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Trade, finance or policies: what drives the cross-border spill-over of business cycles?

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Abstract

In this paper we investigate how income growth rates in one country are affected by growth rates in partner countries, testing for the importance of pairwise country links as well as characteristics of the receiving country (trade and financial openness, exchange rate regime, fiscal variables). We find that trade integration fosters the spill-over of business cycles, both bilaterally and as a country characteristic (trade openness). Results for financial integration are mixed; financial links as pairwise country characteristic are either insignificant or negatively signed (indicating a dampening of cross country spill-overs), but financial openness as characteristic of the receiving country amplifies spill-overs. We find no evidence for a role of the exchange rate regime. Finally, we find that higher government spending and debt reduces countries' vulnerability to foreign business cycles, presumably through the effect of automatic stabilisers.

Keywords: growth spillovers, multi-country models, trade integration, financial integration, FDI, gravity.

JEL: F1, F3, F41, F44.

0 Non-technical summary

In this paper we provide an extensive analysis of how business cycles in one country are affected by macroeconomic conditions in other countries. Understanding international linkages implies being able to estimate, for a shock of type s taking place in country j (the sending country), which characteristics of country i (the receiving country), or link between i and j contribute to the effect of the shock on country's variables of interest (in this paper, real GDP growth). We set the ground for the empirical analysis by providing some baseline simulations which we derive from a standard two-country DSGE models similar to Pappa (2004).

Thereafter, using data for both advanced and emerging markets between 1970 and 2014, we test the role of trade, financial and FDI linkages, and of other factors as transmission channels of foreign shocks into a domestic economy. We also study the role of a set of receiving country's characteristics such as trade and financial openness, exchange rate regime, and fiscal variables, which may work as amplifiers of shocks. Furthermore, we test whether the transmission of shocks is different in normal and crisis times, when business cycle synchronization is often thought to increase. Finally, we investigate whether countries' characteristics play a different role between advanced and emerging countries.

The emphasis of this paper is less on business cycle synchronization and more on the effect of foreign GDP growth on domestic variables, although the two questions are obviously related. Clearly, one has to be careful in interpreting the effect of foreign aggregates as causal even when regressing country-level variables on leave-out means since (as noted, e.g., by Angrist 2013) both domestic and foreign variables could be hit by common shocks. The effect of foreign variables therefore should be meant as including the exposure to common global shocks, as opposed to domestic factors.

In the DSGE model simulation, we show that for all considered shocks (productivity, demand and monetary) trade integration and a fixed exchange rate regime act as an amplifier of the cross border effect of shocks, and financial integration as a dampener. We also argue that this last result is likely to be over-turned in a model where financial shocks are present and where they are a dominant source of business cycle fluctuations.

When we test these predictions on the data based on our empirical approach, we find mixed support for the baseline DSGE simulation. First, the role of trade openness

and trade links as ampliers of shock transmission is fully supported by the analysis, in line with previous literature on business cycle syncronisation. We find that FDI-based links actually slightly prevail in terms of statistical significance in explaining the effect of foreign growth on domestic GDP growth, but based on a reduced sample due to missing observations, trade-based links are almost just as good in terms of fit, with the benfit of many more available observations.

Second, we find that trade integration fosters the spill-over of business cycles, both in terms of bilateral links and as a country characteristic (trade openness). Results for financial integration are instead mixed. While bilateral financial links are mostly insignificant as a transmission channel, financial openness as a characteristic of the domestic economy is instead found to increase countries sensitivity to foreign growth. Moreover, we find no difference for financial links in crisis times, when financial shocks may have been more important. There is hardly any evidence for a significant role of the exchange rate regime as an absorber or amplier of foreign shocks. Finally, fiscal policy, and in particular automatic stabilisers, appear to play a significant role. Higher government spending and debt act as a dampener of the transmission of foreign growth and its effect is statistically and economically significant. The result for government debt is at odds with the idea that reduced fiscal space prevents the action of automatic stabilisers, and is likely due to the fact that debt is a poor measure of the fiscal space.

Finally, our results confirm that the cross border transmission of foreign growth was larger in crisis than in normal times. In terms of the role of receiving country characteristics, however, we do not find any statistically signficant change during the crisis. Turning to differences between advanced and emerging countries, we first find that the spill-over of foreign growth is much larger for emerging countries and trade openness in particular seems to be more important for them. Government spending to GDP is significant only for emerging countries, but is larger in size (though statistically insignificant) for advanced countries.

All in all, the main finding of the paper are that (i) consistent with the conventional wisdom, trade integration fosters the spill-over of business cycles, (ii) there is little evidence for bilateral financial links to play a role, but financial openness as a characteristic of the receiving country is often found to amplify the transmission of shocks, even outside crisis times, and (iii) there are important differences between advanced and emerging

countries, suggesting that an improved understanding of cross border linkages should also take the dimension of the level of development into account.

1 Introduction

Understanding and properly managing international linkages and spill-overs between large and systemic economies is high on the agenda of policy makers at the international level. After some interruption with the global financial crisis, financial and real globalisation continue by and large unabated, and global business cycle synchronization has if anything increased over recent years.

In this paper we provide an extensive analysis of how business cycles in one country are affected by macroeconomic conditions in partner countries. In a nutshell, understanding international linkages implies being able to compute, for a shock of type s taking place in country j (the sending country), which characteristics of country i (the receiving country), or link between i and j contribute to the effect of the shock on country i's variables of interest (in this paper, real GDP growth). In this work, based on data for both advanced and emerging markets between 1970 and 2014, we test the role of trade, financial and FDI linkages, and of other channels such as The exchange rate regime and fiscal policy as transmission channels of foreign shocks into a domestic economy. We also test whether the transmission of shocks is different in normal and crisis times, when business cycle synchronization is often thought to increase.

The paper is related to several previous contributions in the literature. A large number of studies point out that output co-movements across countries are mostly explained by a global component (Diebold and Yilmaz 2013, Canova et al. 2007, Giannone and Reichlin 2006, Kose et al. 2003, Lumsdaine and Prasad 2003). Other research supports the view that in a world where all major economies are significantly more open now than they were only one or two decades ago, international spill-overs are becoming increasingly important. For example, Kose et al. (2008) find that a common factor explains on average a larger fraction of output, consumption and investment in the globalisation period (1986-2003) than in the Bretton Woods period (1960-1972).

The focus of our paper is somewhat less on synchronization and more on the effect of foreign GDP growth and foreign stocks on domestic variables, although the two questions

are obviously interlinked. Clearly, one has to be careful in interpreting the effect of foreign aggregates and shocks as causal even when regressing country-level variables on leave-out means since (as noted, e.g., by Angrist 2013) both domestic and foreign variables could be hit by common shocks. The effect of foreign variables therefore should be meant as including the exposure to common global shocks, as opposed to purely domestic factors.

A small recent literature (see Beetsma et al. 2006, Corsetti et al. 2010, Auerbach and Gorodnichenko 2013) has looked at the cross border effect of fiscal shocks, where the effect is assumed to take place through trade links. We also relate to some recent contributions that focus on the role of trade and FDI linkages as synchronization channels for output growth. Busl and Kappler (2013) find that the trade channel is not that important as suggested by cross-section models, but that FDI have the potential to increase business output co-movements in the EU. Keil and Sachs (2014) and Jansen and Stokman (2011) also find that FDI linkages are more relevant than trade linkages, which supports the idea that FDI links have become more important relative to trade links from the mid-1990s.

