is organized as follows: Section 2 presents the empirical strategy, section 3 describes the data and stylized facts, section 4 discusses the main empirical results and section 5 offers a conclusion.

3.2. Empirical Strategy

3.2.1 SVAR Model and Estimation Strategy

To study the responses of macroeconomic aggregates as well as bilateral trade variables (both quantity and price effects) of open small economies when news TFP shocks occur in their trading partner, we use a SVAR model in which news shocks about the future of total factor productivity are identified as in Barsky and Sims (2011).

We follow Levchenko and Pandalai-Nayar (2018) to choose the estimation strategy. First, we estimate a reduced form VAR in order to evaluate the responses of the US economy when facing news and surprise TFP shocks:

$$Y_t = C_0 + C_1 L Y_t + \ldots + C_p L^p Y_t + u_t$$

where Y_t is the matrix of variables as described below, C refers to matrix of parameters to be estimated, L is lag operators and u_t denotes matrix of residuals.

This model highlights the differences in impulse responses of the US macroeconomic aggregates to surprise and news TFP shocks. It is an extension of the five-variable VAR model estimated in Barsky and Sims (2011). The variables include: Utilization-adjusted TFP of the US, US Real GDP, US real investment (private non-residential gross fixed capital formation as proxy - INV), US real consumption (CON), US employment equal to worked hours multiplied by number of persons (EMP). We also add the variable share of expenditure on domestic goods of the United States (SHARE, equal to one minus the import penetration ratio) to determine how consumption structure changes when facing TFP news and surprise shocks. This variable helps forecast the behavior of exports and imports with trading partners. We call this six-variable model the "core VAR" model.

To estimate the cross-border transmission of news and surprise TFP shocks in the US to other countries, we follow Levchenko and Pandalai-Nayar (2018) in estimation strategy. We include variables of small open countries one by one and order it last in a seven-variable VAR model ("core VAR" model + 1 variable) as macro fluctuations in advanced small economies do not influence the US macro aggregates. The eight variables considered for small open economies are: Real export from each country to the United States (EXP), real import to each country from the United States (IMP), real GDP of each country, real investment of each country (INV, private non-residential gross fixed capital formation is taken as proxy), real consumption of each country (CON), employment equal worked hours multiplied by number of persons (EMP), real exchange rate of the US dollar and each small open country's currency (RER), and relative terms-of-trade between the United States and each small open country (TOT). We follow Nam and Wang (2015) by calculating TOT and RER and including them in the model. First, the real exchange rate between country H and country F is calculated as the ratio between the CPI of country H in country F's currency to CPI of country F. It is equal to:

$$\mathrm{RER} = \frac{\mathrm{CPI}_{\mathrm{H\ in\ H's\ currency}} \times \mathrm{Nominal\ exchange\ rate\ H/F}}{\mathrm{CPI}_{\mathrm{F\ in\ F's\ currency}}}$$

As a result, increases in the real exchange rate mean that the currency of country H appreciates versus the currency F. Second, and similarly, the terms-of-trade is measured by using the nominal exchange rate and the export deflators. It equals to:

$$\mathrm{TOT} = \frac{\mathrm{Export\ Deflator}_{\mathrm{H\ in\ H's\ currency}} \times \mathrm{Nominal\ exchange\ rate\ H/F}}{\mathrm{Export\ Deflator}_{\mathrm{F\ in\ F's\ currency}}}$$

The terms-of-trade represents the international relative price of traded goods. An increase in the measure of terms-of-trade indicates that the traded goods of country H are more expensive relative to those of country F. In this study, country H is the United States and F is a considered an open country.

Hence, for each of the four small open economies, we run the seven-variable SVAR model eight times to have impulse responses of macroeconomic variables as well as trade and relative prices to a favorable news TFP shock in the United States. The same exercise is realized in the case of the surprise shock.

The lag[9] of the model is chosen to be three. As suggested by Barsky and Sims (2011), all variables added in the system are in level. Barsky and Sims (2011) have proposed that estimating the VAR system in levels produces consistence estimates of impulse responses. It is also sufficiently robust to the cointegration of unknown form. According to these authors, although estimating the model in levels or differences produces similar results, the level specification is preferred as the invalid assumptions concerning the common trend can yield misleading conclusions.

3.2.2 News TFP Shock Identification Scheme

We identify the news shock in the SVAR model by using the identification scheme developed by Barsky and Sims (2011). This identification method is described below.

Assuming that TFP follows a process:

$$\mathrm{LnA_t} = [\mathrm{B_{11}(L)}\ \mathrm{B_{12}(L)}\ ] \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} \qquad (3.1)$$

where A_t denotes the TFP at year t, $\varepsilon_{1,t}$ is the surprise technology shock and $\varepsilon_{2,t}$ is the news shock. Barsky and Sims (2011) have only imposed the restriction $B_{12}(0) = 0$, so that news shock does not immediately affect technology. The TFP at a given point in time is affected by three factors, contemporaneous shock, past news shocks, and past TFP changes:

[9] We follow Levchenko and Pandalai-Nayar (2018) to choose lag based on the Akaike Information Criterion.

$$\mathrm{LnA_t = LnA_{t-1} + \varepsilon_{1,t} + \varepsilon_{2,t-j}} \qquad (3.2)$$

They have identified the unanticipated (surprise) shock as the reduced form innovation in TFP. The anticipated (news) shock is then identified as the shock that best explains the remaining TFP future movements. In other words, the news TFP shocks are identified as the first principal component of observed TFP over all forecast horizons, up to a truncation horizon.

Assuming we have a VAR model of observables y_t:

$$y_t = B(L)u_t$$

with a linear mapping between innovations and structural shocks:

$$u_t = A_0\varepsilon_t$$

The model is then re-written:

$$y_t = C_o(L)\varepsilon_t$$

where $C_o(L) = B(L)A_0$ and $\varepsilon_t = A_0^{-1}u_t$.

The h step ahead forecast error is:

$$y_{t+h} - E_{t-1}y_{t+h} = \sum_{t=0}^{h} B_\tau \tilde{A}_0 D\varepsilon_{t+h-\tau}$$

where $\tilde{A}_0D$ is the entire space of permissible impact matrices with D a orthogonal matrix. The share of the forecast error variance that structural shock j contributes to variable i at horizon h is then:

$$\Omega_{i,j}(h) = \frac{e_i'(\sum_{\tau=0}^{h} B_\tau \tilde{A}_0 D e_j e_j' D' \tilde{A}_0' B_\tau')e_i}{e_i'(\sum_{\tau=0}^{h} B_\tau \Sigma B_\tau')e_i} = \frac{\sum_{\tau=0}^{h} B_{i,\tau}\tilde{A}_0\gamma\gamma'\tilde{A}_0' B_{i,\tau}'}{\sum_{\tau=0}^{h} B_{i,\tau}\Sigma B_{i,\tau}'}$$

where e_i is the selection vector in which i^{th} element equals to 1 and the others equal to 0. Equations (3.1) and (3.2) imply that surprise and news shock account for all variations in TFP at all horizons. In the case that TFP occupies the first position in the system, the surprise shock is indexed by 1, the news shock is indexed by 2, and we have:

$$\Omega_{1,1}(h)+\Omega_{1,2}(h)=1 \quad \forall h$$

Since this restriction does not hold reasonably at all horizons in a multivariate VAR setting, the authors have suggested selecting the impact matrix to be as close as possible to holding over a set of truncation horizons. It is done by choosing the second column of the impact matrix to solve the following optimization problem:

$$\gamma^{*} = \arg\max \sum_{h=0}^{H} \Omega_{1,2}(h) = \frac{\sum_{\tau=0}^{h} B_{i,\tau} \tilde{A}_0 \gamma \gamma' \tilde{A}_0' B_{i,\tau}'}{\sum_{\tau=0}^{h} B_{i,\tau} \sum B_{i,\tau}'}$$

so that:

$$\tilde{A}0(1, j) = 0 \qquad \forall j > 1$$

$$\gamma(1,1) = 0$$

$$\gamma\gamma' = 1$$

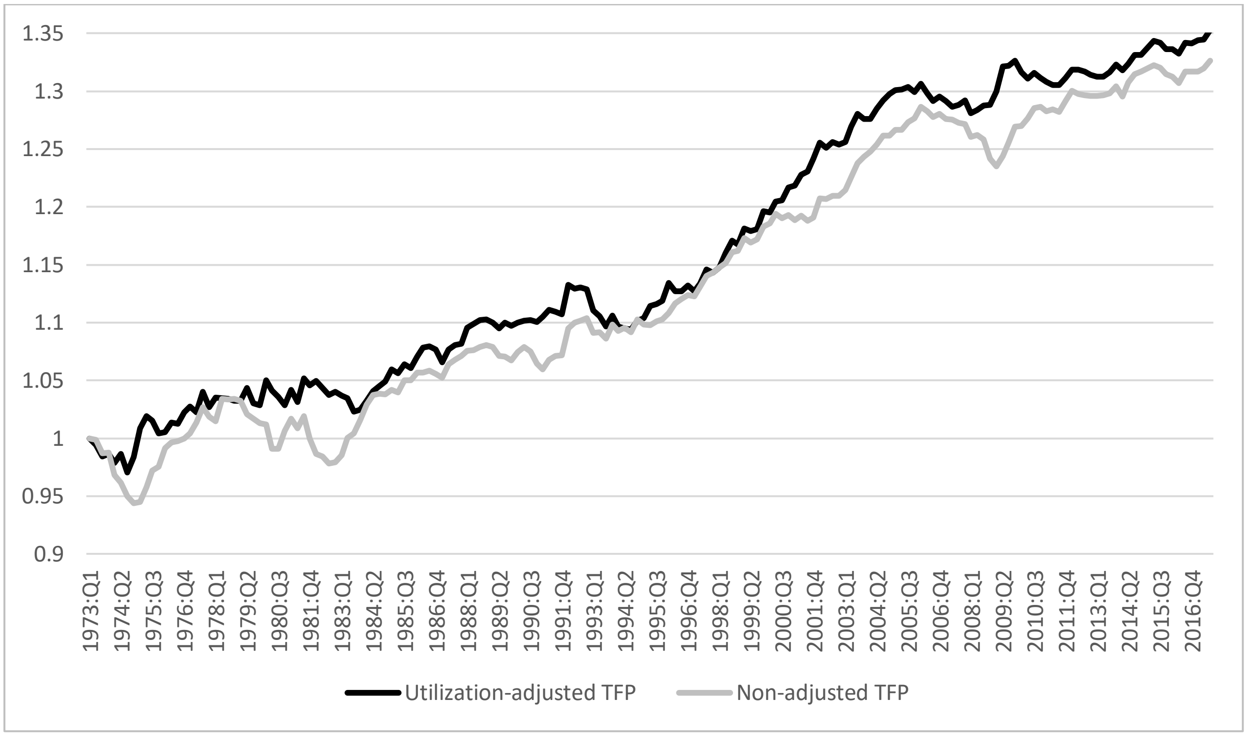
In Barsky and Sims (2011), the truncation period is equal to 40. However, since the TFP series is subject to measurement errors, Kurmann and Sims (2017) have raised a question as to whether identifying news shocks by imposing orthogonality with current productivity and giving weight to short forecast horizons risks confounding news shocks with other business cycle shocks. However, their results have suggested that the main results do not change when the truncation horizons are 20, 40 or 80 quarters. Therefore, we run the models with length of truncation horizon as 40 quarters, thus following the work of Barsky and Sims (2011).

