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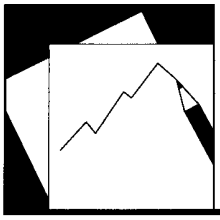

IMF Working Paper

Growth Spillover Dynamics from Crisis to Recovery

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IMF Working Paper

European Department

Growth Spillover Dynamics from Crisis to Recovery

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Abstract

Can positive growth shocks from the faster-growing countries in Europe spill over to the slower growing countries, providing useful tailwinds to their recovery process? This study investigates the potential relevance of growth spillovers in the context of the crisis and the recovery process. Based on a VAR framework, our analysis suggests that the U.S. and Japan remain the key source of growth spillovers in this recovery, with France also playing an important role for the European crisis countries. Notwithstanding the current export-led cyclical upswing, Germany generates relatively small outward spillovers compared to other systemic countries, but likely plays a key role in transmitting and amplifying external growth shocks to the rest of Europe given its more direct exposure to foreign shocks compared to other European countries. Positive spillovers from Spain were important prior to the 2008–09 crisis, however Spain is generating negative spillovers in this recovery due to a depressed domestic demand. Negative spillovers from the European crisis countries appear limited, consistent with their modest size.

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I. INTRODUCTION

Can positive growth impulses from the faster-growing countries in Europe spill over to the slower growing countries, providing useful tailwinds to their recovery process? This analysis investigates the relevance of such potential growth spillovers and seeks to identify the countries most likely to serve as "growth leaders." In particular, we examine the extent to which Germany's current upswing may spill over to other countries and accelerate recovery elsewhere.

A simple correlation between the lagged quarter-on-quarter output growth rates of Germany and other euro area countries shows an increasing co-movement between Germany and other countries, including the European crisis countries (Greece, Ireland, and Portugal), in the last 20 years. A similar pattern can be observed for the correlations of the lagged growth rates of France and Italy with the current GDP growth rate of the rest of the euro area. The correlation of the lagged United States (U.S.) growth rate with other countries' current GDP growth rate has also markedly increased. While more synchronized business cycles are suggestive of increased growth spillovers, they do not provide a measure of the spillover effects of individual countries and could also reflect the growing influence of common factors—such as euro area monetary policy—or global factors—such as oil price developments or financial conditions in major financial centers including the U.S. and the UK.

To disentangle the independent impact of growth shocks in individual countries from the effect of common factors and measure the country-specific spillover effect, we use a structural vector autoregression (SVAR) approach with an identification scheme similar to that proposed in Bayoumi and Swiston (2009). Using this framework, we undertake the following analysis:

- Characterize countries by their international growth spillovers, outward and inward. Unlike former studies, which relied on regional aggregates, we use country level data for a sample of 17 countries (accounting for almost 60 percent of global GDP, at market exchange rates), which includes 11 of the euro area countries (representing 98 percent of euro area output). Focusing on individual members rather than treating the euro area as an aggregate as in earlier studies allows us to shed light on the country-by-country spillovers and inter-linkages which drive growth dynamics.

- Describe the dynamics of these spillovers during the recent crisis and recovery. This is done by applying a dynamic growth accounting calculation to the SVAR estimation results to quantify the contribution of individual countries to the recent decline and recovery in output growth.

- Quantify the relevance of different channels of transmission of spillovers. We use counterfactual analysis and smaller country wise models which include exports as an

additional variable to assess the empirical relevance of various transmission channels, including trade and third-country (e.g., transmission through a common trade partner) effects.

- Analyze the determinants of the spillover size by relating outward spillovers to both the country's size and the relative importance of the domestic demand contribution to the country's growth.

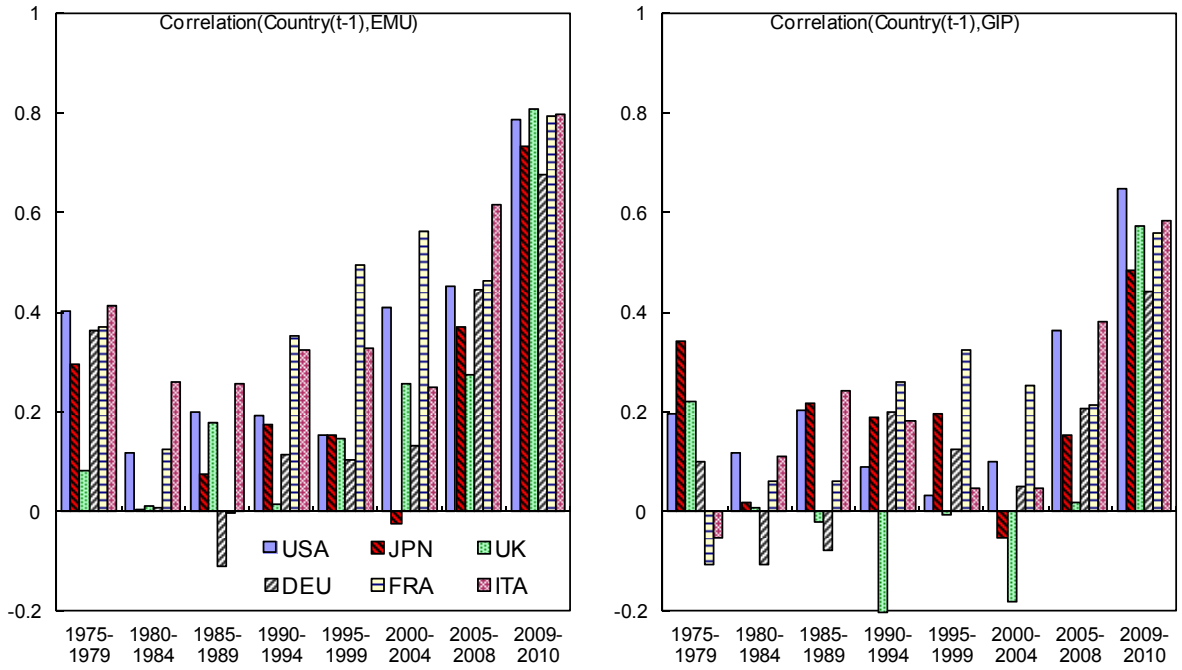
Our main findings can be summarized as follows:

- Confirming earlier results, we find evidence of significant spillover effects from the U.S. to the rest of the world. Outward spillovers from Germany are found to be surprisingly small (relative to growth impulses emanating from other large systemic countries) and largely confined to smaller trade partners.