As in many other domains, the identification of the shocks remains a key challenge. Bayoumi and Bui (2010) have applied the identification by heteroscedasticity proposed by Rigobon (2003) and found that the international business cycle is largely driven by U.S. shocks and global shocks. This approach, however, does not allow to identify the structural nature of the domestic shocks, and the identifying assumptions are unrelated to the open-economy, two-country DSGE models that are the mainstream tool in international macroeconomics. Farrant and Peersman (2006), Peersman (2011), Corsetti et al. (2009) and Enders et al. (2011) all implement an empirical approach based on sign restrictions on relative variables (domestic vs. foreign). In particular, they identify either relative shocks (Farrant and Peersman 2006) or symmetric and asymmetric shocks (Peersman 2011) by imposing some restriction on the relative performance of a given country vs another or by imposing that the reaction goes in opposite directions in two countries for asymmetric shocks. Another interesting piece of work in this domain is the paper of Mumtaz and Surico (2008) who extend the FAVAR approach developed by Bernanke, Bovin and Eliasz (2005) to the open economy. Using a large panel of data covering 17 industrialized countries, they quantify the dynamic effects on a wide range of UK aggregate and disaggregated variables of a common shock to short term interest rates and to real activity in the rest of the world.

The dominant role of US shocks in affecting international business cycles has been emphasized in recent literature. Diebold and Yilmaz (2013) find that the US and Japan are the major net transmitters of shocks to other countries during 1980s and 2000s, whereas Germany is the major net receiver of shocks in 2000s. They also show that a net business cycle connectedness is closely related to the trade balance, with countries with trade surpluses tending to be net recipients of shock and vice versa. Other recent contributions find evidence of qualitative shifts in the cross-border impact of policy shocks starting from mid-1980s. For example, Ilzetzki and Jin (2013) find that a US contractionary monetary shock decreases foreign output before 1984, whereas it *raises* it after 1984. Beaton, Lalonde and Snudden (2010) study the transmission of U.S. and financial shocks to Canada and the role of real-financial linkages in their transmission.

Finally, our paper also relates to the large literature on gravity in international trade and finance; see Kepaptsoglou et al. (2010) and Anderson (2011) for literature surveys. Aviat and Condorcet (2007) use a simultaneous gravity equations framework to explore the complementarity between bilateral trade in goods and bilateral asset holdings. More recently, Chaney (2013) proposes an explanation for the gravity equation in international trade based on the emergence of stable network of input-output linkages between firms.

Our main findings are four. First, FDI weights are more relevant than trade weights but the difference is quantitatively small, and data availability for trade links is much larger. Moreover, in line with our priors we find that trade integration fosters the spill-over of business cycles, both in terms of bilateral links and as a country characteristic (trade openness). Second, results for financial integration are more mixed. Bilateral financial links are mostly insignificant as a transmission channel, but negatively signed (in line with our priors) when statistically significant. By contrast, financial openness as a characteristic of the domestic economy is found to increase countries' sensitivity to foreign growth. Third, there is hardly any evidence for a significant role of the exchange rate regime as an absorber or amplifier of foreign shocks. Finally, fiscal policy, and in particular automatic stabilisers, play a dampening role for spill-over of foreign growth. Higher government spending and debt reduce the sensitivity of domestic growth to foreign growth, and this effect is statistically and economically significant. This suggests in turn that government debt as such may be a poor measure of the fiscal space (see Ghosh et al. 2015).

One important caveat to keep in mind that our analysis is reduced form, i.e. it does not distinguish for the source of shocks. In principle it is possible that different shocks (say, demand vs. supply shocks) lead to a different cross border spill-over of output. As we argue later, however, most models suggest that this is not the case, with the exception of the role of financial integration for the cross border transmission of financial shocks.

The paper is organized as follows. Section 2 contains some preliminary considerations on what should be expected based on existing mainstream models. The empirical model is then presented in Section 3. Section 4 describes the data, Section 5 presents the results, and Section 6 concludes.

2 What should we expect?

To our knowledge, there is no consistent analysis indicating how trade and financial integration as well as country characteristics influence business cycle correlation and spill-overs. Of course, various relevant elements have been already uncovered in the literature and try to summarise them in this section.

Some evidence points to the fact that stronger *trade linkages* lead to increased synchronization of business cycles across countries (Clark and van Wincoop 2001, Frankel and Rose 1998, Kose and Yi 2006). Kose at al. (2013) find that trade integration tends to increase the sensitivity of national cycles to the global cycle. The role of *financial integration* for business cycle synchronization is less clear-cut. Kose et al. (2003) and Imbs (2004, 2006) find that financial integration has a positive impact on business cycle co-movements. However, a number of recent works which look at financial integration through banks and portfolio linkages come to a different conclusion. Kalemli-Ozcan et al. (2013a and 2013b) find that, in normal times, increased banking linkages are associated with *more divergent* output cycles. By contrast, in times of crisis, higher financial integration induces *higher* output co-movement. Consistent with this evidence, a recent chapter in the IMF World Economic Outlook (2013) finds that financial (portfolio) linkages tend to increase output synchronization in time of crisis, whereas they are associated with less synchronized growth of output otherwise.

One primary purpose of this analysis is to understand if the evidence on the cross border transmission of shocks is consistent, at least qualitatively, with the predictions of

a textbook two-country DSGE model which, despite all its limitations, remains a useful starting point. In the model simulation shown in Appendix, we show that (i) *trade integration* leads to more cross border transmission, *financial integration* leads to more risk sharing and hence less correlated business cycles (Baxter and Crucini 1995), and a *fixed exchange rate regime* plays an amplifying role, because it reduces the policy space for the receiving country in reacting to foreign shocks. A similar qualitative consideration can be made for the fiscal policy space, where a country with high debt and low government spending (low level of automatic stabilisers) may import more, and react less to, shocks coming from abroad. Faia (2007)'s model is also consistent with these priors for output co-movement in a two-country DSGE model with financial frictions (higher with more trade openness and a fixed exchange rate regime, lower with more financial openness).

Importantly, our model analysis indicates that, prima facie, the role of the transmission channels (trade, finance, policy space) is the same irrespective of the nature of the shock (demand, supply or monetary). Although this does not rule out that the role would be different for other shocks that we do not consider, or in more elaborated models, it does suggest than an unconditional analysis like the one we carry out in this paper should be informative and a useful complement to the analysis of the transmission of specific shocks, such as monetary policy shocks.

Note that this conclusion is not specific to our model and it is shown in *Table 1* that it is shared (or at least not contradicted) by a large selection of recent studies using two-country DSGE models with various types of friction. On the role of financial integration in particular, however, one important caveat to keep in mind is that the traditional result may be reversed *conditional on financial shocks*. Recent literature has developed two-country models with financial frictions.[1] In those models, it is typically found that higher financial integration *amplifies* the cross border transmission of bank capital or financial shocks (see Kollmann et al. 2014, Kollmann 2013, Kamber and Thoenissen 2013, and Alpanda and Aysun 2014). In periods when financial shocks are important (for example during financial crises) we should therefore expect measures of financial integration to *amplify*, not dampen the cross border transmission. We partly test for this when we consider results in normal and crisis times, but we do not identify financial shocks separately.

[1] See, e.g., Dedola and Lombardo (2012).

(Table 1 here)

We therefore test the following baseline predictions:

(i) trade integration increases the cross border transmission of foreign business cycles;

(ii) financial integration dampens it, unless financial shocks are key drivers of the business cycle;

(iii) a more limited policy space (e.g. fixed exchange rate regime, high public debt) amplifies the transmission.

3 Empirical model

Turning to the empirical model, we focus on regressions trying to identify the effect of foreign real GDP growth (a proxy for the foreign business cycle) for real GDP growth in a given country. Unlike in the literature on business cycle synchronization, we will try to identify the spill-over effect of a shock hitting a generic country j on real GDP growth (the business cycle) in country i. Our approach can be interpreted loosely as a regression of each unit in a group on the leave-out mean (Angrist 2013). Even if each unit is very small, a strictly causal interpretation is precluded by the fact that the right-hand side and the left-hand side of the equation can be hit by the same shocks (common shocks). Our focus on the impact of foreign shocks can be interpreted broadly as the influence of non-domestic sources (common and strictly foreign). The fact that we include characteristics of the *receiving* countries among the possible transmission channels helps somewhat to distinguish between common and foreign shocks as certain characteristics (such as openness) should matter more, or even exclusively, for the latter type of shocks.