As documented in Kurmann and Otrok (2013), this identification approach has several desirable features and is thus easily applied to a large VAR system. First, the approach does not restrict the different VAR variables. Second, the approach does not impose additional or complicated assumptions about other shocks. The approach also allows that contemporaneous TFP shock as well as news TFP shock have a permanent impact on TFP.

3.3. Data and Stylized Facts

Data is extracted over the post-Bretton Woods period: 1973Q1–2016Q4. In the news shock identification approach discussed above, Barsky and Sims (2011) have imposed the restriction that news TFP shock have no impact on current TFP. As the factor utilization – or the intensity that capital and labor are used – responds immediately when a news TFP shock occurs (see Jaimovich and Rebelo, 2009, and Nam and Wang, 2010), this restriction is no longer valid if data on TFP are not adjusted for input utilization. In addition, Barsky and Sims (2011) have supposed that all movements in the true TFP are fully explained by contemporaneous and news shocks, the non-adjusted TFP series may be driven by unobserved factors. Therefore, the TFP series must be adjusted for the utilization rate. Fernald (2014) has produced a quarterly measure for the United States of utilization-adjusted TFP by relying on the annual estimates for utilization from Basu et al. (2006). We have obtained these data from Fernald's website, wherein the author has posted the series in terms of annualized percentage changes. We have divided the original series by 400 and then cumulated them to recover the quarterly TFP series in levels. The first point of productivity series is assumed to be 1. The recovered series is illustrated in Figure 3.1, indicating an increasing trend of the US productivity from 1973Q1 to 2016Q4.

Figure 3.1 US utilization-adjusted Total Factor Productivity (1973Q1–2017Q3)



Source: Fernald's website.

Output, consumption, and investment (in constant local currency) data are extracted from the OECD Economic Outlook database. Employment is calculated by multiplying the total hours worked by the number of working persons. These series are available in the OECD database. All macroeconomic aggregates are taken as logarithms before running the estimation. Bilateral trade in current US dollars comes from the Direction of Trade Statistics (DOTS) database of the IMF. These series are then deflated by the GDP deflator, which has been taken from the International Financial Statistic (IFS) of the IMF. In order to compute the share of expenditure in domestic goods of the United States, we obtain the total exports and imports in current dollars from the OECD database. The nominal exchange rate series are from IFS. Lastly, the CPI and export deflators are also taken from the OECD Economic Outlook.

Stylized facts

Table 3.1 Relative GDP size and Trade Intensity between four countries and the United States (1973–2016)

Country	%GDP/US	TRI/US	Rank of export to US	Rank in import of US
Australia	5.55%	13.83%	4	24
Canada	9.40%	68.93%	1	1
New Zealand	0.90%	13.44%	2	36
United Kingdom	16.30%	11.35%	1	6

Notes: "%GDP/US" is the ratio between real GDP of each country and the US real GDP. "TRI/US" is the trade intensity between each country and the US. "Rank of export to US" is the rank of the US market in each country's export markets. "Rank in import of US" represents the position of each considered country in a list of countries from which the US imports.

Table 3.1 presents information about the four advanced small open countries. The second column indicates the GDP of these economies as a percentage of the US GDP, in average, over the period 1973–2016. Compared to the US, these economies are relatively small since their GDPs correspond to approximately 1% (New Zealand), 5.5% (Australia), 9.4% (Canada) and 16.3% (United Kingdom) of the US GDP. The third column represents the trade intensity between each small economy and the US. This indicator is calculated as the ratio of total bilateral trade with the US on its total trade:

$$TRI/US_i = \frac{1}{T}\frac{EX_{i\_USt} + IM_{i\_USt}}{EX_{it} + IM_{it}}$$

where i is Australia, Canada, New Zealand or the United Kingdom. The numbers in the third column, calculated by using quarterly data over 1973Q1–2016Q4, suggest that Canada trades intensively with the US. The total exports and imports with the US account for nearly 70% of its total trade. Thus, the US is the largest export market of Canada, as indicated in the fourth column (in average over 1973–2017). Trade intensities with the US are roughly 14%, 13.5% and 11% for the cases of Australia, New Zealand and United Kingdom, respectively. The US is also the largest goods and services receiver of the UK, the third largest export market of the New Zealand and the fourth largest export market in the case of Australia (in average over 1973–2017). Column 4 reveals that the US imports mostly from Canada. The United Kingdom occupies the sixth place in countries from which the

US imports. The positions of Australia and New Zealand are, respectively, twenty-fourth and thirty-sixth. These numbers indicate that trade linkages between these economies and the US are high. Hence, macroeconomic aggregates in these economies are sensible when facing shocks in the US. Therefore, these countries are suitable case studies for examining cross-border transmission of US news TFP shock through the trade channel.

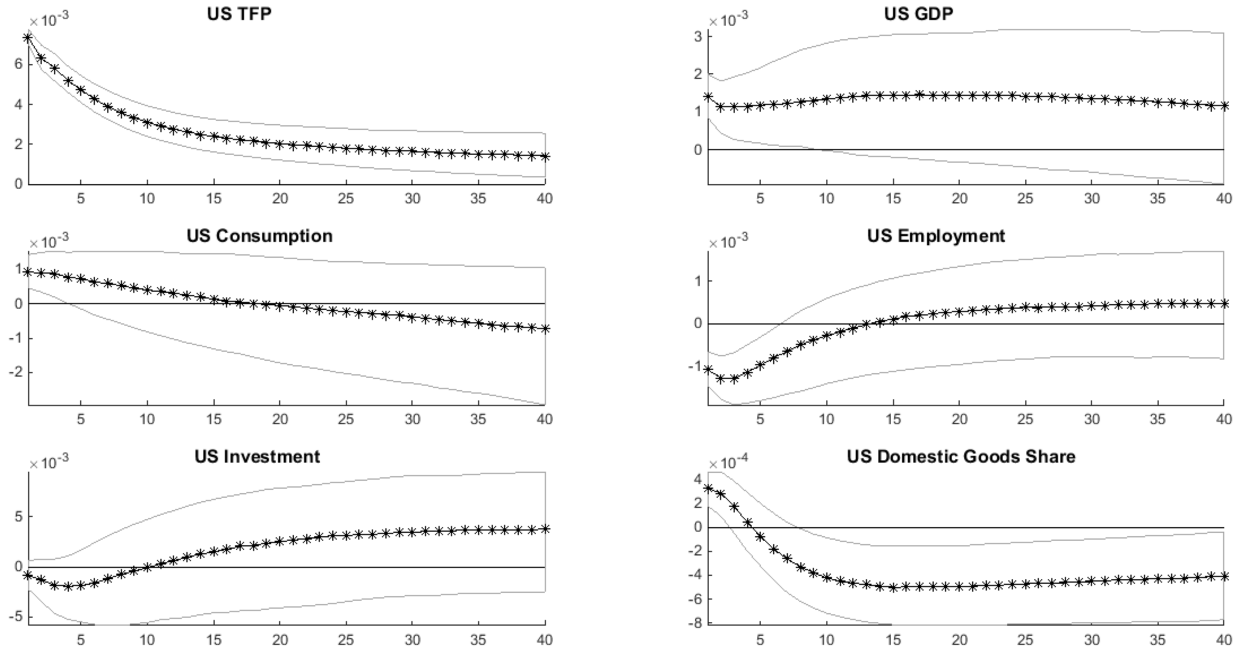
3.4. Empirical Results

We run the six-variable core VAR model in order to evaluate the responses of domestic variables to news and surprise TFP shocks in the United States. We then add one by one trade and macro variables to the core VAR model to discuss how bilateral trade, relative prices and trading partners business cycles react to these two shocks. Since we consider eight variables (including four trade variables and four macro variables) for each country, we run the seven-variable VAR model eight times for each country. The procedure is the same for four countries.

3.4.1. News TFP Shocks Generate Business Cycle in the United States

Figure 3.2 represents the impulses responses of macroeconomic variables in the US to an unanticipated TFP shock. Productivity increases approximately 0.8% on impact, and then gradually decreases to its initial level. Following the shock, US GDP increases slightly on impact, but rapidly drops to its trend after nine quarters. The wealth effect causes an increase in consumption, but the effect exists in the short-term. As such, this aggregate becomes insignificant at the third quarter and falls below the trend. The shock induces a decrease in employment on impact, although it recovers after some periods. Overall, these results are consistent with recent work of Levchenko and Pandalai-Nayar (2018). In addition, we do not find any impact of surprise TFP shock on investment in the US. Its impulse response is not statistically significant. The slight increase on impact of share of expenditure in domestic goods indicates a decrease of total import. This fact may induce a decline in export from trading partners to the US and is investigated in more detail in the following sections. In sum, surprise TFP shocks only generate minute macro fluctuations in the short-term in the US. Moreover, this shock does not cause comovement between GDP, consumption and hours.