- The results suggest that despite the increased correlation of Germany's growth rate with that of the rest of the euro area, the U.S. and Japan remain the key source of growth spillovers in this recovery, with France also playing an important role for the European crisis countries. Positive spillovers from Spain were important prior to the crisis. However, Spain is generating negative spillovers in this recovery due to a depressed domestic demand.

- In line with earlier VAR-based evidence on channels of transmission of spillovers across regions, the results of a country-by-country estimation of a smaller SVAR model augmented with exports suggest that financial and other non-trade channels explain the biggest share of cross-border growth spillovers. Trade effects are, however, particularly relevant in the case of Germany.

- Taking the analysis one step further, we find that countries that generate the largest estimated outward spillovers are the ones where growth is to a larger extent driven by autonomous sources of domestic demand. In contrast, countries which are highly sensitive to external shocks such as Germany tend to have a relatively small independent impact in aggregate on other countries. This result, together with the finding that third country effects play a significant role in the international transmission of shocks, suggests an important role for Germany as a transmitter and amplifier of growth shocks originating in other countries.



Source: OECD, IMF staff caclulations
* EMU refers here to Austria, Belgium, Finland, Greece, Ireland, Netherlands, Portugal and, Spain weighted by their respective share in the group, Simlarly GIP, refers to Greece, Ireland, and Portugal.

Three main caveats should be mentioned at the outset. All three provide interesting avenues for future research but are beyond the scope of this paper.

- Countries not in our sample potentially play an important role in global spillovers either as recipients or source of shocks. For instance, several Eastern European countries are highly integrated with Germany and have become an integral part of the production chain of German products. For these countries, empirical evidence supports the idea that Germany has played a more prominent role in recent years (see Danninger, 2008). China and other large emerging countries likely also play an important role as source of shocks in recent years, reflecting their size and increased trade linkages.[2]

- There may be other sources of growth spillovers beyond business cycle fluctuations considered in this study. For example, foreign direct investment (FDI) outflows between advanced countries and from advanced to developing countries could

[2] While data availability constrains the inclusion of China and other emerging countries in the sample, we indirectly attempted to test this hypothesis in an earlier version of the study by including exports to China, to developing Asia, and to the world as additional control variables. Those variables were not statistically significant and the results remained largely unchanged, suggesting that the sample countries already capture the bulk of relevant global demand shocks for the period under consideration (1975–2010).

generate significant spillovers over time, including through knowledge transfer and employment creation. Quantifying such FDI-related spillovers would require a different approach focused on a long-term horizon as such effects are likely to develop only over time.

- The analysis is backward looking and does not allow for continuous time varying relationships between the countries. In addition to full sample results, we present estimation results for a more recent sub-sample (since 1993) to account for the possibility of changed responses, in line with rapidly increasing cross-border trade and financial linkages. The results confirm that the potential size of cross-border growth spillovers has generally increased, with the notable exceptions of Japan and Germany for which we find no evidence of higher outward spillovers on average in the recent period.

Finally, it should be noted that the analysis is descriptive and an analysis of welfare implications is beyond the scope of this paper.

The remainder of the paper is structured as follows: Section II reviews the related literature on cross-country spillovers, outlining the main empirical approaches that have been pursued and the key findings. In Section III, we discuss the empirical strategies employed in this study. Section IV highlights the main findings and provides estimates of individual countries' relevance for other countries' growth dynamics. The potential reasons for the relevance of particular countries as a source of spillovers are discussed in Section V. Finally, Section VI concludes.

II. Growth Linkages and Spillovers: Related Literature

The empirical literature on growth spillovers has dealt with three interrelated questions: What is the size of growth spillovers? Which countries or regions are the main sources of growth spillovers? and what are the main channels of transmission of growth spillovers?

Existing empirical studies generally confirm the existence of spillover effects, but the empirical evidence about the size of spillovers is inconclusive, as results are not robust to different samples and specifications. Previous studies frequently divide the world into regions,[3] with the euro area being one of them, and examine spillovers from large advanced countries to these regions.[4] The general finding of these studies is that the U.S. is the main

[3] See, for example, Helbling et al. (2007), Arora and Vamvakidis (2006), Bayoumi and Swiston (2009), and Swiston (2010). For an example of similar approaches applied to the case of China spillovers, see Arora and Vamvakidis (2010).

[4] For the latter, see Bayoumi and Swiston (2009). This study examines the extent of spillovers across industrial regions including the U.S., the euro area, Japan, and an aggregate of small industrial countries, using VARs of growth across the four regions.

source of growth spillovers. Relatively few studies have examined the channels through which growth shocks are transmitted to the other regions and countries. Existing findings vary across studies, with simulation-based results suggesting a bigger role for the trade channel—perhaps due to the difficulty of modeling empirically asset price spillovers or confidence channels—while VAR analyses which impose less structure on the interlinkages point to the relative importance of financial and other non-trade channels.

The result that international spillovers are relatively small under standard transmission channels was first established by Helbling et al. (2007). This study finds a limited extent of U.S. growth spillovers into other regions—excluding the euro area and Japan—and even smaller effects of spillovers from the euro area or Japan, when controlling for possible channels of transmission including commodity prices (terms of trade) and financial conditions (Libor interest rate). The results obtained are similar using three alternative approaches (simple panel regressions, a more sophisticated dynamic analysis, and model simulations). The estimated spillovers are moderate in magnitude: the results from annual panel regressions for 130 countries over 1970–2005 suggest that a 1 percentage point decline in U.S. growth is associated in the long run with an average 0.16 percent drop in growth across the sample. The findings based on a VAR approach for 46 countries, both advanced and developing, also suggest that U.S. growth disturbances have on average moderate dynamic effects on growth in other regions. The simulation results in Helbling et al. (2007) also suggest that the potential spillovers from a temporary, U.S.-specific demand shock via trade channels alone are moderate, roughly of the same magnitude as the results from the panel and VAR analyses. However, alternative simulations assuming correlated disturbances across countries generate larger spillover effects. The authors of the study conjecture that such a higher impact of U.S. shocks could arise for example if the transmission had also involved asset price spillovers or confidence channels.

Arora and Vamvakidis (2006) using a long run (five-year average) panel regression approach for 101 countries over 1960–1999 find much larger spillovers. In most specifications, a roughly 1 point increase in U.S. and EU growth is associated with, respectively, a roughly 1 point and ⅔ point increase in other countries' growth (while Japan has an insignificant effect). However, the results could capture forces beyond short-term demand and business cycle effects transmitted via trade channels, such as technology spillovers and are thus not directly comparable to those of Helbling et al. (2007).