3.1 Conceptual framework

We divide our analysis in two conceptually separate steps. We assume that countries' exposure to foreign growth depends on two factors: *(i)* links between the country in question and each other country in the world and *(ii)* the country's overall exposure to external shocks. In a two-country setting it is obviously impossible to distinguish between these two dimensions, but in a multi-country setting they might be relevant. In a three country model, for example, one could imagine the situation of two countries being more

closely related and a third one more isolated, but at the same time the third country could be more vulnerable to external shocks due to its own characteristics (say, lack of policy space to counteract shocks). We deal with the first dimension (identifying which countries matter most) in Section 3.2, and then the question of the overall vulnerability (what drives the exposure to external shocks) in Section 3.3.

3.2 Identifying relevant pairwise characteristics

One key question we want to address in this paper is how to deal with the curse of dimensionality in the context of multi-country models in a way that preserves the key characteristics of the international transmission of shocks. What pairwise country characteristics are important for the international transmission of business cycles? Let us start from the simplest case,

$$\Delta y_{it} = \alpha_i + \beta \Delta y_{it-1} + \gamma_{j \neq i} \frac{1}{n-1} \Delta y_{jt} + \varepsilon_{it} \tag{1}$$

i.e. where output growth Δy_{it} (our simple proxy of the business cycle) is regressed on its lagged value and on an aggregation of growth in other countries with equal weights (leave-out means). Let us consider this as the (naive) benchmark case. Countries are indexed $i = 1, ..., n$.

This is in fact just a very special case of a more general model that can be specified as

$$\Delta y_{it} = \alpha_i + \beta \Delta y_{it-1} + {}_{j \neq i} \gamma_j \Delta y_{jt} + \varepsilon_{it} \tag{2}$$

For n large enough, the model cannot be estimated due to its high dimensionality. This is the well-known "curse of dimensionality"problem in multi-country models emphasized, among others, by Canova and Ciccarelli (2013). Therefore, the γ_j parameters have to be summarized into something of (much) lower dimensionality. For example, in equation (1) $\gamma_j = \frac{\gamma}{n-1}$.

The focus of this paper is on the identification of a small vector of variables, x_{ijt}, which summaries most of the variation in the γ_j parameters. To address this question, we consider models specified as

$$\Delta y_{it} = \alpha_i + \beta \Delta y_{it-1} + \gamma_{j \neq i} x_{ij,t-1} \Delta y_{jt} + \varepsilon_{it} \tag{3}$$

where

$$x_{ij,t-1} = \left(\frac{w_{ij,t-1}}{\sum_{j \neq i} w_{ij,t-1}} \right) \tag{4}$$

and γ is a (rather small) vector of parameters, w are the weights (x are expressed in relative terms so that they sum up to 1 when summed cross countries other than i). If any of the components of γ are significant, it means that some of the variables in x help identifying what pairwise characteristics are most relevant to explain the international transmission of output growth. Notably, our focus is not only on the *statistical* but also on the *economic* significance of the different variables (this will be evident later when we compare FDI and trade weights). When γ is positive (negative) we interpret x as being an amplifier (dampener) of the effect of foreign shocks on domestic business cycles.

We consider trade and financial linkages between country i and j:

Trade linkages. In order to compute trade linkages we follow the approach typical of the GVAR literature as described in Dees et al. (2007). Trade linkages are computed as the sum of exports from country i to country j at time $t-1$ and of imports of country i from country j at time $t-1$ scaled by total trade of country i at time $t-1$ (i.e. sum of total exports and total imports of country i to/from the rest of the world):

$$w^{trade}_{ijt-1} = \frac{exp_{ijt-1} + imp_{ijt-1}}{totexp_{it-1} + totimp_{it-1}} \tag{5}$$

Financial linkages. We follow the same approach to compute financial linkages. We explore the transmission potential of three financial channels: FDI linkages, bank linkages and portfolio linkages. To compute FDI linkages we use the sum of FDI stock of country i in country j and of FDI stock of country j in country i, scaled by the sum of total inward and outward FDI stock of country i. We use portfolio investment assets and liabilities (from countries' International Investment Position) between country i and country j scaled by the sum of total portfolio investment and liabilities of country i to compute portfolio linkages. Finally, to compute bank linkages we take the sum of cross-border banking claims and liabilities of country i *vis à vis* country j scaled by the sum of total cross-border banking claims and liabilities of country i.

3.3 Explaining the overall exposure to external shocks: receiving country characteristics

As noted, we also study the role of the characteristics of the receiving country in explaining the international transmission of shocks. Suppose that we identify a small set of variables, say x^*, which stands out as an economically and statistically significant set in the estimation of equation (3). This would provide us with an optimal weighting scheme summarising the pairwise characteristics that matter to explain the cross border spill-over. Armed with these optimal weights, we can then write equation (3) as

$$\Delta y_{it} = \alpha_i + \beta \Delta y_{it-1} + \gamma^*_{j \neq i} x^*_{ij,t-1} \Delta y_{jt} + \varepsilon_{it} \tag{6}$$

Characteristics of the receiving country may also matter for the strength and direction of the transmission of external shocks. Let us define

$$z^*_{it} =_{j \neq i} x^*_{ij,t-1} \Delta y_{jt} \tag{7}$$

We can therefore estimate the following equation,

$$\Delta y_{it} = \alpha_i + \gamma^* z^*_{it} + \lambda z^*_{it} \zeta_{it-1} + \mu \zeta_{it-1} + \varepsilon_{it} \tag{8}$$

where ζ_{it-1} is a vector of predetermined country characteristics. If any component of the vector λ is significant, then the corresponding characteristic in ζ is relevant to explain how vulnerable a country is to receive shocks from the rest of the world. In the ζ vector we consider trade and financial openness (both de iure and de facto), the exchange rate regime (i.e. the stabilization capacity of monetary policy), public spending to GDP ratio and public debt to GDP which may influence the degree to which fiscal policy can be used for stabilization purposes. Note that in the relevant tables we do not report the term $\mu \zeta_{it-1}$, which is generally not interesting, but it is always included in the regressions.

4 Data

In order to study the international transmission of business cycles, we use the database on international linkages (*IntLink*), which was developed in the framework of the ECB International Linkages and Spill-overs Network. The database brings together annual

series capturing real and financial international linkages across countries, combining data from several sources.[2]

Country coverage. The model is estimated for a sample of 15 euro area countries (Austria, Belgium, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia, and Spain), 11 (non-euro area) European countries (Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Latvia, Lithuania, Poland, Romania, Sweden, and United Kingdom) and other 24 non-European countries (Argentina, Australia, Brazil, Canada, China, Chile, Hong Kong, India, Indonesia, Israel, Japan, Malaysia, Mexico, Pakistan, Peru, Philippines, Russia, Saudi Arabia, South Africa, South Korea, Switzerland, Turkey, United States, and Venezuela) for the period 1970-2014.

Data sources. Data on exports and imports are from the Direction of Trade Statistics (DOTS) of the International Monetary Fund (IMF) and cover 1970-2014. The source of data on FDI inward and outward is the OECD Foreign Direct Investment by country data set. The data set contains bilateral FDI flows and stock from 1981 to 2011. Data on portfolio investment holdings are from the Coordinated Portfolio Investment Survey (CPIS) of the IMF. The CPIS covers year end data for 1997 and from 2001 onwards. International and foreign claims are from the Bank of International Settlements (BIS) consolidated banking statistics data set. Data are compiled on immediate risk basis and cover the period 1983-2014. GDP and GDP per capita are form the World Development Indicators (WDI) of the World Bank. Government gross debt (% GDP) and government spending (% GDP) are from the World Economic Outlook (WEO) database of the IMF. Data are available for all countries starting from 1980 to 2014. The index of overall restriction (all assets) is from the dataset on capital control measures developed by Fernandez et al. (2015) . The index is used to measure the degree of financial restrictions (i.e. a de iure measure of financial openness) of a country and is available for 1995-2013.[3] The exchange rate regime variables (peg exchange rate and dollar peg exchange rate) are taken from Klein and Shambaugh (2010) and cover the period 1970-2014. Peg exchange rate is a dummy variable which takes value 1 if a country has pegged its currency to another

[2] A Code Book of the database IntLink describing variables and sources is available at *http* : *//www.ecb.europa.eu/home/html/researcher*$_i$*ntlink.en.html*

[3] This measure is obviously negatively correlated with financial openness: more restrictions, less openness.

currency in a year between 1970-2014 and 0 otherwise. Dollar peg exchange takes value 1 only if a country has pegged its currency to the dollar. *Table 2* contains a detailed overview of the definition of the variables and of the data sources.