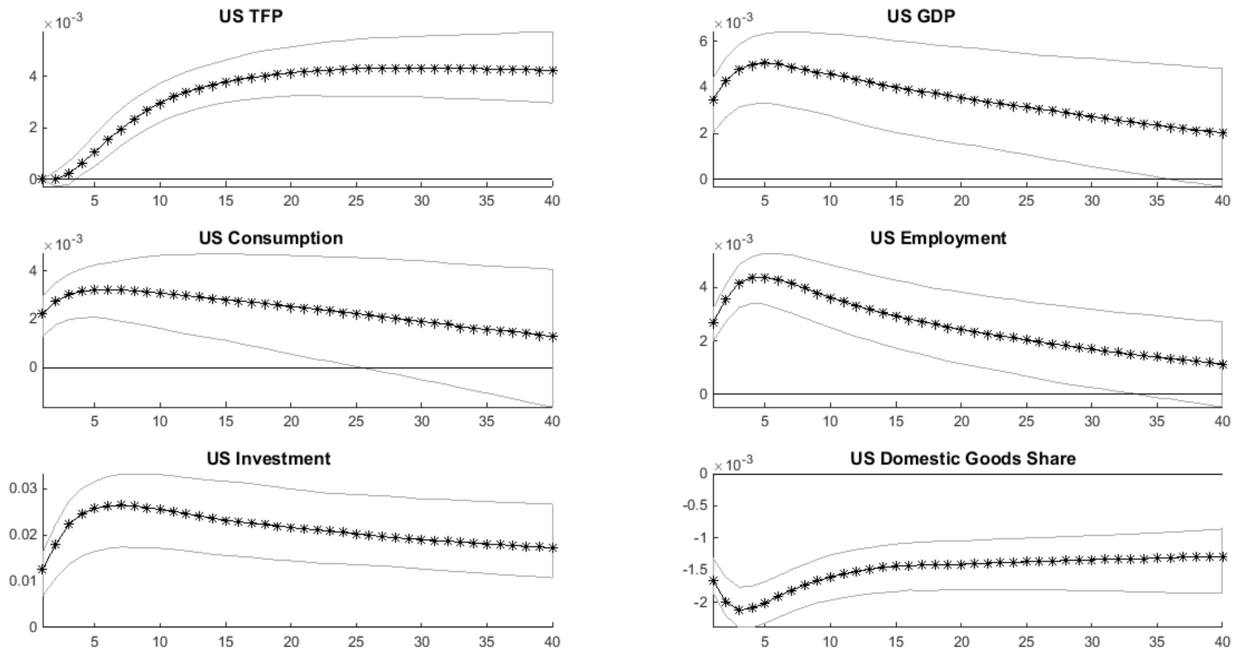
Figure 3.2 Impulse responses of US macro aggregates to a surprise TFP shock



Note: This figure presents impulses responses of macroeconomic variables in the United States to a positive surprise TFP shock. The model is run over the post-Bretton-Wood period, 1973Q1 to 2016Q4.

In contrast to the surprise productivity shocks, news TFP shocks generate business cycles in the US in the medium-term. Impulse responses are depicted in Figure 3.3, and the impulse response of TFP is near to zero in the two first periods as the news has no actual impact on productivity. It then increases gradually and permanently. Following the shock, GDP, employment, consumption, and investment jump up on impact and continue to increase over the next five to ten quarters before returning to the trend. The news TFP shocks is therefore a source of comovement of these macro aggregates. In particular, real GDP deviates from its initial level by approximately 0.3% on impact. This variable continues to increase until the sixth quarter. The shock signals a positive deviation of 0.3% in employment on impact. The effect on this variable peaks at the seventh quarter and then declines but remains significant. Investment exhibits an increase of 1.1% on impact and peaks after seven quarters. In general, the effects of news TFP shocks on macro aggregate variables in the United States persist significantly. These results align with those of Nam and Wang (2015) and Levchenko and Pandalai-Nayar (2018). However, the later study has suggested that there is no significant effect of the shock on GDP on impact and that employment exhibits a slight decline before turning positive one year after the shock. The impulse response of GDP peaks two years after the shock and that of employment peaks at the ninth quarter. Although there are differences between our results and those of Levchenko and Pandalai-Nayar (2018) regarding the initial effects of the news TFP shock on GDP and employment, at large the responses are similar. The news TFP shock causes an economic boom in the United States in the medium-term. Moreover, impulse response reveals that the share of expenditure in domestic goods declines significantly due to the increase of total import, or the export of US trading partners. With a significant increase in total import, economic expansion is transmitted across countries via the trade channel, and the news TFP shocks may therefore generate international business cycles. In the following section, we analyze the responses of bilateral trade and relative prices (real exchange rate and terms-of-trade).

Figure 3.3 Impulse responses of US macro aggregates to a news TFP shock



Note: This figure presents impulses responses of macroeconomic variables in the United States to a positive news TFP shock. The model is run over the post-Bretton-Wood period: 1973Q1 to 2016Q4.

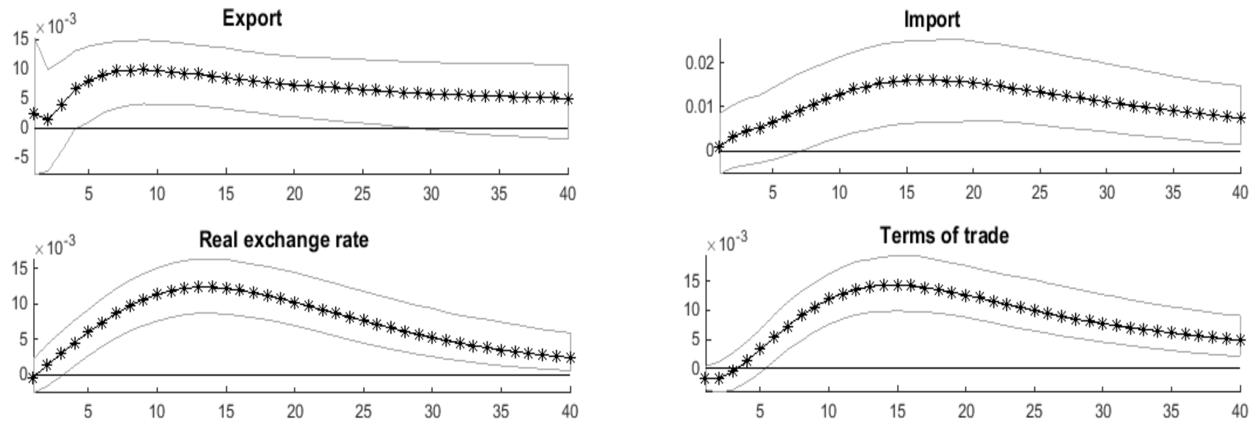
3.4.2. Responses of Bilateral Trade and Relative Prices following Surprise and News TFP Shocks

We first examine the impacts of the surprise productivity shock in the United States on other small economies. Figure 3.4 illustrates the responses of bilateral trade (export and import), real exchange rate and terms-of-trade between the United States and four advanced small open countries to a surprise TFP shock in the United States. For Australia and New Zealand, exports increase after three to four quarters but quickly return to their initial levels. The exports of Canada to the United States decrease slightly on impact but recover to zero after one period. We do not find any impact of shock on exports from the United Kingdom. The behavior of imports from the United States to these countries is similar to exports. It jumps up for certain quarters in the case of Australia but is not statistically significant in Canada, New Zealand or the United Kingdom. To conclude, the surprise TFP shock seems to have no major impact on bilateral trade between the United States and these small open countries. These results align with those of Levchenko and Pandalai-Nayar (2018). As discussed above, the surprise TFP shocks only generate some macro fluctuations in the US economy, or in other words, very small economic booms. The increase in domestic demand is satisfied by domestic goods. The minute effects on exports from small countries to the US have been predicted by the increase in the share of expenditure in domestic goods of the US.

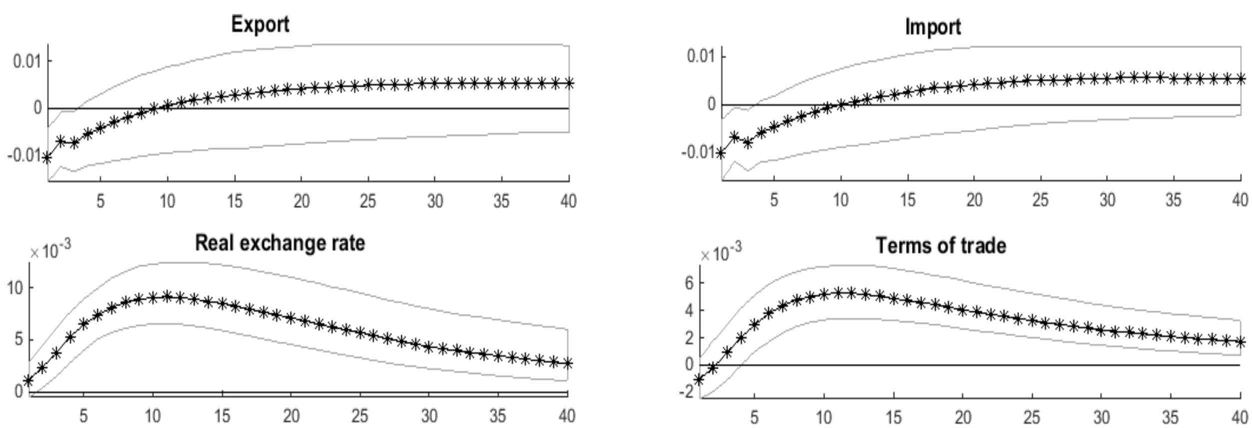
On the other hand, the effects of the surprise TFP shock on relative international prices are clear. These two variables exhibit hump-shaped impulse responses that increase significantly in ten to fifteen quarters and then begin to decline to the trend. The increase of real exchange rate indicates a depreciation of the US dollar or, in other words, an appreciation of trading partner's currency. The increase of terms-of-trade similarly means that goods and services in the US become cheaper than its trading partners. These results are in line with the findings of Nam and Wang (2015). In sum, a favorable surprise productivity shock in the US makes its goods and services more competitive in the international market. That explains why the exports of small open economies in our sample does not change (United Kingdom) or only very slightly fluctuates (in cases of Canada, Australia and New Zealand). Otherwise, in most cases we do not find an increase in imports of these countries from the United States, although US goods are cheaper (except Australia, which benefits from cheaper US goods in international market). That is explained by the fact that domestic demand in these countries does not increase.