Similar to Helbling et al. (2007), Bayoumi and Swiston (2009) focus on short run dynamics across industrial regions during 1970–2006. Their main results suggest significant U.S. spillovers to other industrial regions, including the eurozone, Japan, and a group of smaller advanced economies (of one-quarter to one-half the size of the U.S. shock after two years). Spillovers from the euro area or Japan are found to be smaller than spillovers from the U.S. and insignificant in most cases, except for spillovers from Japan to the euro area (which are found to be of similar size to those from the U.S.).

Helbling et al. (2007) generally find lower spillovers from the U.S. to other countries compared to Bayoumi and Swiston (2009). This is due to two main reasons: First, Helbling et. al. (2007) use the U.S. Libor rate as a control variable. This amounts to some extent to shutting off a potential transmission channel and thus implies a lower estimated growth spillover from the U.S. GDP. In fact, Bayoumi and Swiston (2009) provide estimates of this transmission channel and show that the interest rate channel accounts for close to 50 percent of the transmission of U.S. growth shocks. Thus, once Helbling et al. (2007)'s results are adjusted by this gap, spillover effects from the U.S. to other countries are closer to Bayoumi and Swiston (2009)'s estimates. Second, Helbling et al. (2007) look at responses in countries which exclude the eurozone and Japan. As the authors note themselves, countries which have higher financial and trade linkages with the U.S. respond stronger to growth shocks in the U.S. In fact, they find for Canada and Mexico responses to U.S. growth shock at an order of magnitude comparable to the average response in Bayoumi and Swiston (2009) to U.S. shocks. Thus the sample choice appears to explain the remaining difference in the estimated impact. Our results are comparable to Bayoumi and Swiston (2009) when looking at the entire sample period, but show an even higher response to U.S. GDP when looking at the more recent episode from 1993 to 2010. This reflects to a large extent the higher financial integration of the U.S. with other countries in this period compared to the period from 1975 to 1993.

To our knowledge, few studies have examined growth spillovers and linkages within Europe. For Germany, empirical results suggest relatively small growth spillover effects. Danninger (2008) estimates a VAR model for the growth rates of the U.S., Japan, Germany, an aggregate of other euro area members, and an additional aggregate for the new EU member countries, for the period 1993–2007. While he finds significant spillovers from the euro area aggregate to the new EU member states and to Germany, he finds very limited spillovers from Germany to other countries. However, estimation results for a more recent sample (since 1998) suggest stronger spillovers from Germany to the euro area and the new member countries with 40 percent and 100 percent, respectively, of any German growth shock transmitted after three quarters.

A related literature examines fiscal policy spillovers within Europe. Bénassy-Quéré and Cimadomo (2006) generally find positive cross-border spillovers from Germany, in the sense that a fiscal expansion in Germany raises GDP abroad, at least in neighboring and smaller countries. Similarly, Beetsma, Giuliodori, and Klaassen (2005) find that, averaged across all partner countries, the effects of a 1 percent of GDP fiscal stimulus in Germany is estimated at 0.12 percent on foreign GDP for a spending increase and 0.03 percent for a net tax cut. Ivanova and Weber (2011) find spillovers of a similar order of magnitude for fiscal consolidation in Germany, France, the United Kingdom (U.K.), and the U.S. The authors argue that even when multipliers are very large spillovers are limited, in particular from core EU countries to peripheral countries, since trade links between the two areas are not very strong.

Few studies have examined the transmission channels of spillovers, that is, the major international channels through which shocks are propagated. Using model-based simulation analysis, Helbling et al. (2007) find that most of the U.S. spillover effects are trade-related and the effects are relatively small, roughly of the same magnitude as identified in the panel and VAR analyses. To generate larger effects, alternative simulations need to assume that disturbances are correlated around the world. The authors posit that such correlated disturbances could be related to increased trade and/or financial integration and could particularly arise in times of financial crisis.

The simulation results in Bagliano and Morana (2011) also suggest a relatively more important role for the trade channel as a transmission mechanism of U.S. economic developments to the rest of the world. Based on a large scale open economy factor VAR macroeconometric model, Bagliano and Morana (2011) find no clear-cut impact of adverse U.S. financial developments on foreign economic activity. While increases in a U.S. credit spread index lead to an output contraction abroad, U.S. stock price dynamics do not have any relevant effect on foreign GDP, and U.S. house price dynamics only affect the non-OECD group. Hence, the authors of the study conclude that the trade channel appears to be the key transmission mechanism of U.S. shocks to the rest of the world.

By contrast, Bayoumi and Swiston (2009) find that the largest estimated contributions to spillovers come from financial rather than trade variables. Their result is based on a comparison of the response of GDP growth in a basic VAR model to that of a model augmented with a potential spillover source (either trade, commodity prices, or financial conditions) to measure the contribution of this source to the estimated spillovers. In particular, short-term interest rates and financial conditions more generally (bond yields and equity prices) are found to play an important role in the international transmission of U.S. growth shocks. Galesi and Sgherri (2009), using a global VAR approach, also report that equity prices are the main channel through which—in the short-run—financial shocks are transmitted from the U.S. to other countries. They find that other variables—including real credit growth, real GDP growth, and real interbank rate—become more important over a two-year horizon.

The analysis of cross-country growth spillovers and, more generally, multi-country estimations is generally hampered by dimensionality constraints. Four different VAR-based approaches have been suggested to tackle this issue:[5] Bayesian VARs, factor model VARs, global VARs, and VARs based on regional groupings. All four techniques require additionally an approach for resolving the identification issue.

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[5] Another possibility is to use model-based simulation analysis. See, for example, the analysis based on structural estimated macro models using panel unobserved components estimation as suggested by Vitek (2009 and 2010).

- The Bayesian VAR approach tackles the problem with the use of priors about the cross-country correlation patterns, which are subsequently updated with the data (Banbura et al., 2007, and Canova and Ciccarelli, 2006).

- Factor models, instead, collapse cross-country co-movements of several variables into common factors which are then allowed to affect the dynamics of the individual countries (Bénassy-Quéré and Cimadomo, 2006).

- Global VARs reduce the individual countries' spillovers to their share in a weighted average for the variable of interest, which then affects the individual countries' dynamics.[6] The spillover in the global VAR has thus a direct interpretation, unlike the spillover in the factor VAR (Bussière et al., 2009, Galesi and Sgherri, 2009, and Dees et al., 2007).