Table 3 contains the summary statistics for the variables that we use in the empirical analysis, in particular the data for weighted foreign GDP growth, i.e. $_{j\neq i}x_{ij,t-1}\Delta y_{jt}$. *Table 4* looks at the correlations between the weighted GDP growth series, according to the variable determining the weights (say, trade or financial links). A main message here is that measures of weighted foreign GDP growth are all highly positively correlated, which will pose significant challenges in trying to identify the best weighting scheme in equation (3).

(Tables 2-4)

5 Results

Before going through our results in detail, it is useful to first provide an overview of key findings. We find first that FDI weights are more relevant than trade weights but the difference is quantitatively small, and data availability for trade links is significantly larger. Moreover, in line with our priors we find that trade integration fosters the spill-over of business cycles, both in terms of bilateral links and as a country characteristic (trade openness). By contrast, results for financial integration are more mixed. We find that bilateral financial links are mostly insignificant as a transmission channel, but negatively signed (in line with our priors) when statistically significant. Financial openness as a characteristic of the domestic economy (both de iure and de facto), by contrast, is found to increase countries' sensitivity to foreign growth. There is hardly any evidence for a significant role of the exchange rate regime as an absorber or amplifier of foreign shocks. Finally, fiscal policy, and in particular automatic stabilisers, appear to play a significant role. Higher government spending and debt act as a dampener of the transmission of foreign growth and their effect is statistically and economically significant.

5.1 Results for pairwise characteristics

We show the baseline results for pairwise characteristics in *Table 5*. We report all specifications with and without time fixed effects. Three main results arise from Table 5. First,

FDI weights are the most significant when included with other weights, including trade weights. This is visible for example in the last two columns of the table, where we put together weights based on FDI, trade, bank and portfolio links (with the caveat that data availability is severely restricted when we put all weights together). Second, aggregates based on finance (i.e. bank or portfolio) weights are either insignificant or, when significant, negative, in line with our priors and model simulations. Finally, trade weights lead to a positive coefficient of the resulting weighted foreign output and data availability is by far the highest for these weights. Hence, the main message here is that trade and FDI links amplify the cross-border spill-over, while finance links play a dampening role or no role.

Table 6 compares trade, FDI and finance weights (the latter constructed as the first principal component of DFI, bank and portfolio linkages) on the *overlapping sample* (the same for which data for both weighting schemes are available, to ensure full comparability). The relative weights of trade- and FDI-weighted foreign growth are around 1/3 and 2/3 respectively. Hence, the results in Table 6 confirm that FDI weights are the most relevant and finance weighted aggregates are insignificant if included together with trade or FDI weighted aggregates. Combining trade and FDI weights (columns (8) and (9)) leads to a coefficient of around 1.2 for foreign output growth without time dummies, and around 0.8 with dummies, which (especially in the latter case which controls for all common time effects) appears relatively large.

(Tables 5-6 here)

In thinking about the optimal weighting scheme we need to consider not only the *statistical* but also the *economic* significance and also, from a practical standpoint, the number of observations that are available under each weighting scheme. When comparing FDI and trade weights from this standpoint, it is notable that the fitted values derived when using one of the weighting schemes individually in the regression (*Table 7*) are very highly positively correlated, suggesting that while there may be nuances of statistical significance the weighting schemes lead to very similar results. This in turn suggests that data are not really able to distinguish between different weighting schemes, as right hand side variables are highly positively correlated. In turn, this suggests that data availability may also be important for an optimal weighting scheme, because results do not depend

much on the weighting scheme. Data for trade weights are generally more available than for FDI weights. For this reason, in the continuation of this analysis we mostly use trade weights as the baseline weighting scheme although strictly speaking FDI weights appear to be more statistically significant, at least on the overlapping sample.

(Table 7 here)

In *Table 8a* we report some robustness analysis of the baseline results of Table 5, notably with and without time dummies, excluding large countries, as well as interacting with the crisis dummy in order to distinguish normal and crisis times. In terms of the different weighting schemes, results are generally in line with the baseline. In particular, excluding the large countries (US, Japan, Germany and China) does not lead to significantly different results, nor this is the case when restricting the sample to G20 countries. Moreover, in the last column of this table we apply instrumental variables using US GDP growth as the external instrument for trade-weighted foreign GDP for each country. The reasoning behind this exercise is that our modeling strategy is predicated on the assumption that country i is small, so that the direction of causality goes from the global to the domestic variable; if the source of the shock for foreign growth is within country i itself, then our estimates would be biased. Excluding large countries may not be sufficient to address this concern, because each country i could still be small on a global scale but large on a regional basis, which implies that it is not small for the weighted aggregate of foreign growth rates. In this robustness exercise, in particular, we instrument z^* with US real GDP growth at time t weighted by trade between the receiving country i and the US at time $t-1$ (this regression obviously excludes the US from the sample of countries receiving the shock). We find that in this estimation the impact of foreign growth is somewhat less than, but quite close to, the baseline. When including time dummies, the effect of foreign trade-weighted growth on domestic growth is around 0.6.

At the same time, we also find, at least for trade-weighted GDP growth (second column), that the impact of foreign growth on domestic growth was much larger than normal during the global financial crisis.[4] The additional effect is around 0.3, which is economically significant.

[4]To proxy the global financial crisis we use a dummy variable taking value 1 in 2008 and 2009, and zero otherwise.

In *Table 8b* we test for additional lags for trade- and FDI-weighted foreign growth, in particular $t-1$ (columns (1) and (2)) and the average of $t-3$ to $t-1$ (columns (3) and (4)). The message from these regressions is that there is little value added from including lags.[5] In columns (5) and (6) we report regressions using the Anderson-Hsiao IV approach to test for the Nickell bias. As the coefficients are very similar to those of the baseline (see columns (5) and (6) in Table 6) we conclude that the Nickell bias is unlikely to be a serious problem in our estimations.

(Tables 8a-8b here)

5.2 Receiving country characteristics

We next turn to results concerning the role of country characteristics as amplifying or dampening factors of the cross border spill-over of business cycles. Let us recall here that the defining characteristics have generally been standardised, with the exception of the exchange rate regime which is a dummy variable. Therefore a coefficient of, say, 0.1 implies that moving one standard deviation up in a certain receiving country characteristic, say trade openness, makes the cross border effect stronger by 0.1 (a 1% increase in foreign output implies an additional 0.1% increase in the receiving country with higher trade openness). Also note that in this section all regressions contain time dummies.

Table 9 reports results for all countries, using trade weights to compute the foreign aggregate due to the higher data availability. We report the interaction terms only, first individually and then together in column (8), where we show the best model (obtained in a general to specific way by gradually eliminating insignificant variables). Looking at country charateristics individually, we find that trade openness increases the spill-over from foreign growth, by about 0.1% for a one standard deviation increase. For financial openness, we find that both definitions (de iure and de facto) lead to an amplification of the spill-over, by 0.1 for the de iure measure and 0.05 for the de facto measure. However, financial openness is generally insignificant when included with other interaction terms. Measures of the exchange rate regime (Peg and Dollar peg) are insignificant. Interestingly, both higher government spending and debt to GDP have a statistically significant dampening effect on the spill-over of foreign growth. The effect is around 0.1 for a standard

[5] Additonal lags of the dependent variable (not reported for brevity) also make little difference to the results.

deviation increase in government spending and 0.2 for government debt. These results suggest that fiscal automatic stabilisers are important for dampening the effect of foreign shocks. The result for the government debt to GDP may appear puzzling because it could be expected that a higher debt actually *reduces* the fiscal space and may hence increase the spill-over, but government debt may simply not be a good measure of the fiscal space (see, e.g., Ostry et al. 2015).