Figure 3.4 Impulse responses of trade and relative price variables in small open economies to a surprise TFP shock in the United States

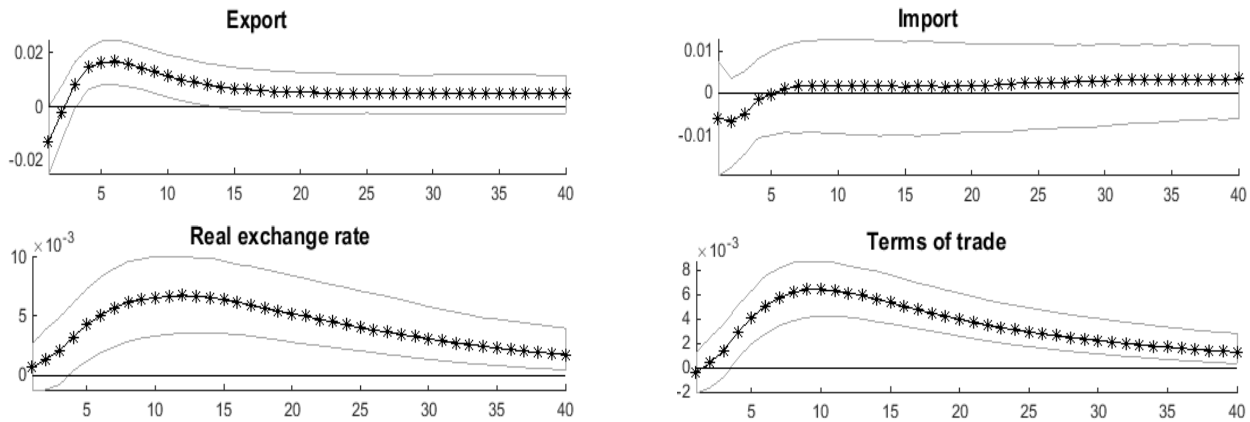
3.4A – Australia



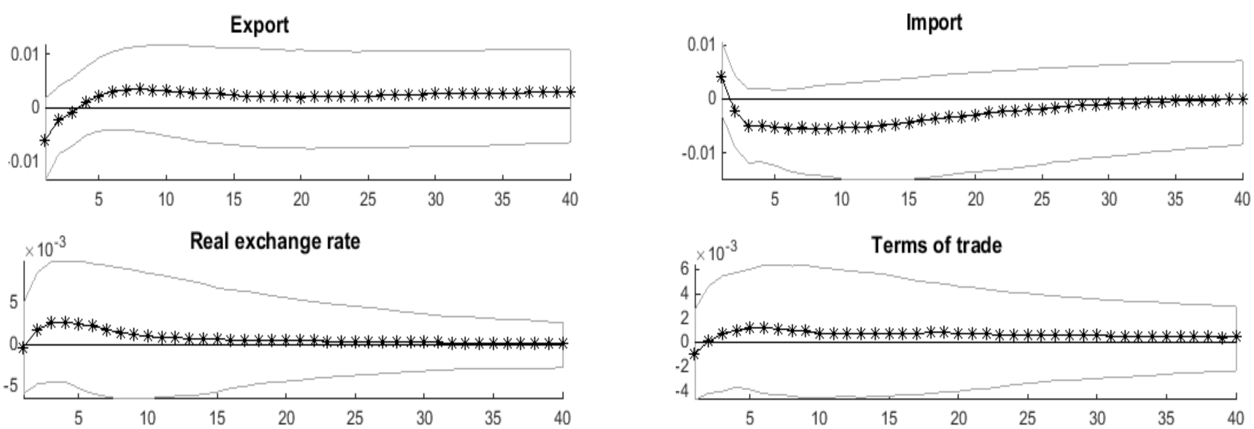
3.4B - Canada



3.4C – New Zealand



3.4D – United Kingdom

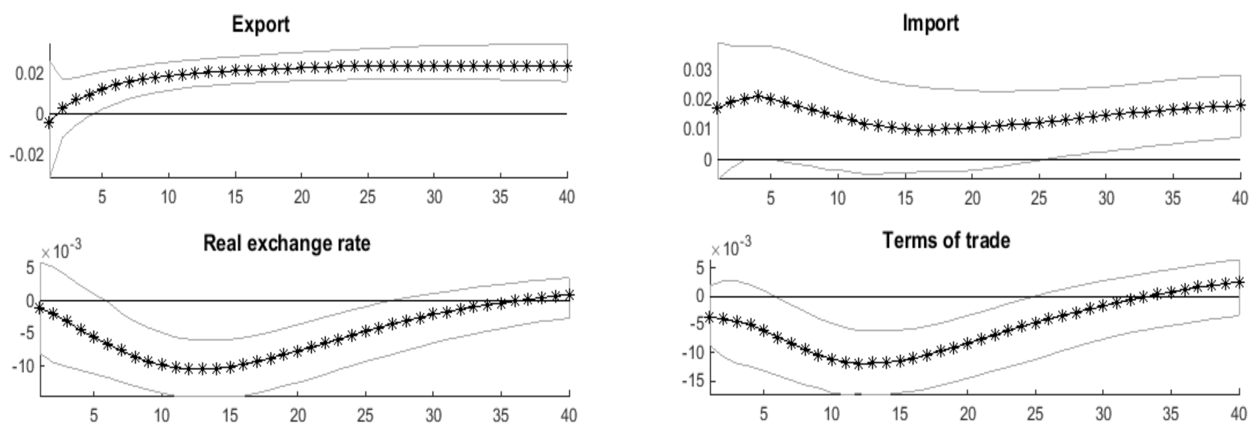


Notes: This figure presents impulse responses of bilateral export and import as well as real exchange rates and terms-of-trade between the United States and each small open economy to a favorable surprise TFP shock in the United States. Each impulse response is obtained by including the small country's variables one at a time to the core VAR model in order to have a seven-variable VAR system.

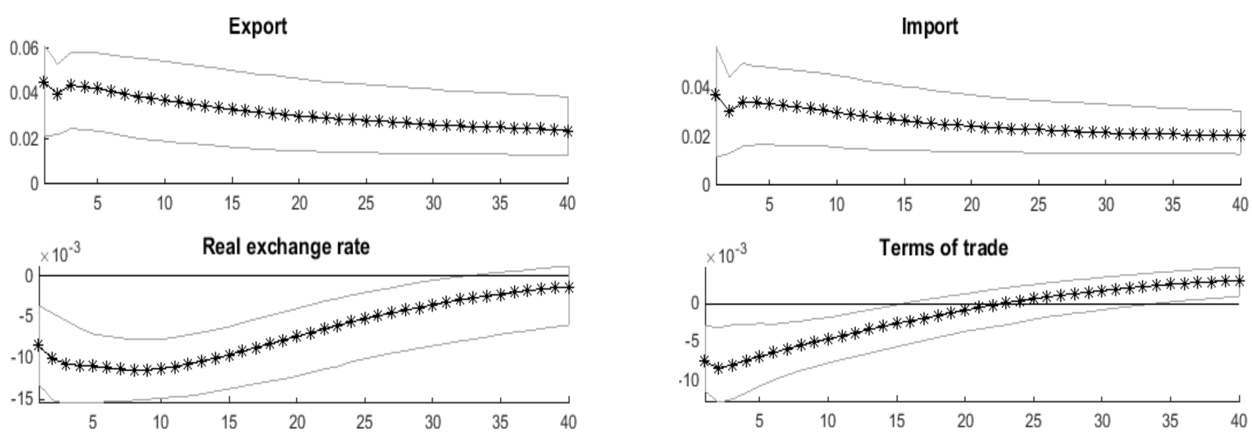
We then study the effect of a positive news TFP shock on trade variables. To explain behavior of exports to and imports from the US, we begin by analyzing the impulse responses of relative prices, including real exchange rate and terms-of-trade. The results are presented in figure 3.5. Following positive news about future productivity in the US, real exchange rates between this economy and the four small open economies decline on impact. They continue to decrease but then begin to recover approximately nine to twelve quarters after the shock. This fact indicates an appreciation of the US dollar and makes US goods and services more expensive in the international market. The behavior of the terms-of-trade is similar to that of the real exchange rates as the terms-of-trade also exhibit J-shaped impulse responses. These results are also in line with those of Nam and Wang (2015). In conclusion, the appreciation of the US dollar and the decline of terms-of-trade make US goods and services less competitive, and therefore favors the export of its trading partners.

Figure 3.5 Impulse responses of trade and relative price variables in small open economies to a news TFP shock in the United States

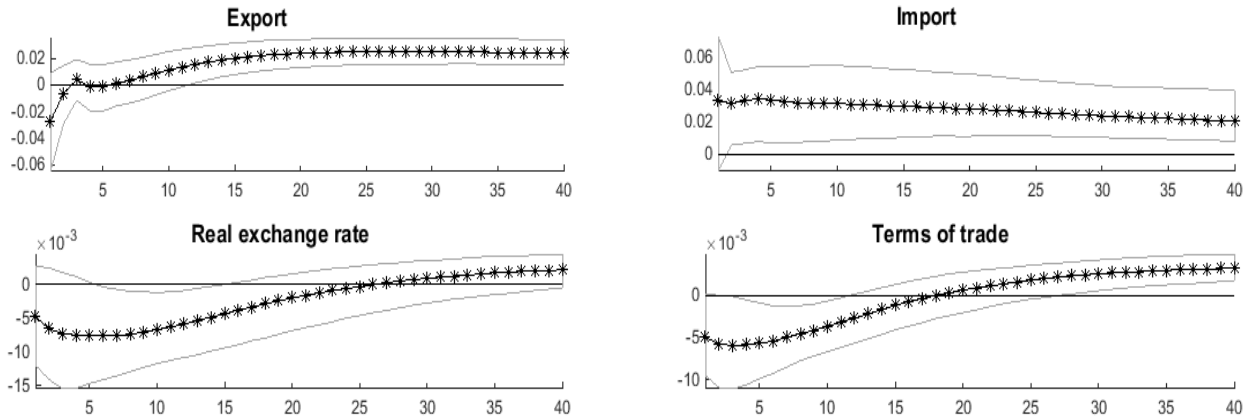
3.5A – Australia



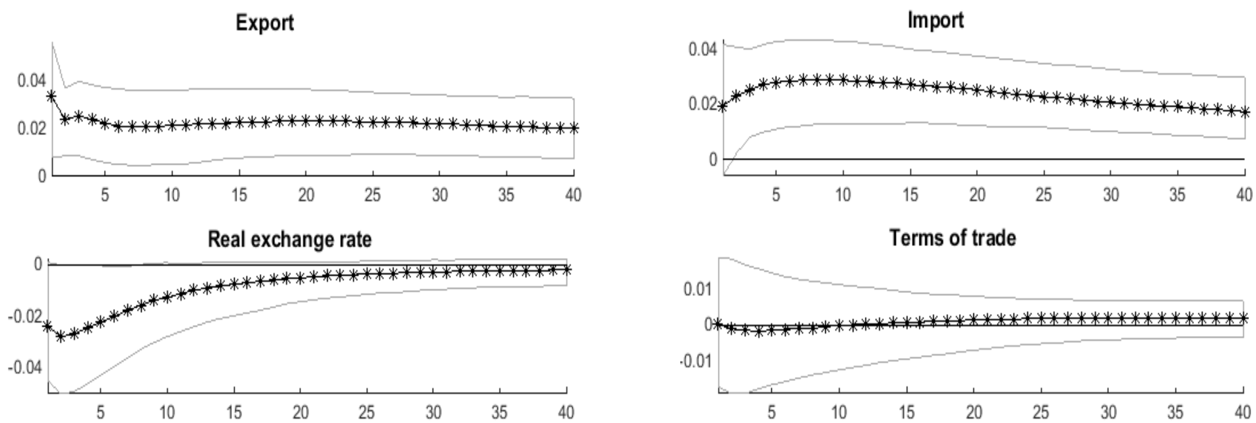
3.5B - Canada



3.5C – New Zealand



3.5D – United Kingdom



Notes: This figure presents impulse responses of bilateral export and import as well as real exchange rates and terms-of-trade between the United States and each small open economy to a favorable news TFP shock in the United States. Each impulse response is obtained by including the small country's variables one at a time to the core VAR model in order to have a seven-variable VAR system.