- A fourth approach focuses on a small set of countries or regions—usually two to four—and then uses the traditional structural VAR (SVAR) approach (Bayoumi and Swiston, 2009 and Danninger, 2008). The degrees of freedom are preserved by reducing the number of regressors, i.e. by reducing either the number of countries involved or the number of variables considered, or a combination of both.

Bayesian VARs and SVARs are more general than global VARs or factor VARs since they impose less structure on the inter-linkages. Compared to SVARs, Bayesian VARs require making more assumptions on the data generating process in return for more degrees of freedom, which makes the estimation feasible, if the number of regressors is high relative to the size of the available data sample. The SVAR approach proposed by Bayoumi and Swiston (2009) requires an extensive dataset, but has the advantage that it imposes no structure on the inter-linkages, and thus the coefficient estimates are purely data driven.

Our analysis takes the existing literature further in the following way:

- We confirm the finding of earlier studies, based on the assessment of spillovers across regions, that the U.S. remains the main source of growth spillovers using an approach which involves a larger set of 17 individual countries.

- We provide a decomposition of countries' growth rate into the contributions from domestic and foreign components during the recent crisis and the recovery process.

- We confirm the importance of financial transmissions channels for growth spillovers, but find that trade channels are also relevant for several countries.

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[6] Cross-border trade weights are generally used to estimate the country-specific aggregate foreign variable, although one study uses annual bank lending exposures over 1999–2007 (Galesi and Sgherri, 2009).

- A more general distinction made evident by the analysis in this paper is that between autonomous country demand and transmission of global demand shocks. Our findings suggest that while spillovers vary positively with size, they also reflect the extent to which growth is domestically driven. This has implications for the extent to which some economies can be considered engines of global or regional growth or alternatively can be considered transmitters of growth shocks that originate elsewhere.

III. Empirical Approach

Given our focus on a univariate growth spillover framework we follow Bayoumi and Swiston (2009) and minimize the structure we impose on the data. The resulting coefficient estimates thus capture all potential channels of transmission of shocks, including both trade and financial channels (the latter of which may be the most relevant in times of financial crises, when correlations between all risky assets tend to rise). The main specification is based on a reduced form VAR estimation. Identification is obtained via weighting different orderings. The results from the different orderings can then be summarized by focusing on the average impulse response. This approach has the additional advantage that it provides not only a measure of uncertainty regarding the coefficient estimates but also a measure of uncertainty associated with the variation of responses across different orderings. The following derivations are reduced to a minimum, when referring to the Bayoumi and Swiston (2009) approach.

A. Estimation Framework

The general model is given by the following reduced form model for the growth rate of output:

$$B(L)y_t = D(L)x_t + e_t$$

where the vector y is given by stacking each country's GDP growth rate ($y_{i,t}$):

$$y_t = \begin{pmatrix} y_{1,t} & \cdots & y_{I,t} & \cdots & y_{i,t} \end{pmatrix}'$$

We consider the following sample of 17 countries: Austria, Belgium, Canada, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. The model is estimated on quarterly real PPP-adjusted GDP data, from 1975:Q1 to 2010:Q3, from the OECD Economic Outlook database. The control vector *x* includes two dummy variables for the oil shocks in 1979 and in 1990, respectively, and a constant term. When discussing the results we refer to the baseline regression as the regression which includes additionally a crisis dummy which takes the value 1 from 2008:Q4–2009:Q1, to reflect estimates of "normal times," while the

framework without the crisis dummy reflects also the relationship across growth rates in crisis times.[7]

Identification is obtained using the Choleski ordering of the countries in the sample, which provides the structural errors and coefficients:

$$\varepsilon_t = A(0)^{-1} e_t \qquad A(l) = A(0)^{-1} B(l) \qquad F(l) = A(0)^{-1} D(l)$$

For the ordering we distinguish three sets of countries according to their share in the total sample size measured in USD PPP-adjusted GDP: Countries which surpass the 8 percent threshold are considered large countries and can be a leading country (U.S., Japan, and Germany). Countries which contribute less than 4 percent to the total output are considered small economies (Canada, Netherlands, Belgium, Sweden, Austria, Switzerland, Greece, Portugal, Ireland, and Finland). These countries are ordered last in the order of their size. Since we focus on shocks from the major countries to other nations, the ordering for the group of the remaining smaller countries does not affect the results. The intermediate group of countries comprises the medium size countries (United Kingdom, France, Italy, and Spain). While they are never ordered first they are generally ordered before the small countries.

We arrange the orderings roughly according to the respective country's relative size. The orderings assign a probability of 50 percent to the United States being the lead country (in line with Bayoumi and Swiston, 2009), i.e. the country which is not contemporaneously affected by other countries and respectively a 25 percent probability to the U.S. to be ordered second or third. Japan and Germany are throughout treated symmetrically (although Japan is somewhat larger than Germany). Germany and Japan both have a chance of being ordered first, second, or third of 25 percent and a 12.5 percent probability of being ordered fourth or fifth. The United Kingdom, France and Italy are also treated symmetrically given their comparable average size. Each country has a probability of being ordered second or third of 8⅓, of being ordered fourth or sixth of 25 percent, and of being ordered fifth or seventh of 16⅔ percent. Spain has a probability of being ordered fifth or sixth of 25 percent and of being ordered seventh of 50 percent. This size based procedure results in 48 different orderings, the details of which are provided in the Appendix.

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[7] Alternative control variables, including the oil and non-oil commodity price indices, U.S. and German short-term and long-term interest rates, U.S. investment grade and high-yield credit spreads, German corporate bond spreads, U.S. and German real equity prices, world trade, and Asia trade, were also included as a robustness check in an earlier version of the analysis. However, none of these control variables except the U.S. credit spreads and, to a lesser extent, U.S. real equity prices were significant and their inclusion left the results unchanged. The impact of the U.S. credit spread however becomes insignificant when included in addition to the 2008–09 crisis dummy, suggesting that this variable is essentially a proxy for the global financial crisis.

The computation of the standard errors and the ordering uncertainty follow Bayoumi and Swiston (2009).