Finally, in *Table 10* we report the baseline results of Table 9 including interaction terms with the crisis dummy (column (2)) and showing results separately for advanced and emerging countries (columns (3) and (4)). As regards the crisis dummy, we confirm that the cross border transmission of foreign growth was larger in crisis than in normal times. In terms of the role of receiving country characteristics, however, we do not find any statistically significant change in the crisis years. Turning to differences between advanced and emerging countries, we first find that the spill-over of foreign growth is much larger for emerging countries and trade openness in particular seems to be more important for them. Government spending to GDP is significant only for emerging countries, but is larger in size (though statistically insignificant) for advanced countries.

(Tables 9-10 here)

6 Conclusions

This paper has provided an extensive analysis of how real GDP growth in one country (as a proxy for the business cycle) are affected by growth rates in partner countries, by testing for alternative transmission channels. Using annual data for both advanced and emerging countries for the period 1970-2014, we explore which factors among trade, FDI and financial linkages explain the cross border transmission of business cycles. We interpret our results against some baseline predictions which we derive from a standard two-country DSGE models similar to Pappa (2004), described in the Appendix. In that model, we show that for all considered shocks (productivity, demand and monetary) trade integration and a fixed exchange rate regime act as an amplifier of the cross border effect of shocks, and financial integration as a dampener. We also argue that this last result is likely to be over-turned in a model where financial shocks are present and where they are a dominant source of business cycle fluctuations.

The main results of our paper are four. First, FDI weights are more relevant than trade weights in a statistically significant way to explain the cross-border spill-over of business cycles, but the difference is quantitatively small and the data availability for trade links much larger. Second, trade integration fosters the spill-over of business cycles, both in terms of bilateral links and as a country characteristic (trade openness). This is certainly in keeping with the predictions of standard two-country models and with conventional wisdom. Second, results for financial integration are more mixed and difficult to interpret. Third, we find that bilateral financial links are mostly insignificant as a transmission channel, but negatively signed (in line with our priors) when statistically significant. Moreover, we find no difference for financial links in crisis times, when financial shocks may have been more important. At the same time, the overall effect of foreign growth on domestic growth is larger during the global financial crisis, reflecting the global nature of the slump. Financial openness as a characteristic of the domestic economy is instead found to increase countries' sensitivity to foreign growth, although its effect is not robust to the inclusion of other interaction terms. There is hardly any evidence for a significant role of the exchange rate regime as an absorber or amplifier of foreign shocks. Fourth and finally, fiscal policy, and in particular automatic stabilisers, appear to play a significant role. Higher government spending and debt act as a dampener of the transmission of foreign growth and its effect is statistically and economically significant. The result for government debt is at odds with the idea that reduced fiscal space prevents the action of automatic stabilisers, and is likely due to the fact that debt is a poor measure of the fiscal space.

Despite recent advances, our results suggest that there is still a lot of work to be done in order to understand cross border spill-overs. Key questions that remain un-addressed or have been only partly addressed are: are spill-overs shock-dependent? Are they time-varying? Do estimated spill-overs depend on the model type (say, DSGE vs. reduced form estimation)? Are event studies representative enough? Can we identify a narrow set of factors (say, trade and financial integration) explaining the bulk of the variation across section and over time in the cross border spill-over? Moreover, other important research questions concern the implications of spill-over for optimal policy cooperation and coordination. All in all, a rich research agenda lies ahead.

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Appendix: spill-overs in a standard DSGE model

In order to set the stage for the empirical analysis we provide some simulations of the cross border effect of structural shocks (demand, technology and monetary policy shocks) in a standard, textbook New Keynesian two-country DSGE model. As a typical representative of this class of models we consider a simplified version of the model of Pappa (2004), who employes this model to study optimal monetary policy cooperation between the euro area and the US. The core equations of the log-linearised version of the model are, for the Home economy,

$$c_t = E_t c_{t+1} - \frac{1}{\sigma}(R_t - E_t \pi_{t+1}) + \frac{\alpha}{\sigma} E_t(s_{t+1} - s_t) + \varepsilon_t^d \tag{9}$$

$$\pi_t = \beta E_t \pi_{t+1} + k_c(c_t - \widetilde{c}_t) + k_s(s_t - \widetilde{s}_t) \tag{10}$$

where c is consumption, π is the inflation rate in domestically produced goods and s is the terms of trade (all in deviation from the steady state), R is the nominal interest rate, σ is the relative risk aversion coefficient and, importantly, α is the degree of trade openness in the economy ($\alpha = 0$ is autarky, $\alpha = \frac{1}{2}$ is complete good market integration). Equation (9) is an open-economy Euler equation, equation (10) an open-economy Phillips curve. The terms $\widetilde{c}_t$ and $\widetilde{s}_t$ represent the flexible price level (in deviation from the steady state) of respectively consumption and the terms of trade, as they are driven by (Home and Foreign) supply shocks. k_c and k_s are parameters that are function of α and σ (note that k_s converges to zero if α gets close to zero). Finally, ε_t^d is an AR(1) positive demand shock. The same equations hold for the Foreign country, apart from changing the signs of the terms involving the terms of trade.

The uncovered interest rate parity (UIP), expressed in real terms, reads

$$E_t(s_{t+1} - s_t) = \Phi[R_t - E_t \pi_{t+1} - (R_t^* - E_t \pi_{t+1}^*)] \tag{11}$$

where R^* is the foreign interest rate and π^* foreign inflation. Note that the standard international risk sharing condition can be derived directly from the UIP equation in (11); if $\Phi = 1$, this model implies a frictionless trading in one-period bonds. However, as suggested among others by Heathcote and Perri (2002) and Corsetti et al. (2009) the evidence appears inconsistent with the presence of full cross country insurance resulting from complete financial integration. Heathcote and Perri (2002) note that the evidence is, if anything, closer to a model with financial autarky than to a model with full risk-sharing.

For this reason, we also consider a simulation with imperfect financial integration in the market for one-period bonds and choose a value $\Phi < 1$ implying imperfect substitutability between domestic and foreign bonds. This brings us closer to the situation of a country imposing effective capital controls on one-period bonds.[6] Note that in the context of the log linearised version of this model, deviations from the UIP with $\Phi = 1$ cannot be justified based on risk premia; the UIP is fully equivalent with the covered interest parity (CIP). CIP deviations are traditionally associated with capital controls or other impediments to full financial integration (Frankel 1992). Assuming $\Phi < 1$ is an *ad hoc* way to creat CIP deviations and therefore capture the idea that restrictions to capital mobility allow countries to weaken the correlation between interest rates and exchange rates, thus also allowing them to find a different position in the "trilemma" compared with the case of full capital mobility (see also Chinn 2006). The case $\Phi = 0$ allows a complete decoupling, making for example domestic monetary policy independence and pegging the exchange rate mutually compatible.

The model is closed by the assumed reaction function of the monetary policy authorities. In the baseline calibration, we assume that the two countries follow a standard Taylor rule on their domestic consumption and inflation,

$$R_t = 0.5c_t + 1.5\pi_t + \varepsilon_t^{mp} \tag{12}$$

$$R_t^* = 0.5c_t^* + 1.5\pi_t^* \tag{13}$$

where ε_t^{mp} is an AR(1) monetary policy shock in the Home country. In an alternative calibration, we assume that the Foreign country's monetary authority pegs the nominal exchange rate to the Home country, which implies that R_t^* mimics R_t very closely. We also consider (not reported for brevity) the case of a monetary union, where the Home monetary authority reacts to an average of Home and Foreign consumption and inflation; the results of that variant of the model are close to the currency peg case.[7]

In *Figures 1-3* we report the effect of respectively demand, supply and monetary policy shocks in the Home country on consumption in the Foreign country. We consider a

[6] This is well known in the literature as the Backus-Smith puzzle; for a recent analysis see Hess and Shin (2010). Note that the case $\Phi < 1$ is not considered by Pappa (2004). Also note that in this simple model we do not consider more generalised restrictions to trade in a complete set of assets, going beyond one-period risk free bonds.