Following a favorable news TFP shock, exports from Canada and the United Kingdom to the US increase by 4.5% and 4%, respectively, on impact. These effects persist significantly. However, in the cases of Australia and New Zealand, exports positively deviate from the trend from the fifth quarter and twelfth quarter, respectively. The difference between the two groups of countries is explained by the fact that the US is the first export market of Canada and the United Kingdom (see Table 3.1). Moreover, these two countries are geographically closer to the US than Australia and New Zealand. Hence, the exports of these two countries to the US react faster and more strongly to macro fluctuations in the US economy. The increase in exports to the US is explained by the economic boom generated by the news TFP shock as well as by the fact that goods and services from these small countries become more competitive due to the effects of the shock on real exchange rates and terms-of-trade. The responses of imports from the US to these small open economies are similar to that of exports, except for Australia, wherein the effect of the shock on the import is not significant until quarter 26. The increase in imports is explained by the fact that the economic boom in the US is transmitted to these economies and therefore favors domestic demand. With a significant increase in bilateral trade, the news TFP shock is transmitted across countries and hence generates business cycle comovement. In the following section, we investigate the responses of macro aggregate variables in the small open countries.

3.4.3. Responses of Macro Aggregates of Small Open Countries following Surprise and News TFP Shocks

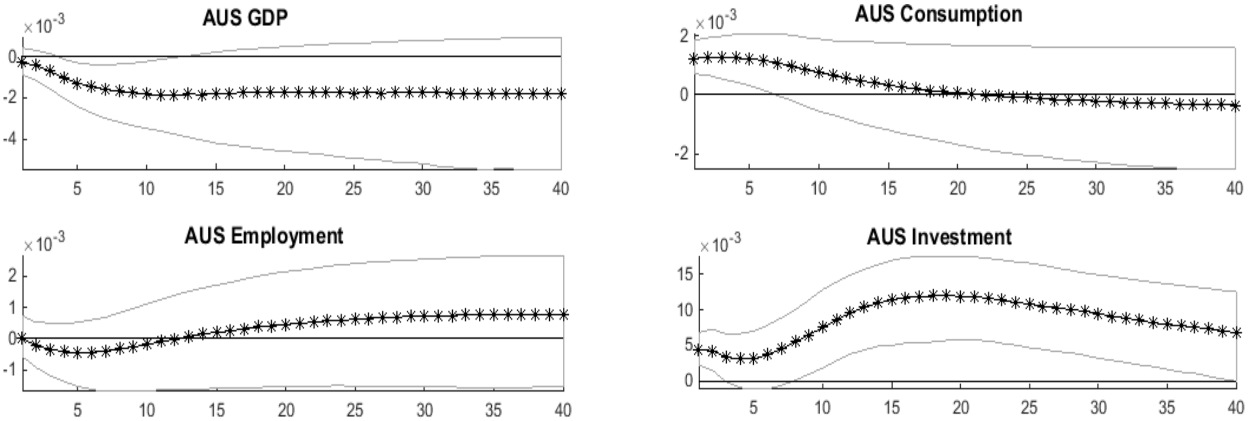
Figure 3.6 illustrates the impulse responses of macro-economic variables in four advanced small open economies following a surprise TFP shock in the US. More specifically, the GDP of Australia, Canada and New Zealand exhibit a slight decline on impact before recovering rapidly to the initial levels. The effect of the shock on GDP is not significant in the case of United Kingdom due to the relative size between the UK and the US in comparison with other small open economies (See Table 3.3). In general, the surprise TFP shock generates a small decrease in GDP for four to five periods due to the collapse of exports from these countries to the US. The impulse responses of consumption in small economies tell the same story. In the cases of Australia and the United Kingdom, consumption increases slightly (about 0.2%) on impact. However, this effect dies out quickly after three to five quarters. In the cases of Canada and New Zealand, we do not find any significant effect of the shock on consumption. The behavior of employment is similar.

It decreases significantly in the case of Canada but is not significant for other small countries due to the declines in GDP. Investment increases significantly from the ninth quarter after the shock in the cases of Australia and Canada. In the case of New Zealand, the effect of the shock on investment is not significant. Investment in the UK declines significantly until twelfth quarter after the shock.

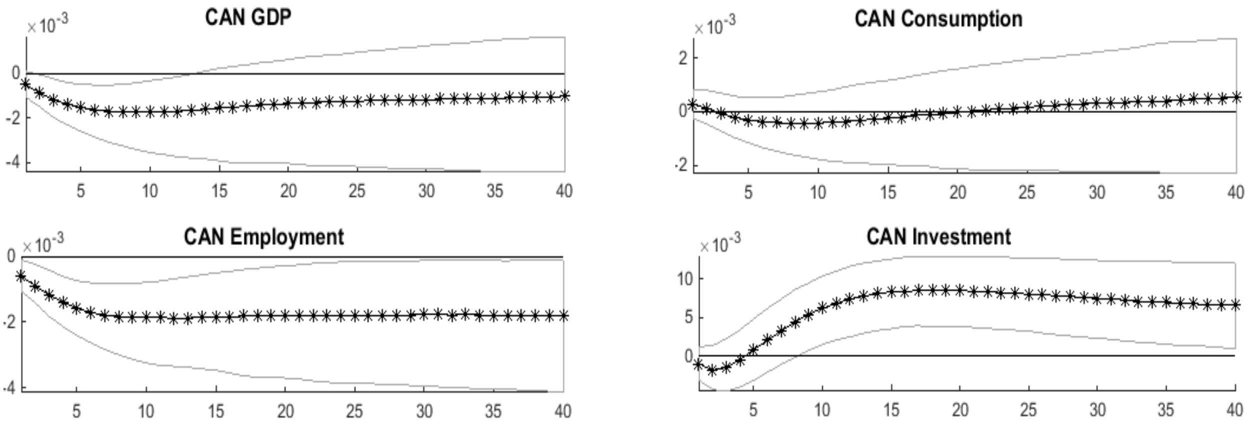
In sum, a surprise TFP shock in the US generates only small fluctuations in trading partner economies. Thus, this shock is not a source of the international business cycle comovement. This result is consistent with findings of Levchenko and Pandalai-Nayar (2018).

Figure 3.6 Impulse responses of trade and relative price variables in small open economies to a news TFP shock in the United States