B. Dynamic Growth Contribution

The dynamic contribution is computed by applying to each ordering the following algorithm:
Step 1: Determine the structural errors at each point in time using the Cholesky decomposition.

$$\hat{\varepsilon}_t = \hat{A}(0)^{-1}\hat{e}_t \quad \forall t \in T$$

Step 2: Compute the moving average (MA) representation of the entire history of each country's growth rate

$$y_T = \sum_{t=0}^{T} \hat{M}(t)\varepsilon_{T-t}$$

Step 3: Create an identity matrix of dimension *N* and combine the MA representation and the structural errors to derive the contribution of the respective country's shocks to the quarterly growth rate of GDP of the country under consideration:[8]

$$\hat{C}_{\tilde{t}} = \sum_{t=0}^{\tilde{t}} \hat{M}(t) I \hat{\varepsilon}_{\tilde{t}-t}$$

Step 4: Apply the relevant compounding rule to compute the annualized contribution.[9]
While the ordering of the small countries matters in theory for this exercise, in practice the ordering of these countries is of minor importance for the decomposition of the growth contribution since growth dynamics are dominated by the larger economies.
A similar calculation applies to the constant term, which allows decomposing the long-run growth rate into the contributions from the individual countries in the sample.

C. Transmission Channels

To gain a better understanding of the transmission channels of the shocks, we employ a twofold strategy. The first approach uses a counterfactual analysis. We maintain the estimation framework as outlined above, but contrast the results to a scenario under which only the direct impact of the shock in country *i* is allowed to affect country *j* and all spillovers via third countries are prevented. This provides us information about the relevance

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[8] Note that $\hat{y}_{\tilde{t}} = \hat{C}_{\tilde{t}} i$ where i is a column vector of ones, with dimension N in the absence of any exogenous controls.

[9] The rule will depend on whether the dependent variable and the shock are a level variable or a growth rate.

of inter-linkages across countries for the transmission of shocks. In a second approach, we estimate country-wise VARs in which we include real exports as an explanatory variable to test for the importance of the trade channel.

Counterfactual Analysis

In the counterfactual analysis, we constrain the structural coefficients, which are associated with third country effects, to equal zero. Thus, if we are interested in looking at the direct spillover from country *i*'s growth shocks to country *k*'s growth rate, we set all structural coefficients corresponding to the impact of country *j*'s growth shocks on country *k* equal to zero:[10]

$$\alpha_{kj}(l) = 0$$

for all l = 0,…,L and all $j \neq$ i and j $\neq$ k, where α are the structural coefficients. Impulse responses are then recalculated under the counterfactual assumptions.

Country-by-country regressions

To arrive at a parsimonious specification, we assume the sensitivity to specific countries to be homogenous within a region and the difference in the slopes within a group to be random. The U.S., Japan, Canada, Sweden, Switzerland and the United Kingdom comprise the non-European Monetary Union (non-EMU, or RoW) group and the rest of the countries constitute the EMU group. For each country we then run the following regression:

$$A(L)\, y_t = e_t$$

where the vector y is given by: $y_t = \left(y_{i,t}^{RoW} \quad y_{i,t}^{EMU} \quad EXP_{i,t} \quad y_{i,t} \right)'$ and $y_{i,t}^{EMU}$ is the growth rate of the output of the EMU area ($Y_{i,t}^{EMU} = \sum_{k \neq i} Y_t^k$) where *k* runs over all EMU members except for country *i* (when it is an EMU country) and $y_{i,t}^{RoW}$ is the growth rate of the output of the non-EMU group ($Y_{i,t}^{RoW} = \sum_{j \neq i} Y_t^j$) where *j* runs over all non EMU members except for country *i* (when it is not an EMU country).[11] While we keep throughout this exercise the

[10] This is likely to underestimate the relevance of the third country effects since it is still possible that third countries can have a positive feedback to country i and via this to country k. In practice these are very small.

[11] For all EMU members the RoW shock is identical while for all RoW members the EMU shock is identical.

ordering as above, we allow in a robustness test also for different orderings.[12] This approach has the advantage that it provides a more convenient framework to distill the importance of the trade channel as a transmission channel and reduces the problem of ordering to a simpler choice. By grouping countries and using the group's growth rate, we implicitly allow for an increasing weight of a country as it grows bigger relative to other countries. To see this consider the coefficient on the growth rate of the non-EMU variable:

$$\alpha(0)\, y_{k,t}^{RoW} = \alpha(0)\left(\frac{\sum_{j\neq k} Y_t^j}{\sum_{j\neq k} Y_{t-1}^j} - 1\right) = \alpha(0)\sum_{i\neq k}^{I} \frac{Y_{i,t-1}}{\sum_{j\neq k} Y_{j,t-1}}\left(\frac{Y_{i,t}}{Y_{i,t-1}} - 1\right)$$

The right hand version of the coefficient may be conveniently rewritten in the following form:

$$\sum_{i\neq k}^{I} \alpha_{i,t}(0)\, y_{i,t} \qquad\qquad \alpha_{i,t}(0) = \alpha(0)\frac{Y_{i,t-1}}{\sum_{j\neq k} Y_{j,t-1}}$$

Thus this model and the baseline estimation are identical under the assumption that $\alpha_{i,t}(l) = \alpha_{i,t-\tilde{t}}(l) = \alpha_i(l)$ for all $l = 1,..,L$ and all $\tilde{t} = 1,..,T$ for this model and all $\alpha_{ki}(l) = \alpha_k(l) + v_{ki}$ with $E(v) = 0$ and $E(vv) = \sigma_v I$ in the baseline model and the extension that the real exports of country k are included as an additional variable.[13]

IV. Results

This section provides an overview of the key transmission channels (trade vs. financial linkages) to help interpret the results, followed by a discussion of the main results derived from the estimation framework. The first set of results focuses on the potential impact of spillovers from a one percent growth shock in selected countries on other European countries. The second set of results presents the actual impact of selected countries on all other countries in the run up to, during, and in the recovery from the recent financial crisis by

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[12] In particular, we look at the average response to an EMU and a non -EMU shock ordering once $Y_{i,t}^{RoW}$ and once $Y_{i,t}^{EMU}$ first. This leaves the point estimates mostly unchanged. Allowing additionally for the following ordering $Y_t = \left(EXP_{i,t} \quad Y_{i,t} \quad Y_{i,t}^{RoW} \quad Y_{i,t}^{EMU}\right)'$ affects the point estimates, but not the relative magnitude across countries, leaving the interpretations unchanged.

[13] Maybe unsurprisingly, this turns out not to hold and the aggregation bias causes responses to be more pronounced (Imbs et al. 2005). Results are discussed in more detail in the respective section.

combining the country-specific shocks with the impulse response functions. A third and fourth set of results, respectively, provide indications about the relevance of different transmission mechanisms of growth shocks and of different potential determinants of spillover size.