[7] See Gali and Monacelli (2008) on further analysis of the monetary union case in a two country DSGE.

baseline calibration of the model, using the same parameters as in Pappa (2004) (see Table 1 on page 763 in that paper) except for the monetary policy rules, and three variants, (i) a lower trade home bias ($\alpha = 0.4$ rather than $\alpha = 0.2$ in the baseline), (ii) the case where the Foreign country pegs to the Home country, and (iii) a case of imperfect risk sharing (incomplete financial integration), with $\Phi = \frac{1}{2}$. In each figure, the baseline is depicted as a solid blue line, and the alternative as a dashed red line.

(Figures 1-3 here)

We find that in all figures the variants of the model result in an *amplification* of the international transmission of shocks. This is of course not surprising for trade openness; a lower degree of home bias results in a stronger transmission of shocks. The case of the central bank pegging the exchange rate is also relatively straightforward, since the Foreign central bank loses one stabilization instrument by following the Home interest rate in all circumstances. What is perhaps more surprising is the magnitude of the effect, which is very large in our simulation. Finally, we find that imperfect financial integration is also an amplifier of the cross border transmission of shocks as it leads to less risk sharing and more correlated business cycles (as in Baxter and Crucini 1995). Again, we should emphasize that these results are model-dependent, and although the model is representative of a broad class of "plain vanilla" two country DSGE models results may still change when adding additional features to the model, such as investment or financial frictions.

Table 1. Literature review: Dampening or amplification of shocks in two-country DSGE models

Paper	*Structural characteristic*	*Amplification or dampening?*	*Shock type*	*Model type*	*Notes*
Alpanda and Aysun (2014): *International transmission of financial shocks in an estimated DSGE model*	Financial integration	Amplification of spillovers	Financial shocks	Two-country DSGE, estimated	Financial integration is rendered through correlated financial shocks.
Baxter, M. and M. J. Crucini (1995): *Business cycles and the asset structure of foreign trade*	Financial integration	With higher financial integration consumption co-moves in *home* and *foreign* while output moves in opposite direction. The reverse is true with lower financial integration	Technology shock	Two-country RBC, calibrated	Financial integration becomes important when shocks are highly persistent.
Dedola, L. and G. Lombardo (2012): *Financial frictions, financial integration and the international propagation of shocks*	Financial integration	Amplification of spillovers (see note for technology shocks)	Financial shock, Technology shock	Two-country DSGE, calibrated	Technology shock: with financial integration financial co-movement turns from low and negative to high and positive. It does not affect macroeconomic variables.
Devereux and Yetman (2010): *Leverage constraints and the international transmission of shocks*	Financial integration	Amplification of spillovers	Technology shock	Two-country DSGE, calibrated	
Faia (2007): *Finance and international business cycles*	Fixed exchange rate regime, trade openness, financial openness	Amplification of spillovers from fixed exchange rate regimes and trade openness. Dampening of spillovers from financial openness	Technology shock, Monetary policy shock	Two-country DSGE, calibrated	

Faia (2009): *Financial frictions and the choice of exchange rate regimes*	Fixed exchange rate regime	Amplification of spillovers	Monetary policy, Technology shock	Two-country DSGE, calibrated	Differences in the financial structure (premia) decrease cyclical correlations.
Gertler, M., S. Gilchrist and F.M. Natalucci (2007): *External constraints on monetary policy and the financial accelerator*	Fixed exchange rate regime	Amplification of spillovers	Shock to borrowing premium	Two-country DSGE, calibrated	In the context of the model, this shock is equivalent to a shock to the foreign interest rate.
Kamber and Thoenissen (2013): *Financial exposure and the international transmission of financial shocks*	Financial integration	Amplification of spillovers	Banking shocks	Two-country DSGE, calibrated	Financial integration is 'measured' as increased banking exposure.
Kollmann (2013): *Global banks, financial shocks, and international business cycle: evidence form an estimated model*	Financial integration	Amplification of spillovers	Financial (banking) shocks	Two-country DSGE, estimated	
Kollmann et al. (2012): *Global banking and international business cycles*	Financial integration	Amplification of spillovers from loan default shock, little effect on technology shock transmission	Technology shock, Loan default shock	Two-country DSGE, calibrated	Loan loss must be exceptionally large to have business cycle effects.
Mendoza and Quadrini, (2010): *Financial globalization, financial crises and contagion*	Financial integration	Amplification of spillovers on asset prices	Financial (banking) shock	Two-country DSGE, calibrated	
Perri and Quadrini (2010): *International recessions*	Financial integration	Amplification of spillovers	Credit shocks	Two-country DSGE, calibrated	

Table 2. Data sources

Variable	*Definition*	*Source*	*Data coverage*
Exports	Exports of country *i* to country *j* (USD m)	IMF Directions of Trade Statistics (DOTS)	1970-2014
Total exports	Total exports of country *i* (USD m)	IMF Directions of Trade Statistics (DOTS)	1970-2014
Imports	Imports of country *i* from country *j* (USD m)	IMF Directions of Trade Statistics (DOTS)	1970-2014
Total imports	Total imports of country *i* (USD m)	IMF Directions of Trade Statistics (DOTS)	1970-2014
Outward FDI stocks	Total outward FDI stocks of country *i* in country *j* (USD m)	OECD Foreign Direct Investment (FDI)	1985-2013
Total outward FDI stocks	Total outward FDI stocks of country *i* (USD m)	OECD Foreign Direct Investment (FDI)	1985-2013
Inward FDI stocks	Total inward FDI stocks of country *i* from country *j* (USD m)	OECD Foreign Direct Investment (FDI)	1985-2013
Total inward FDI stocks	Total inward FDI stocks of country (USD m)	OECD Foreign Direct Investment (FDI)	1985-2013
Portfolio assets	IIP portfolio investment assets of country *i* in country *j* (USD m)	IMF Coordinated Portfolio Investment Survey (CPIS)	1997-2014
Total portfolio assets	IIP total portfolio investment assets of country *i* (USD m)	IMF Coordinated Portfolio Investment Survey (CPIS)	1997-2011
Portfolio liabilities	IIP portfolio investment liabilities of country *i* in country *j* (USD m)	IMF Coordinated Portfolio Investment Survey (CPIS)	1997-2014
Total portfolio liabilities	IIP total portfolio investment liabilities of country *i* (USD m)	IMF Coordinated Portfolio Investment Survey (CPIS)	1997-2011
Foreign bank claims	Foreign banking claims of country *i* on country *j* (immediate risk basis, USD m)	Bank of International Settlements (BIS)	1983-2014
Total foreign bank claims	Total foreign banking claims of country *i* (immediate risk basis, USD m)	Bank of International Settlements (BIS)	1983-2014
Foreign bank liabilities	Foreign banking liabilities of country *i* on country j (immediate risk basis, USD m)	Bank of International Settlements (BIS)	1983-2014
Total foreign bank liabilities	Total foreign banking liabilities of country *i* (immediate risk basis, USD m)	Bank of International Settlements (BIS)	1983-2014
Real GDP	GDP of country *i* (constant prices, USD m)	World Bank - World Development Indicators (WDI)	1970-2014
Nominal GDP	GDP of country *i* (current prices, USD m)	World Bank - World Development Indicators	1970-2014