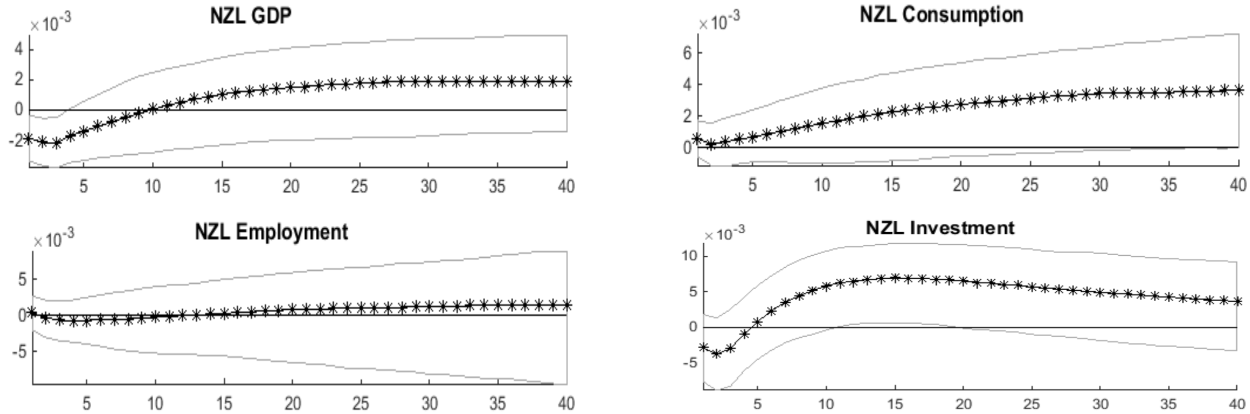
3.6A - Australia



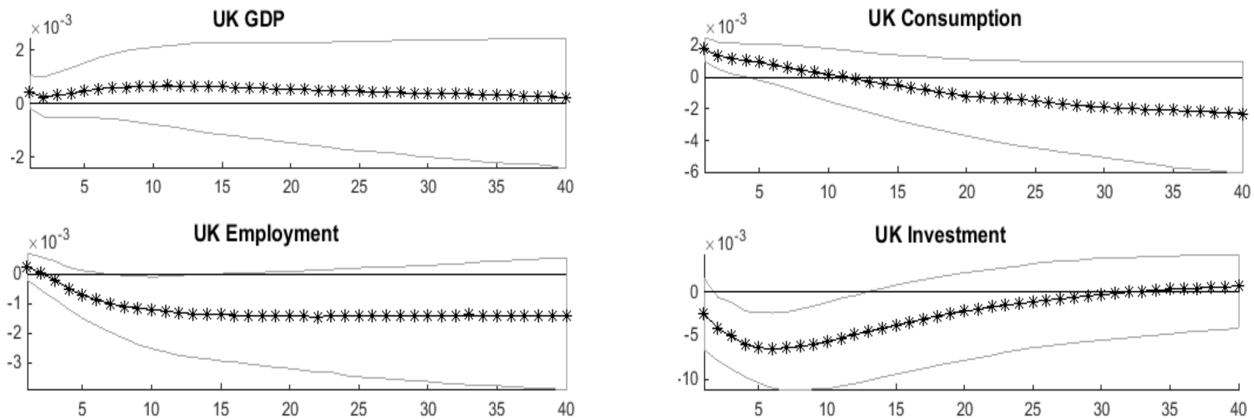
3.6B - Canada



3.6C - New Zealand



3.6D – United Kingdom



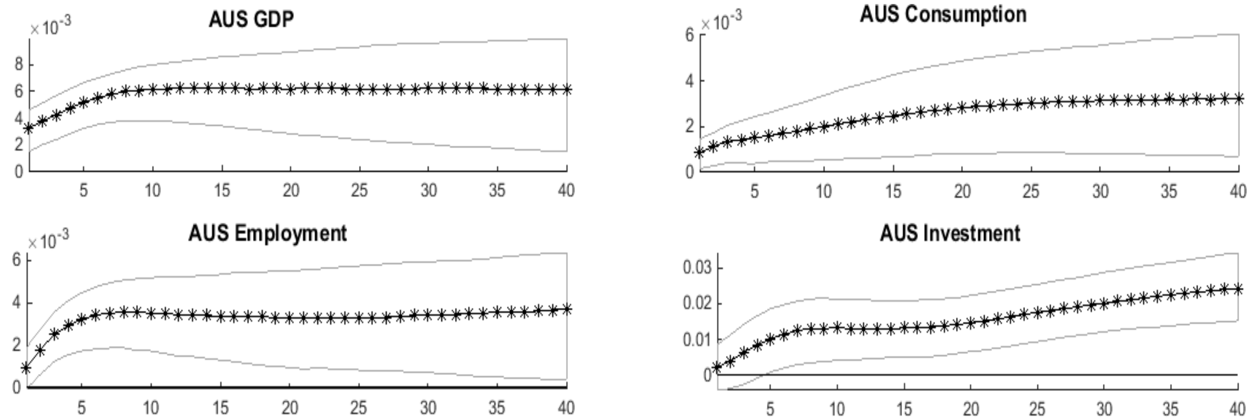
Notes: This figure presents impulse responses of macroeconomic variables of each small open economy to a favorable surprise TFP shock in the United States. Each impulse response is obtained by including the small country's variables one at a time to the core VAR model in order to have a seven-variable VAR system.

The effects of news TFP shock are depicted in Figure 3.7. Following a favorable news TFP shock in the US, the GDP of Australia and Canada increase by approximately 0.4% on impact. This number is 1.1% and 0.3% in the cases of New Zealand and United Kingdom, respectively. The effects of the shock on GDP are significant and permanent, as indicated in Figure 3.7. News productivity shock generates economic boom in the US, and this economic expansion then favors the export of trading partners, which induces an increase in real activity. As GDP increases, employment in these small open countries also increases, except in the case of New Zealand, where the effect is not significant. The employment increases by 0.1%, 0.25% and 0.1% in the cases of Australia, Canada and United Kingdom, respectively. The impact of the news shock on consumption and investment are similar. These two macro aggregates increase significantly and permanently after the shock.

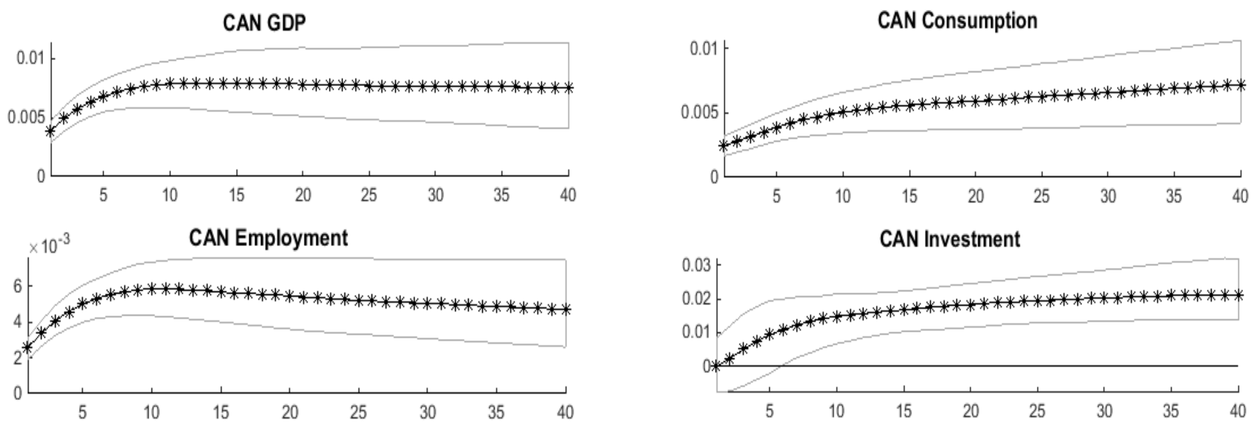
To conclude, the effects of news TFP shocks are transmitted across countries by increasing bilateral trade. In particular, the shock favors the exports from other economies not only by generating economic booms in the US that increase the demand for foreign goods but also by making the US goods less competitive in the international market. Therefore, the economic expansion spills over economies via trade channels. As a result, news TFP shock is one of important sources of the international business cycle comovement. These results are summarized in Table 3.2.

Figure 3.7 Impulse responses of macro aggregates in small open economies to a news TFP shock in the United States

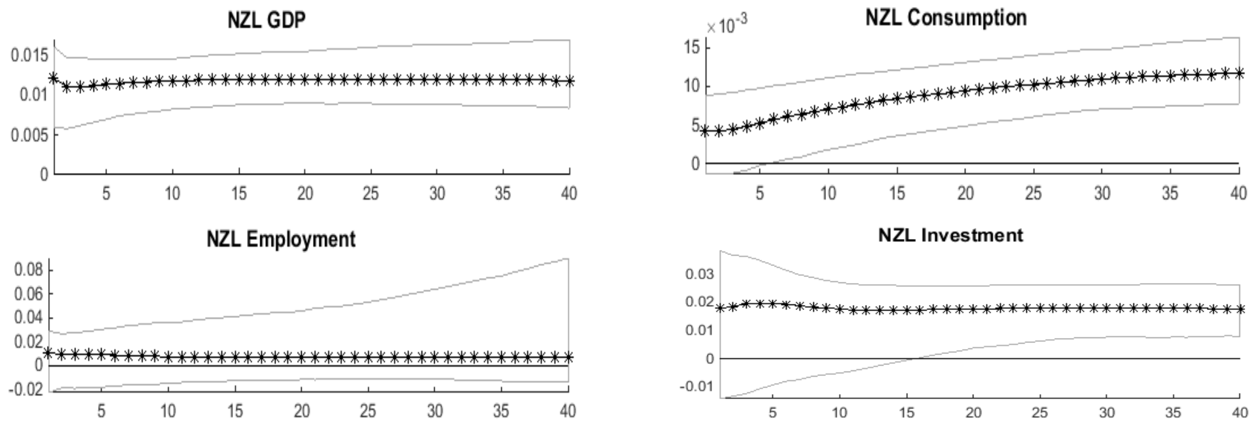
3.7A – Australia



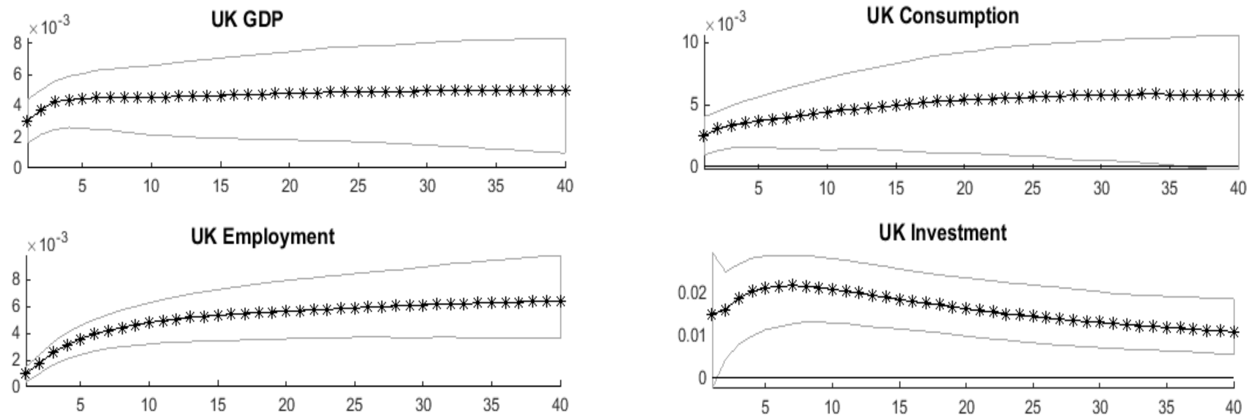
3.7B - Canada



3.7C - New Zealand



3.7D – United Kingdom



Notes: This figure presents impulses responses of macroeconomic variables of each small open economy to a favorable news TFP shock in the United States. Each impulse response is obtained by including the small country's variables one at a time to the core VAR model in order to have a seven-variable VAR system.