A. Cross-Border Linkages

To interpret our results on the growth linkages, it is helpful to understand some key facts about the relative exposures of countries in the sample to the largest economies and regions. The most obvious channel is trade linkages: a rise in trading partners' growth leads to an increase in their demand for imports, which then contributes directly to an increase in the net exports of the home country (Table 1). With growing financial integration and cross-border ownership of assets, growth spillover effects may also be transmitted through financial linkages (Table 2). Both trade and financial exposures highlight the importance of intra-euro area transmission channels. For most European countries in our sample, the euro area as a whole is by far the biggest export market and accounts for the largest single banking sector exposure. The U.S. is also a key source of financial spillover risk for European countries. Within the euro area, it is noteworthy that for most countries except the smaller trade partners, trade exposures to Germany are relatively smaller than trade exposures to the rest of the euro area as a whole, reflecting Germany's relatively limited demand for imports from other European advanced countries. Several European countries, however, have large financial exposures to Germany.

Trade exposures follow a strong regional pattern. In particular, they suggest a limited relevance of Asia for the sample countries (although growing in importance in the case of China). More specifically, we find that:

- The importance of trade links within Europe is evident in Table 1. The euro area is the largest export market for member countries in the sample, except Greece. For the Netherlands and Belgium, exports to the euro area account for about half of GDP with a sizeable share (30 to 40 percent) directed to Germany alone.[14] Even for Ireland, which has close trade ties with the U.S., the share of exports going to the euro area exceeds that going to the U.S.

- The euro area is also the largest importer for the U.K. and Switzerland, and the second largest for the U.S. However, it is only the fourth export destination for Japan, which relies more on U.S., Chinese, and other regional markets.

[14] This holds also true when controlling for re-exports.

- Despite its size and reflecting a relatively closed economy, the U.S. is generally not the major trade partner for European countries.

- Trade exposures to Japan are even more limited. Trade exposures to China are also limited (except in the case of Japan), although the growing importance of China is underscored by the fact that China has now overtaken Japan in terms of its importance as importer for all sample countries (except Ireland).

- Similar to the U.S. and Japan, Germany's relevance as an importer is relatively limited—including for other eurozone countries. While Germany is the second largest export destination for Austria and the Netherlands, it is only at best the third largest export exposure for the other European countries. These countries export relatively more either to the non-German euro area as a whole or to the rest of the world (excluding the euro area, the U.S., the U.K., China, and Japan). In the case of non euro area countries, exports to Germany account for less than ½ percent of GDP.

Financial linkages single out the U.S. and Europe in aggregate as main sources of global spillover risks, while Germany's importance is mostly regional. Overall, financial exposures—proxied by bilateral bank lending exposures on an ultimate risk basis—follow a broadly similar regional pattern as trade exposures, illustrating the relative importance of intra-European linkages:

- For European countries, exposure to European developed countries is the single largest source of spillover risks, amounting to 30 percent of GDP or more (except in Finland and Greece).[15] For the U.S., exposure to Europe also ranks as the first source of risks; however, relative to GDP many European countries (including Switzerland, the U.K., France, Germany, and the Netherlands) have much larger exposures to the U.S. than the U.S. does to Europe.

- Within Europe, some countries have high exposures to Germany of 10 percent of GDP or more (France, Austria, Switzerland, Netherlands, Ireland, Sweden). By contrast, non-European countries (U.S., Canada, and Japan) have banking exposures to Germany at or below 3 percent of GDP, well below their level of exposures to the U.K. in the case of the U.S. and Canada.

- For Canada and Japan, financial linkages highlight the key role of the U.S. as a source of spillover risks, with European exposure the second largest source of risk.

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[15] In all cases, except for Greece, Spain, Austria, and the U.K., which also have significant exposures to the rest of the world (excluding the U.S., Japan, and Europe) and Switzerland (which has the largest single exposure to the U.S.), European developed countries are the single largest source of banking exposures.

- Exposures to Japan are at or below 6 percent of GDP for all countries (except Switzerland) and exposures to China are below 1 percent of GDP in most cases (except the U.K., the Netherlands, and Switzerland).

Table 1.Exports to Selected Countries and Regions, 2010 (percent of GDP)

	With Germany	With Euro Area 1/	With United States	With United Kingdom	With Japan	With China	With Rest of World
Austria	12.7	9.3	1.4	1.2	0.3	0.9	13.6
Belgium	16.5	37.0	4.6	6.2	0.8	1.4	20.1
Canada	0.2	0.8	18.4	1.0	0.6	0.8	2.8
Finland	2.9	6.4	2.0	1.4	0.5	1.4	14.0
France	3.2	6.5	1.0	1.3	0.3	0.5	6.8
Germany	...	15.7	2.0	2.4	0.4	1.8	14.2
Greece	0.8	2.2	0.3	0.4	0.0	0.1	3.2
Ireland	4.5	18.2	12.1	8.9	1.1	1.0	9.2
Italy	2.8	6.6	1.2	1.2	0.3	0.5	8.8
Japan	0.4	0.8	2.2	0.3	...	2.7	7.8
Netherlands	18.8	26.2	2.7	5.6	0.5	0.9	17.7
Portugal	2.8	10.9	0.7	1.2	0.1	0.1	5.4
Spain	1.8	7.9	0.6	1.1	0.1	0.2	5.4
Sweden	3.5	9.9	2.1	2.6	0.4	1.0	13.5
Switzerland	7.2	10.9	3.8	2.2	1.2	1.4	10.6
United Kingdom	1.9	6.5	1.9	...	0.2	0.4	5.8
United States	0.3	0.9	...	0.3	0.4	0.6	6.1

Source: DOTS, WEO, and IMF staff calculations.
1/ Excluding Germany.