		(WDI)	
GDP per capita	GDP per capita of country *i* (constant prices, USD m)	World Bank - World Development Indicators (WDI)	1970-2014
De iure financial openness	Index of overall capital restriction (all assets)	Fernandez et al. (2015)	1995-2013
De facto financial opennness	Total foreign assets and liabilities of country *i* over GDP of country *i*	IMF Coordinated Portfolio Investment Survey (CPIS)	1997-2014
Exchange rate regime			
Peg exchange rate	Dummy set to 1 if country *i* has a peg exchange rate regime and 0 if it has a float regime	Klein and Shambaugh (2010)	1970-2014
Dollar peg exchange rate	Dummy set to 1 if country *i* has a dollar peg exchange rate regime and 0 if it has a float regime	Klein and Shambaugh (2010)	1970-2014
Gross government debt (% GDP)	General government gross debt (% GDP) of country *i*	IMF World Economic Outlook (WEO)	1980-2014
Government Expenditure (% GDP)	General government expenditure (%GDP) of country *i*	IMF World Economic Outlook (WEO)	1980-2014
Trade linkages	Ratio between the sum of exports and imports of country i to/from country j and the sum of total exports and total imports of country i	Authors' calculation	1971-2014
FDI linkages	Ratio between the sum of outward FDI stocks and inward FDI stocks of country i to/from country j and the sum of total outward FDI stocks and total inward FDI stocks of country i	Authors' calculation	1986-2014
Portfolio linkages	Ratio between the sum of portfolio assets and portfolio liabilities of country i vis a' vis to country j and the sum of total portfolio assets and total portfolio liabilities of country i	Authors' calculation	1998-2011
Portfolio banking	Ratio between the sum of foreign banking claims and foreign banking liabilities of country i vis a' vis to country j and the sum of total foreign banking claims and total foreign banking liabilities of country i	Authors' calculation	2000-2014

Table 3. Summary statistics

Variables	Obs	Mean	St.Dev	Min	Max
Growth rates	1933	0.033	0.039	-0.160	0.204
Lag Dep. Variable	1933	0.033	0.039	-0.160	0.204
Simple average GDP Growth(t)	2200	0.034	0.017	-0.036	0.071
Trade(t-1) weighted GDP growth(t)	1936	0.028	0.017	-0.077	0.086
Bank links(t-1) weighted GDP growth(t)	275	0.015	0.020	-0.072	0.060
Portfolio links(t-1) weighted GDP growth(t)	485	0.016	0.021	-0.064	0.045
FDI(t-1)weighted GDP growth(t)	569	0.021	0.018	-0.080	0.052
Trade and FDI(t-1) weighted GDP growth(t)	567	0.018	0.015	-0.070	0.048
Finance weighted GDP growth(t)	177	0.022	0.153	-0.870	1.620
Observations	2250				

Table 4. Correlation between weighted GDP growth rates

	Trade(t-1) weighted GDP growth(t)	FDI(t-1)weighted GDP growth(t)	Bank links(t-1) weighted GDP growth(t)	Portfolio links(t-1) weighted GDP growth(t)
Trade(t-1) weighted GDP growth(t)	1			
FDI(t-1)weighted GDP growth(t)	0.9267*	1		
Bank links(t-1) weighted GDP growth(t)	0.8019*	0.8885*	1	
Portfolio links(t-1) weighted GDP growth(t)	0.8599*	0.9652*	0.8655*	1

***/**/* denotes significance at the 1/5/10 per cent confidence level. See Table 1 for the description of the variables. Sample period: annual data from 1970 to 2014.

Table 5. Baseline results

Dependent variable: Real GDP growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Lag Dep. Variable	0.325***	0.362***	0.220***	0.353***	0.138**	0.267**	0.199***	0.266***	0.166**	0.306***	0.127*	0.246*
	(0.037)	(0.040)	(0.060)	(0.070)	(0.052)	(0.106)	(0.034)	(0.062)	(0.057)	(0.083)	(0.062)	(0.117)
Trade(t-1) weighted GDP growth(t)	0.934***	0.549*	0.365***	0.392**	1.320***	0.859***	1.262***	1.541***	0.357***	0.833***	-0.238	0.116
	(0.129)	(0.287)	(0.088)	(0.154)	(0.183)	(0.266)	(0.157)	(0.176)	(0.078)	(0.252)	(0.205)	(0.235)
FDI(t-1)weighted GDP growth(t)			0.727***	0.602**					1.233***	1.147**	1.684**	1.344*
			(0.091)	(0.221)					(0.333)	(0.456)	(0.572)	(0.671)
Bank links(t-1) weigh. GDP growth(t)					-0.349	-0.552**					-0.571**	-0.612**
					(0.202)	(0.247)					(0.222)	(0.247)
Portfolio links(t-1) weigh. GDP growth(t)							-0.053	-0.010	-0.461	-0.847***	0.042	-0.551
							(0.161)	(0.299)	(0.314)	(0.198)	(0.416)	(0.496)
Time dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	1,810	1,810	567	567	275	275	485	485	309	309	177	177
Number of countries	50	50	31	31	24	24	45	45	30	30	22	22

Robust standard errors in parentheses, ***/**/* denotes significance at the 1/5/10 per cent confidence level. Weights based on trade are computed as the ratio between the sum of exports and imports of the reporter country to/from the partner country at time t-1 and the sum of total exports and total imports of the reporter country at time t-1. Bank weights are computed as the ratio between the sum of foreign banking claims and foreign banking liabilities of the reporter country vis-a-vis the partner country at time t-1 and the total sum of foreign banking claims and foreign banking liabilities of the reporter country at time t-1. Portfolio weights are calculated as the ratio between the sum of portfolio investment assets and portfolio investment liabilities of the reporter country vis-a-vis the partner country at time t-1 and the sum of total portfolio investment assets and total portfolio investment liabilities of the reporter country at time t-1. FDI weights are calculated as the ratio between the sum of outward FDI stocks and inward FDI stocks of the reporter country vis-a-vis the partner country at time t-1 and the sum of total outward FDI stocks and total inward FDI stocks of the reporter country at time t-1.

Table 6. Trade, FDI and finance weights

Dependent variable: Real GDP growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lag Dep. Variable	0.227***	0.233***	0.358***	0.220***	0.353***	0.175***	0.348***	0.236***	0.372***
	(0.030)	(0.027)	(0.037)	(0.026)	(0.037)	(0.050)	(0.071)	(0.027)	(0.037)
Simple average GDP Growth(t)	0.876***								
	(0.043)								
Trade(t-1) weighted GDP growth(t)		1.083***	0.786***	0.365***	0.392**	0.979***	0.284		
		(0.044)	(0.133)	(0.133)	(0.187)	(0.067)	(0.361)		
FDI(t-1)weighted GDP growth(t)				0.727***	0.602***				
				(0.127)	(0.203)				
Finance weighted GDP growth(t)						-0.000	-0.001		
						(0.009)	(0.009)		
Trade and FDI(t-1) weighted GDP growth(t)								1.249***	0.765***
								(0.051)	(0.146)
Time dummies	No	No	Yes	No	Yes	No	Yes	No	Yes
Observations	567	567	567	567	567	177	177	567	567
R-squared	0.504	0.589	0.646	0.612	0.652	0.614	0.671	0.588	0.641
Number of countries	31	31	31	31	31	22	22	31	31

See notes to Table 5 and Table 1 for a description of the variables. Finance is the principal component of FDI linkages, portfolio linkages and bank linkages. Financial weights are computed as the ratio between financial linkages of the reporter country with the partner country at time t-1 and the sum of total financial linkages of the reporter country at time t-1.

Table 7: High correlation between fitted values obtained under different weighting schemes

Dependent variable: Real GDP growth

	Fitted values Simple average GDP growth(t)	Fitted values Trade(t-1)weighted GDP growth(t)	Fitted values Trade(t-1) and FDI(t-1) weighted GDP growth(t)	Fitted values Trade(t-1)ad finance(t-1) weighted GDP growth(t)	Fitted values Trade(t-1) and FDI(t-1) weighted GDP growth(t) (estimated weights)
Fitted values Simple average GDP growth(t)	1				
Fitted values Trade(t-1)weighted GDP growth(t)	0.863***	1			
Fitted values Trade(t-1) and FDI(t-1) weighted GDP growth(t)	0.871***	0.969***	1		
Fitted values Trade(t-1)ad finance(t-1) weighted GDP growth(t)	0.894***	0.997***	0.971***	1	
Fitted values Trade(t-1) and FDI(t-1) weighted GDP growth(t) (estimated weights)	0.868***	0.947***	0.972***	0.951***	1

Notes: Correlation between fitted values of a model with the simple average of GDP growth rates in partner countries, a model with trade weighted GDP growth, a model which includes both trade weighted GDP growth and FDI weighted GDP growth, a model with the first principal component of the three financial channels we consider (FDI linkages, bank linkages and portfolio linkages) and a model where GDP is weighted by a combination of trade and FDI weights (the weights are based approximately on the estimated coefficients of model 5 in Table 5).