Table 3.2 Summary of results

		United States	Australia	Canada	New Zealand	United Kingdom
Surprise TFP shock	GDP	0.15% / died out at 9th Q	slight decrease	slight decrease	slight decrease	not significant
	INV	not significant	significant from 9th Q	significant from 9th Q	not significant	-0.3% / recovered at 12th Q
	CON	0.1% / died out at 3rd Q	0.2% / died out at 5th Q	not significant	not significant	0.2% / died out at 3rd Q
	EMP	-0.1% / recovered at 6th Q	not significant	-0.2% / recovered from 25th Q	not significant	not significant
	SHARE	0.03% / died out at 3rd Q	-	-	-	-
	EXP	-	significant from 5th to 27th Q	-1% / recovered at 2nd Q	significant from 3rd to 12th Q	not significant
	IMP	-	significant from 7th Q	slightly decrease	not significant	not significant
	RER	-	hump-shaped	hump-shaped	hump-shaped	hump-shaped
	TOT	-	hump-shaped	hump-shaped	hump-shaped	hump-shaped
News TFP shock	GDP	0.3% / died out at 35th Q	0.4% / > 40th Q	0.4% / > 40th Q	1.1% / > 40th Q	0.3% / > 40th Q
	INV	1.1% / > 40th Q	significant from 5th Q	significant from 6th Q	1.5% / > 40th Q	1.5% / > 40th Q
	CON	0.2% / died out at 25th Q	1% / > 40th Q	0.25% / > 40th Q	0.3% / > 40th Q	0.3% / > 40th Q
	EMP	0.3% / died out at 33rd Q	0.1% / > 40th Q	0.25% / > 40th Q	not significant	0.1% / > 40th Q
	SHARE	-0.15% / > 40th Q	-	-	-	-
	EXP	-	significant from 5th Q	4.5% / > 40th Q	significant from 12th Q	4% / > 40th Q
	IMP	-	significant from 26th Q	4% / > 40th Q	4% / > 40th Q	significant from 1st Q
	RER	-	J-shaped	J-shaped	J-shaped	J-shaped
	TOT	-	J-shaped	J-shaped	J-shaped	J-shaped

Notes: This table presents deviations on impact of variables and numbers of periods that impulse responses are still significant; Q: quarter; > 40th Q: still significant after 40th quarter; GDP: Real Gross Domestic Product, INV: Real Investment, CON: Real Consumption, EMP: Employment, SHARE: Share of expenditure on domestic goods, EXP: Export, IMP: Import, RER: Real Exchange Rate, TOT: terms-of-trade.

3.4.4 Forecast Error Variance Decomposition

To evaluate the role of TFP shocks on fluctuations of variables for different horizons, this section analyzes the forecast error variance decomposition. The forecast error variance attributable to positive surprise and news TFP shocks is reported in Tables 3.2 and 3.3, respectively. Here, we begin with the US variables. As the shock identification scheme imposes that the surprise and news shocks nearly account for all variations of TFP, the forecast error variance of this variable is largely affected by these shocks. The unanticipated shock contributes 100% of the forecast error variance for the first quarter ahead forecast. In the long-term (10 years), this number declines to 38.67%. In contrast, the news TFP shock contributes increasingly to the TFP forecast error variance: from 0% for the first quarter ahead forecast to 59.71% for ten years ahead forecast.

The forecast error variances of the US GDP, consumption, employment, and investment are mostly accounted for by the news technology shock. In the short-term (1 quarter to 10 quarters), the news TFP shock contributes between 22.6% and 34.43% of the variability of the US GDP, 13.89% to 22.63% in case of consumption, 27.93% to 44.77% for employment, and 49.77% to 67.59% for investment. In the long-term (10 years ahead forecast), news TFP shock continues to account for large shares of forecast error variance of these variables: 24.3% for GDP, 15.37% for consumption, 28.26% for employment and 74.29% for investment. On the contrary, the role of surprise TFP shock is negligible. Its contributions to the forecast error variance of GDP, consumption, and employment are smaller than 5% at all forecast horizons. It only contributes approximately 7% to the variability of the US investment for the ten-year forecast. This fact emphasizes the role of news TFP shock in generating business cycles in the US.

Table 3.3 Surprise TFP shock: variance decomposition

Country	Quarters	TFP	GDP	CON	EMP	IVT	EXP	IMP	RER	TOT
US	1	100.00	2.32	4.18	0.39	3.02	-	-	-	-
	10	87.84	1.78	2.53	0.93	2.61	-	-	-	-
	20	62.37	2.03	2.70	1.82	5.27	-	-	-	-
	40	38.67	2.68	3.17	3.12	7.19	-	-	-	-
AUS	1	-	0.39	3.37	0.32	2.53	0.32	0.33	0.34	0.70
	10	-	2.61	2.89	0.97	2.94	2.89	2.30	9.71	6.42
	20	-	3.76	2.75	1.77	10.21	4.60	6.98	22.50	20.84
	40	-	4.57	2.83	2.94	12.91	5.16	10.67	26.62	27.25
CAN	1	-	0.56	0.35	0.99	0.34	1.97	1.45	0.42	0.45
	10	-	2.52	0.89	4.16	2.09	1.51	1.66	11.72	5.47
	20	-	2.76	1.26	4.61	6.62	2.10	2.33	19.51	12.54
	40	-	3.22	2.17	5.07	8.99	3.03	3.51	22.54	15.93
NZL	1	-	0.92	0.34	0.25	0.53	0.62	0.30	0.27	0.28
	10	-	1.70	1.05	0.75	2.03	3.98	1.10	3.82	7.03
	20	-	2.33	2.49	1.28	4.25	4.21	1.53	8.38	14.09
	40	-	3.02	5.00	2.07	5.58	4.21	2.03	10.53	15.62
UK	1	-	0.42	3.13	0.35	0.38	0.46	0.36	0.28	0.29
	10	-	0.89	1.49	1.36	2.81	1.08	1.24	0.98	0.91
	20	-	1.35	1.68	2.07	3.06	1.44	1.55	1.47	1.40
	40	-	1.89	2.50	2.48	3.53	2.01	2.17	1.89	1.96

Notes: US: United States, AUS: Australia, CAN: Canada, NZL: New Zealand, and UK: United Kingdom, CON: consumption, EMP: Employment, IVT: investment, EXP: Export, IIMP: Import, RER: real exchange rate, and TOT: terms-of-trade. The numbers are in percentages.

Table 3.4 News TFP shock: variance decomposition

Country	Quarters	TFP	GDP	CON	EMP	IVT	EXP	IMP	RER	TOT
US	1	0.00	22.60	13.89	27.93	49.77	-	-	-	-
	10	10.74	34.43	22.63	44.77	67.59	-	-	-	-
	20	36.64	30.68	20.61	38.99	71.75	-	-	-	-
	40	59.71	24.30	15.37	28.26	74.29	-	-	-	-
AUS	1	-	19.89	1.85	1.85	2.80	2.16	6.74	2.38	3.55
	10	-	41.28	5.60	15.37	13.74	9.71	12.69	9.98	9.53
	20	-	46.79	9.53	17.86	22.74	22.35	13.45	19.22	18.11
	40	-	49.54	14.57	21.26	46.43	41.05	21.00	21.12	19.38
CAN	1	-	27.68	13.64	18.29	3.72	38.95	22.58	16.22	15.89
	10	-	53.24	30.58	43.11	15.07	51.62	39.71	31.31	19.34
	20	-	58.84	40.31	46.10	35.63	52.69	46.68	35.81	19.63
	40	-	62.27	51.01	44.50	57.74	55.64	52.89	36.17	22.07
NZL	1	-	38.84	10.54	46.56	20.44	3.74	4.89	4.89	5.43
	10	-	55.65	18.15	48.51	36.15	6.21	18.24	9.74	9.33
	20	-	68.20	31.90	48.34	47.57	12.99	25.22	12.38	10.48
	40	-	77.09	52.13	51.11	59.22	24.86	32.08	13.71	14.06
UK	1	-	13.62	6.67	2.58	10.38	11.92	6.15	11.44	5.89
	10	-	23.80	13.63	24.52	34.26	16.94	20.30	14.99	7.03
	20	-	25.52	17.09	32.83	44.02	21.33	27.34	16.28	7.84
	40	-	28.11	19.53	38.22	50.71	27.92	33.06	17.67	9.74

Notes: US: United States, AUS: Australia, CAN: Canada, NZL: New Zealand, and UK: United Kingdom, CON: consumption, EMP: Employment, IVT: investment, EXP: Export, IIMP: Import, RER: real exchange rate, and TOT: terms-of-trade. The numbers are in percentages.

The forecast error variance decompositions of small open countries variables suggests conclusions about the international transmission of shocks. Regarding bilateral trade and relative price variables, the news TFP shock contributes small shares of variance at short frequencies, except in the case of Canada. Its contributions to the variance of exports to the US, imports from the US, real exchange rate and terms-of-trade, on average, are, respectively, 5.94%, 5.93%, 6.24% and 4.96% for the first quarter forecast. Given the fact that nearly 70% of Canada's trade is with the US, the news TFP shock in the US can substantially explain the forecast variability of the trade and relative price variables of this economy. At longer frequencies, the role of news TFP shock becomes more important. It explains 25% to 55% of the forecast error variance of the bilateral export from small open countries to the US, 21% to 53% in the case of the import, 13% to 36% in the case of real exchange rate, and 10% to 22% in the case of terms-of-trade. Again, the surprise TFP shock contributes marginally to forecast error variance of the trade variables at all forecast horizons. Its contributions to bilateral exports and imports are smaller than 5%. However, the surprise TFP shock accounts for a large share of forecast error variance of the relative price variables in the long-term, except for United Kingdom, wherein its role is negligible. The surprise shock is responsible for 26.62% of variance of real exchange rate of Australia at 10 years. This number is 22.54% and 10.53% in the cases of Canada and New Zealand, respectively. Surprise shock also explains up to 27.25%, 15.93% and 15.62% of the variance of the terms-of-trade in the cases of Australia, Canada and New Zealand, respectively. In sum, while the news TFP shock significantly affects the forecast error variance of trade and relative price variables, the surprise TFP shock contributes little to the forecast variability of the former.

Regarding macro aggregates, as reported in Tables 3.2 and 3.3, surprise TFP shock in the US explains little about the forecast error variance of GDP, employment, consumption, and investment of the four small open economies. At ten years, it explains only 4.57%, 3.22%, 3.02% and 1.89% of the GDP forecast variability of Australia, Canada, New Zealand and United Kingdom, respectively. In contrast, the news TFP shock in the US accounts for from 14% (Australia consumption) to 77% (New Zealand GDP) of forecast error variance of the macro aggregates for the ten year forecast. This analysis supports our findings concerning the importance of news TFP shock in international business cycle convergence.

3.5. Conclusion

It is important to shed light on how bilateral trade, relative prices (terms-of-trade and real exchange rate), real activity and other macro aggregates of a small open economy react to news TFP shocks in its largest trading partner. By using a structural VAR model in which news TFP shock is identified as in Barsky and Sims (2011), we examine the dynamics of responses of aggregate macroeconomic variables in four advanced small open economies to anticipated (news) and unanticipated (surprise) TFP shocks in United States. We then compare the international spillovers of these two shocks. The United States is considered as the country source that diffuses the shocks because of the relative size of its economy in comparison with other advanced small open economies as well as its data availability. The destination countries are four advanced small open economies that trade intensively with the US: Australia, Canada, New Zealand and United Kingdom.