Table 2. Banking Exposures to Selected Countries and Regions, 2010 (percent of GDP) 1/

	With Germany	With European Developed Countries 2/	*Of which:* with Euro Area 3/	With United States	With Japan	With China	With United Kingdom	With Rest of World
Austria	14.1	37.0	...	4.7	0.4	0.5	5.4	67.1
Belgium	4.1	41.2	...	8.1	0.2	0.3	8.5	22.0
Canada	1.0	4.3	...	30.6	0.4	0.3	5.5	10.2
Finland	1.0	6.7	...	0.2	0.0	0.0	1.0	1.3
France	11.0	54.0	49.4	21.5	6.0	0.8	12.4	23.7
Germany	...	41.2	37.8	15.7	1.7	0.5	14.4	16.6
Greece	1.8	7.1	...	1.5	0.0	0.0	5.5	30.3
Ireland	21.7	67.2	...	41.7	5.9	...	91.0	31.5
Italy	12.9	15.2	14.1	2.1	...	0.2	2.2	11.7
Japan	3.0	7.1	5.9	24.8	...	0.7	2.9	5.4
Netherlands	22.0	57.6	...	32.2	2.1	1.5	16.5	40.9
Portugal	2.0	31.7	...	3.7	0.0	0.1	3.6	22.4
Spain	3.1	15.8	14.4	3.2	0.1	0.5	14.1	42.8
Sweden	16.3	94.3	...	9.9	0.1	0.5	8.8	24.1
Switzerland	24.5	53.0	47.6	132.6	15.8	2.7	36.7	56.2
United Kingdo	8.0	42.5	38.4	48.6	6.5	3.7	...	62.2
United States	1.6	5.1	4.1	...	5.1	0.5	4.7	4.4

Source: BIS, WEO, and IMF staff calculations.
1/ International bank claims of domestically-owned banks, consolidated - ultimate risk basis.
2/ Excluding Germany and the UK.
3/ Excluding Germany.

B. Country-specific Outward and Inward Growth Spillovers

We illustrate the potential cross-border spillovers by calculating the maximum weighted cumulative impulse response of the other countries to a one percent growth shock in the originating country. Detailed impulse responses of single countries are shown in the Appendix.

Outward Growth Spillovers

The baseline regression results (full sample, including a dummy for the 2008–09 crisis) suggest that the U.S. remains the largest source of spillovers to all countries in the sample. By contrast, Germany plays a minor role for the sample in aggregate, although some smaller European countries are strongly affected by German growth. The U.K. and Japan fall in between the two as do France, Italy, and Spain. Since the regressions include a crisis dummy, this first set of results can be interpreted as the "normal" response outside times of crisis.

Regression results for an alternative specification excluding the crisis dummy show much higher outward spillover effects from all regions, supporting the view that non-standard transmission channels are at play during crises times. Such channels could include for example correlated downturns in asset prices and/or confidence effects, which amplify the effect of a given growth shock over and above the standard transmission of shocks through trade and/or lending channels. While spillovers from all the large countries are found to increase during times of crisis, the increase is especially pronounced during the recent period for the U.S., the U.K., and the non-German euro area. This could reflect the fact that the 2008–09 crisis was triggered by the housing correction in the U.S. and the U.K., which later affected other countries like Spain where the real estate market was similarly overheated. In contrast, Germany was not an independent source of shocks during the recent financial crisis.

Estimates for the more recent subsample (1993:Q1–2010:Q3) do not suggest an increasingly important role of Germany for spillovers to other countries. By contrast, we find evidence of increased importance of Italy and the U.S. for spillovers to other countries in recent years.

Looking at disaggregated results within Europe, Germany's role in generating outward spillovers appears limited despite its large size, in part reflecting Germany's own dependence on growth in the rest of the eurozone (as discussed in the next section). Germany is particularly sensitive to growth shocks in the other three large euro area countries (France, Italy, and Spain) and in Japan, while the U.K. is less relevant. France is sensitive to Spain and, to a somewhat lesser extent, Italy, and much less sensitive to growth shocks in Germany than Germany is to growth shocks in France. Italy's growth reacts relatively similarly to growth shocks in the other three large euro area countries, the U.S., and Japan, but shows little sensitivity to the U.K. in normal times. Spain's growth is potentially strongly affected by growth shocks in the U.K. and in France (possibly due to Spanish banks' relatively large exposures to the U.K.) and to a lower extent by growth shocks in Italy. Germany and Japan

generate only minor outward growth spillovers to Spain, reflecting limited trade and financial linkages.

In particular, there is little support for the view that euro area peripheral countries could benefit strongly from Germany's ongoing recovery. The results suggest that positive growth shocks in France and Italy generate larger spillover effects to the European periphery. The impact of Germany and other large countries on Greece, Ireland, and Portugal (thereafter, the GIP) can be summarized as follows:

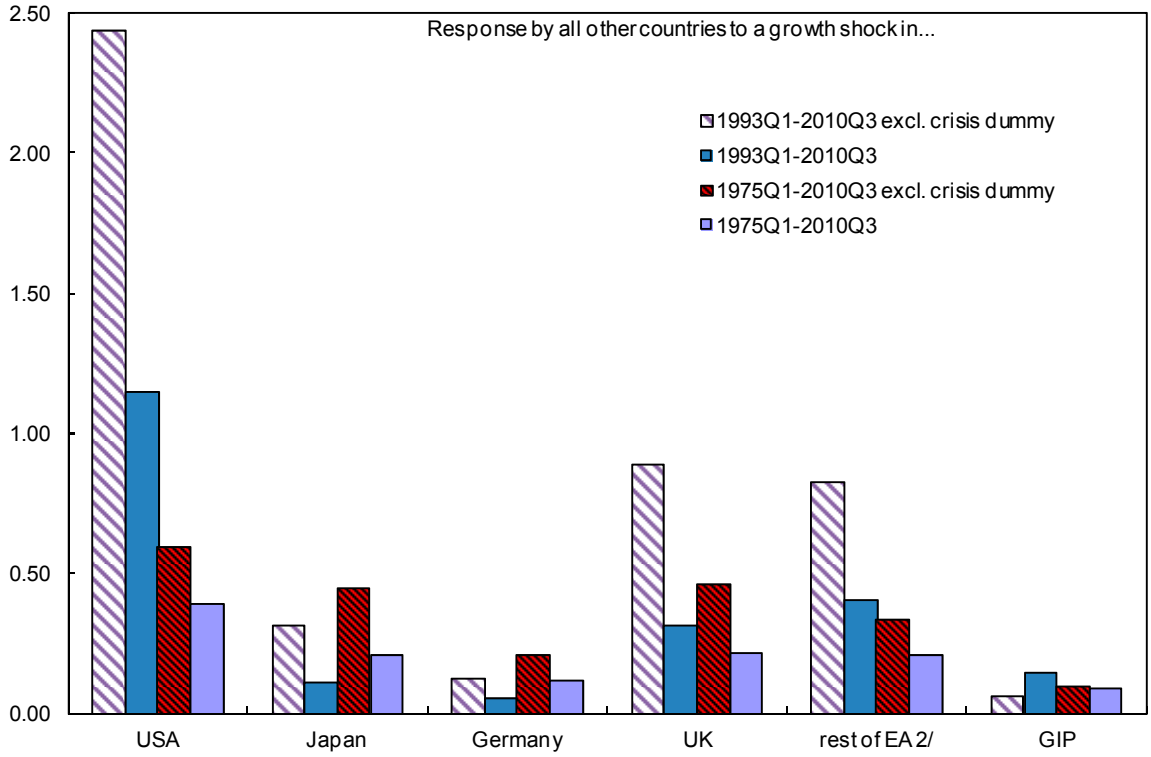
- Germany plays a less prominent role for the GIP than France and, to a lesser extent, than Italy. However, this result masks considerable heterogeneity in the responses across the GIP. Italy and France appear to have a relevant influence on Ireland and Portugal. This is much less the case for Germany. However, Germany tends to have more influence on Greece than Italy, but less than France.