Table 8a. Robustness I

Dependent variable: Real GDP growth

	(1) Full sample	(2) Full sample - crisis	(3) Finance	(4) Ex. US JP DE CN	(5) IV (US GDP growth)	(6) IV (US GDP growth)
Lag Dep. Variable	0.362***	0.329***	0.348***	0.323***	0.327***	0.361***
	(0.022)	(0.019)	(0.071)	(0.040)	(0.020)	(0.022)
Trade(t-1) weighted GDP growth(t)	0.549***	0.769***	0.284	0.476**	0.937***	0.567***
	(0.106)	(0.055)	(0.361)	(0.213)	(0.044)	(0.106)
Crisis*Trade(t-1) weighted GDP growth(t)		0.336***				
		(0.118)				
Crisis (2008,2009)		-0.015***				
		(0.003)				
Finance(t-1) weighted GDP growth(t)			-0.001			
			(0.009)			
FDI weighted(t-1) GDP growth(t)				0.707***		
				(0.218)		
Time dummies	Yes	No	Yes	Yes	No	Yes
Observations	1,810	1,810	177	483	1,767	1,767
R-squared	0.353	0.324	0.671	0.666	0.313	0.353
Number of countries	50	50	22	28	49	49

See notes to Table 5 and Table 1 for a description of the variables. In the IV estimates in columns (7) and (8) the instrument is reported in parenthesis; all other estimates are OLS. Finance is the principal component of FDI linkages, portfolio linkages and bank linkages. Financial weights are computed as the ratio between financial linkages of the reporter country with the partner country at time t-1 and the sum of total financial linkages of the reporter country at time t-1.

Table 8b. Robustness II

Dependent variable: Real GDP growth

	(1)	(2)	(3)	(4)	(5) IV: Lag 2 of the dependent in levels	(6) IV: Lag 2 of the dependent in differences
Lag Dep. Variable	0.435***	0.426***	0.367***	0.341***		
	(0.073)	(0.070)	(0.089)	(0.092)		
Trade(t-1) weighted GDP growth(t)	0.447***	0.573***	0.384**	0.468*		
	(0.121)	(0.166)	(0.170)	(0.247)		
FDI(t-1)weighted GDP growth(t)	0.667***	0.729**	0.717***	0.816*		
	(0.140)	(0.300)	(0.191)	(0.429)		
Lag trade(t-1) weighted GDP growth(t)	-0.336*	-0.262	-0.150	-0.037		
	(0.191)	(0.260)	(0.267)	(0.346)		
Lag FDI(t-1)weighted GDP growth(t)	-0.123	-0.647	-0.240	-0.542		
	(0.180)	(0.433)	(0.261)	(0.600)		
Mean of Lags (1)-(3) trade(t-1) weighted GDP growth(t)			-0.234	-0.307		
			(0.203)	(0.369)		
Mean of Lags (1)-(3) FDI(t-1)weighted GDP growth(t)			0.225	-0.393		
			(0.166)	(0.499)		
Lag Dep. Variable (first difference)					0.201***	0.182**
					(0.047)	(0.086)
Trade(t-1) weighted GDP growth(t)(first difference)					0.408**	0.416**
					(0.172)	(0.172)
FDI(t-1)weighted GDP growth(t)(first difference)					0.729***	0.716***
					(0.175)	(0.180)
Time dummies	No	Yes	No	Yes	No	Yes
Observations	527	527	458	458	527	527
R-squared	0.663	0.68	0.65	0.673	0.572	0.582
Number of countries	31	31	31	31	31	31

See notes to Table 5 and Table 1 for a description of the variables. Columns (1)-(6) add to the original model first and second lags in levels of the dependent variable and of all explanatory variable to detect any highly persistent behaviour in our variables of interest. Column (7) and (8) show the results obtained by implementing the Anderson-Hsiao approach that we use as a test for Nickell bias. The Anderson-Hsiao approach consists of using IV on a first difference transformation of all variables. The second lag of the dependent variable in levels and in first differences is used as instruments of the first lag of the dependent variable in first difference in column (7) and (8), respectively.

Table 9. Trade openness amplifies, government spending dampens the spill-over

Dependent variable: Real GDP growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lag Dep. Variable	0.362***	0.365***	0.283***	0.371***	0.326***	0.358***	0.358***	0.299***	0.299***
	(0.040)	(0.040)	(0.050)	(0.047)	(0.038)	(0.039)	(0.041)	(0.046)	(0.045)
Trade(t-1) weighted GDP growth(t)	0.549*	0.503*	1.077***	0.965***	1.024***	0.551*	0.596**	1.087***	1.023***
	(0.287)	(0.262)	(0.192)	(0.311)	(0.170)	(0.287)	(0.291)	(0.229)	(0.180)
Trade openness(t-1)*Trade weighted GDP growth(t)		0.114**							0.114**
		(0.047)							(0.053)
Index of overall restriction(t-1)*Trade weighted GDP grow			-0.094*						
			(0.053)						
De facto financial openness(t-1)*Trade weighted GDP growth(t)				0.052***					
				(0.017)					
Gov. debt(t-1)*Trade weighted GDP growth(t)					-0.236***				
					(0.054)				
Peg exchange rate regime(t-1)*Trade weighted GDP growth(t)						-0.005			
						(0.110)			
Dollar peg exchange rate regime(t-1)*Trade weighted GDP growth(t)							-0.202		
							(0.180)		
Gov. spending to GDP(t-1)*Trade weighted GDP growth(t)								-0.094**	-0.092**
								(0.035)	(0.036)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,810	1,809	851	1,131	1,070	1,801	1,801	1,180	1,179
Number of countries	50	50	45	50	50	50	50	50	50

See notes to Table 5 and Table 1 for a description of the variables. Note that the original regressions also include the non-interacted terms (for example, trade openness(t-1) for Trade openness(t-1)*Trade weighted GDP growth(t)); they are not reported for brevity in the table.

Table 10. Robustness: Receiving country characteristics

Dependent variable: Real GDP growth

	(1) Full sample	(2) Crisis	(3) Emerging countries	(4) Advanced countries
Lag Dep. Variable	0.299***	0.261***	0.233***	0.367***
	(0.045)	(0.034)	(0.072)	(0.055)
Trade(t-1) weighted GDP growth(t)	1.023***	0.963***	1.153***	0.591***
	(0.180)	(0.102)	(0.342)	(0.116)
Trade openness(t-1)*Trade weighted GDP growth(t)	0.114**	0.076	0.288***	0.083*
	(0.053)	(0.067)	(0.098)	(0.042)
Gov. spending to GDP(t-1)*Trade weighted GDP growth(t)	-0.092**	-0.095***	-0.128***	-0.781
	(0.036)	(0.029)	(0.036)	(2.994)
Crisis*Trade(t-1) weighted GDP growth(t)		0.029		
		(0.116)		
Crisis*Trade openness(t-1)*Trade weighted GDP growth(t)		0.055		
		(0.056)		
Crisis*Gov. spending to GDP(t-1)* Trade weighted GDP growth(t)		-1.753		
		(1.466)		
Crisis		-0.005		
		(0.004)		
Time dummies	Yes	No	Yes	Yes
Observations	1,179	1,179	494	685
Number of countries	50	50	24	26

See notes to Table 5 and Table 1 for a description of the variables. Note that the original regressions also include the non-interacted terms (for example, trade openness (t-1) for Trade openness(t-1)*Trade weighted GDP growth(t)); they are not reported for brevity in the table.

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