We provide updated empirical evidence on the responses of the US macro variables to surprise and news TFP shocks. We indicate that positive news about future productivity generates economic booms in the US while the surprise productivity shock does not. This paper reaches two main findings. First, we conclude that the effects of news TFP and surprise shocks on bilateral trade and relative prices between the US and small open economies are different. The news shock favors exports to the US not only by generating economic booms but also by depreciating the US dollar and the terms-of-trade. Second, we contend that news TFP shocks in the US generate significant macroeconomic fluctuations and comovement in small trading partners while the surprise TFP shock only causes small changes. The news TFP shocks are therefore one of the most important sources of the international business cycle. As a result, countries should focus on bilateral trade with innovative countries and diffused technology countries in order to benefit from economic booms generated by the news productivity shock.

Future research may focus on the trade-based news TFP shock transmission between developed and developing countries. Furthermore, studies could distinguish the responses in fixed and flexible exchange rate regimes or in countries and regions that sign free trade agreements. In term of the theoretical side, incorporating news TFP shock may help develop a new viewpoint regarding the trade-comovement puzzle. That requires further investigation.

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GENERAL CONCLUSION

Business cycle synchronization has been at the center of many debates and has attracted much attention in contemporary international macroeconomics (Erden and Ozkan, 2014). Several studies have discussed the existence of a global business cycle and the globalization and Europeanization of business cycles. Others have examined the transmission of business cycle through spillover effects. Thus, an important research question asks, what determinants drive GDP comovement across countries? After the seminal work of Frankel and Rose (1998), a large body of literature has examined the impacts of trade on international output correlations. Most studies have confirmed that bilateral trade is one of the most important determinants of business cycle comovement, among other factors such as financial integration, industrial specialization, international coordination of monetary and fiscal policy, foreign direct investment, and firm-level linkages, and exchange rate regimes. Economies that trade more intensively with each other exhibit a higher output correlation. As such, this dissertation provides evidence on how and to what extent bilateral trade influences business cycle comovement. In particular, we add to the existing literature by developing three empirical essays on the trade-comovement relationship, with specific focus on the trade spillover effects and macro interdependences in a common currency area, structure of trade, and the transmission of different types of shock. The three chapters in this dissertation explore three mechanisms through which trade enhances the output correlation: demand-supply spillover, technology transmission and terms-of trade effects.

In the first chapter, we investigate the trade spillover effects of the euro area on the CEECs. By using a near-VAR model that captures direct and indirect effects (through a third country) of trade over a sample of twelve founding members of the euro area and seven CEECs from 1996 to 2015, we obtain three notable results. First, three main economies of the euro area (Germany, France and Italy) have the most important influences on CEECs though trade channels. Second, trade spillover effects from the euro area to CEECs are stronger after the European Union enlargement in 2004 (3.3 times larger on average). Finally, and most importantly, the adoption of the euro significantly enhances responses of CEECs (4.9 for countries that have adopted the euro versus 2.1 for the countries do not) but does not increase trade intensity (1.07 versus 1.12). The empirical results also reveal that trade effects on the macro interdependences are positive in the same currency area but are negative for the CEECs that have not yet adopted the euro. This chapter focuses on the demand-supply mechanism of trade. Other mechanisms explaining the positive relation between trade and output correlation include technology transmission and terms-of-trade effects. Chapter 2 focuses on these two channels to provide further insight into the trade-comovement puzzle.

According to the trade-comovement puzzle defined in Kose and Yi (2006), theoretical models fail to fully reproduce the positive impact of trade on business cycle comovement. The existing literature has suggested that trade at extensive margin transmits the technology and knowledge embedded in the new products and therefore enhances the correlation of aggregate productivity between trading partners. A higher correlation of productivity induces a stronger correlation of output. Juvenal and Santos Monteiro (2017) have proposed that output correlation may be decomposed into comovement of productivity, comovement of share of expenditure on domestic goods and comovement of these two factors. In this chapter, we question whether trade at the extensive margin generates a pro-cyclical terms-of-trade, thereby increasing the correlation of shares of expenditure on domestic goods and enhancing business cycle synchronization. By using a sample of forty countries over the period 1990–2015, we first re-investigate the factor structure of business cycle comovement proposed by Juvenal and Santos-Monteiros (2017). Then we test the technology transmission through the extensive margin of trade, as documented in Liao and Santacreu (2015). Finally, we observe that the extensive margin of trade is responsible for the comovement of shares of expenditure on domestic goods. Its effect equals to 0.079 and is significant, at 5%, compared to 0.074 of the effect of overall trade estimated by Juvenal and Santos Monteiro (2017). The effects of the intensive margin are ambiguous[10]. That is explained by the fact that when the positive effect of total trade on shares of expenditure on domestic goods is captured by the extensive margin, the role of intensive margin is no longer important. In the DSGE model developed by Liao and Santacreu (2015), the intensive margin generates a counter-cyclical terms-of-trade while the extensive margin implies a pro-cyclical one. This finding suggests that theoretical models should integrate the extensive margin of trade in attempt to solve the trade-comovement puzzle with a technology shock because the extensive margin of trade generates a pro-cyclical terms-of-trade. Pro-cyclical terms-of-trade is the most important feature of the model in order to solve the puzzle, as documented in Juvenal and Santos-Monteiros (2017).

In previous works that have addressed the trade-comovement puzzle, macro fluctuations are generated from a positive productivity shock. This shock is an unanticipated, or surprise, shock. However, recent developments in the literature regarding news (anticipated) shock (Nam and Wang, 2015, Kamber et al., 2017, among others) have contended that empirical differences exist between the transmissions of news and surprise productivity shock. Chapter 3 considers the transmission of good news about future productivity across countries via trade channels. This chapter analyzes trade spillovers of a news TFP shock in the United States to four advanced small open economies, Australia, Canada, New Zealand and the United Kingdom. The results obtained from a SVAR model illustrate that news TFP shocks generate economic booms in the United States (GDP and Employment increase 0.3% on impact, Investment 1.5% and Consumption 0.2%). This economic expansion is transmitted to small open countries by increasing their exports to the United States (export from Canada and United Kingdom to the United States jump up 0.4% and 0.3% on impact, respectively; export from Australia and New Zealand increase 1.5% after 5th quarter and 12th quarter, respectively). Moreover, two reasons explain the increase in exports of small open economies to the US: demand for final goods in United States increases following the shock and foreign goods are relatively cheaper due to the

[10] These results are robust for some different checks.

effects of the shock on real exchange rate and terms-of-trade. In contrast, the effects of surprise shocks are not significant. Economic booms generated by the surprise shock are not sufficiently large to be transmitted to trading partners (GDP just increases 0.015% on impact and dies out at 5th quarter, employment decreases 1% on impact and recovers at the 6th quarter, investment and consumption fluctuations are not significant, and responses of export from trading partners are not significant or are small). Furthermore, the way surprise shocks affect the relative price (exchange rate and terms-of-trade) favors US goods. These results emphasize the role of news TFP shock on international business cycle convergence.

The main contribution of this thesis is to provide more empirical evidence for the trade-comovement relationship. The three essays help us understand more clearly how bilateral trade enhances business cycle synchronization in different frameworks and why theoretical models fail to fully replicate this positive association. This understanding is important for international policy implications, notably in a common currency area where trade exchange is highly encouraged, and the high level of business cycle synchronization assures the efficiency of common economic policies.

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UNIVERSITE BRETAGNE LOIRE / ECONOMIE ET GESTION

UNIVERSITÉ DE RENNES 1

Titre : Trois essais sur la relation entre le commerce et la synchronisation des cycles économiques

Mots clés : Synchronisation des Cycles Economiques, Transmission des Cycles Economiques, Intégration Commerciale

Résumé : Ma thèse vise à étudier empiriquement les effets du commerce sur la synchronisation des cycles économiques. Premièrement, la recherche se concentre sur la relation entre l'intégration commerciale et les interdépendances macroéconomiques au sein de l'Union Européenne. Les résultats obtenus indiquent que l'adhésion à l'Union Européenne et l'adoption de l'euro permettent aux Pays d'Europe Centrale et Orientale d'amplifier les effets du commerce sur l'interdépendance macroéconomique et de s'intégrer plus rapidement à la zone euro. Deuxièmement, la recherche porte sur le puzzle de commerce-synchronisation selon lequel les modèles théoriques sont incapables de reproduire des effets du commerce sur les corrélations du cycle économique aussi forts que ceux estimés par des études empiriques. En décomposant le commerce bilatéral entre la marge intensive et la marge extensive, je trouve que la marge extensive augmente non seulement la corrélation de la Productivité Global des Facteurs (PGF) entre les partenaires commerciaux mais aussi la corrélation entre les parts de dépenses en biens domestiques. Ce résultat souligne que les nouveaux produits exportés transmettent les chocs de la PGF et ne détériorent pas, voire améliorent, les termes de l'échange. Je suggère donc qu'afin de résoudre le puzzle, il faut que les modèles théoriques intègrent la marge extensive du commerce. Troisièmement, je trouve que les chocs de nouvelle, en combinaison avec le commerce bilatéral, sont une source importante du cycle économique international. Il faut donc que les économies augmentent les échanges avec les pays innovateurs pour profiter les expansions économiques générées par ce type de choc.

Title : Three essays on the relation between trade and business cycle synchronization

Keywords : Business Cycle Synchronization, Business Cycle Transmission, Trade Integration

This dissertation studies the impacts of bilateral trade on business cycle synchronization. First, the chapter 1 examines the relation between trade integration and business cycle interdependences in the European Union. The results obtained indicate that the accession to the European Union and the adoption of the euro enable the Central and Eastern European Countries to amplify the effects of trade on macroeconomic interdependences and to integrate more rapidly into the euro area. Second, the research focuses on the trade-comovement puzzle, according to which theoretical models are unable to replicate trade effects on business cycle correlations as strong as those estimated by empirical studies. By decomposing the bilateral trade into the intensive margin and extensive margin, I find that the extensive margin of trade not only increases the correlation of Total Factor Productivity (TFP) between trading partners but also increases the correlation between each country's shares of domestic goods. This result emphasizes that new exported products transmit TFP shocks and improve instead of deteriorating the terms-of-trade. Therefore, the extensive margin of trade should be integrated into theoretical models to solve the puzzle. Third, in chapter 3, I find that news TFP shocks, in combination with bilateral trade, are an important source of the international business cycle instead of contemporaneous TFP shocks. As a result, countries should focus on bilateral trade with innovative and technology-diffusing countries in order to benefit from economic booms generated by the news productivity shock.