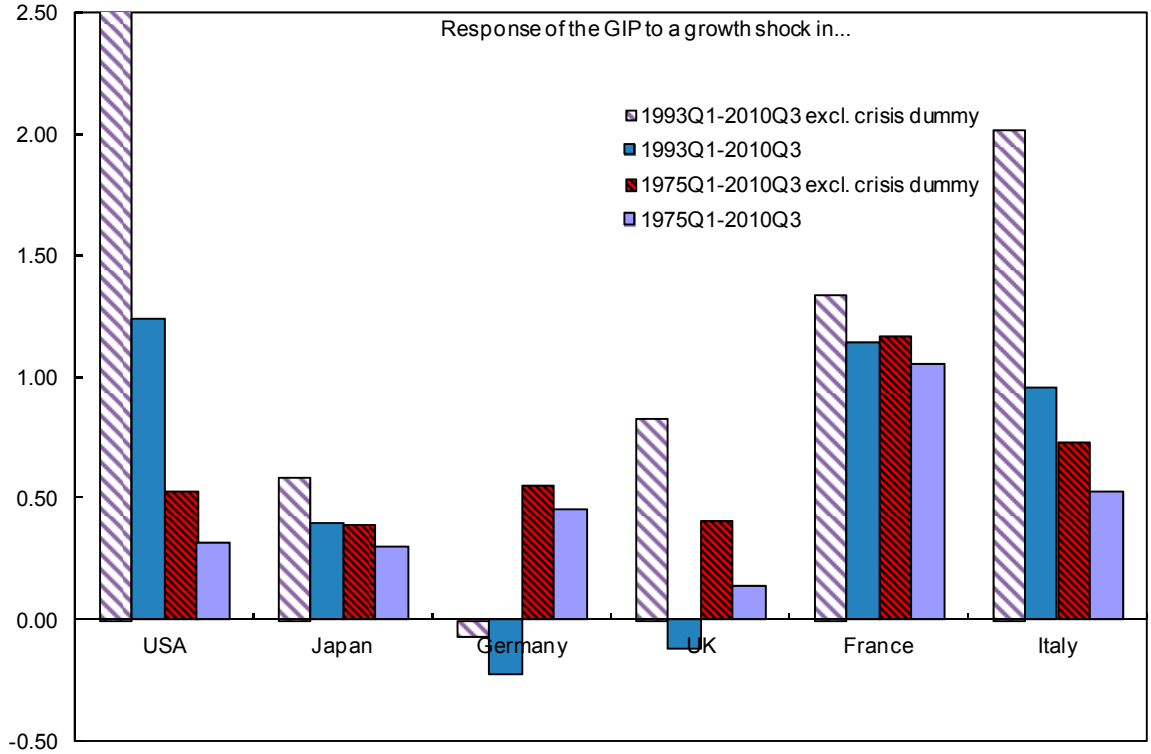
- The U.S. has primarily an impact on Ireland, consistent with results in Kanda (2008) and the close trade and financial linkages between the two countries. The U.S. also has a more pronounced impact on Greece and Portugal in the context of the financial crisis and the more recent episode.

- Japan and the U.K. play a relatively minor role for the GIP, although the U.K.'s impact during the crisis was more pronounced.

Finally, the results suggest that potential negative growth spillovers from the GIP to other countries are limited, although a broadening of the crisis to larger eurozone countries would have significant real implications. The impact of Greece, Portugal, and Ireland as a group on other countries appears relatively small, consistent with their modest size. A shock to Spain's growth, however, has potentially a much larger impact particularly on other European countries (see Appendix).

Cumulative Peak Impulse Response after 10 quarters
to a 1 percent growth shock (in percent) 1/





1/ GDP-weighted average response of other countries.
2/ excluding Germany.

Inward Growth Spillovers

Turning to the sensitivity of the four large euro area members to inward spillovers, the results underline Germany's high sensitivity to external shocks. A first set of estimates from the small country VARs show that Germany responds to a growth shock in EMU countries more strongly than any of the other large EMU countries and exhibits the second largest response (after Italy) to growth shocks in non-EMU countries. Thus Germany's growth is sensitive to a larger extent than other large EMU countries' growth to foreign shocks, especially those originating within the EMU. This is consistent with Germany's large trade and banking exposures to the rest of Europe. The result that Germany is highly sensitive to foreign shocks also supports the view that Germany is less of a source of independent spillovers and more of a conduit for U.S. and other external shocks to the rest of Europe (see section IV.D). A second set of estimates from the main baseline estimation (i.e., large model)[16] yields the same rank ordering of sensitivity to external shocks as the smaller country specific VARs.[17]

Regression results for the more recent period (since 1993, based on the large model) show that inward spillovers from the U.S. to the four large EMU member states have increased, while the U.K. and Japan have become less relevant. In the baseline estimation, a 1 percent growth shock in the U.S. tends to increase output growth within 10 quarters by about 0.3 percent in Germany, 0.4 in Italy and France and 0.1 percent in Spain in normal times. These values increase to 0.4 percent in Germany and Spain, 0.5 percent in France, and 0.6 percent in Italy when not controlling for the effect of crisis times. The respective values more than double for Germany and Spain, in the more recent episode (estimation for 1993:Q1–2010:Q3 including a crisis dummy), as both become more sensitive to the U.S. than France and Italy. The increased sensitivity to the U.S. is in line with the increased correlation of the EMU countries' GDP growth with the lagged GDP growth of the U.S. (Figure 1). This reflects rising financial linkages which have gained in importance in particular in the latter half of the sample period and is consistent with similar findings by Helbling et al. (2007) who find spillovers to be increasing in financial and trade linkages and significantly higher spillovers from the U.S. to other countries in the period from 1987–2006 compared to the entire 1970–2006 period. Since, our sample includes with 2007 and 2008 years which mark the peak of financial linkages, we find even higher effects.

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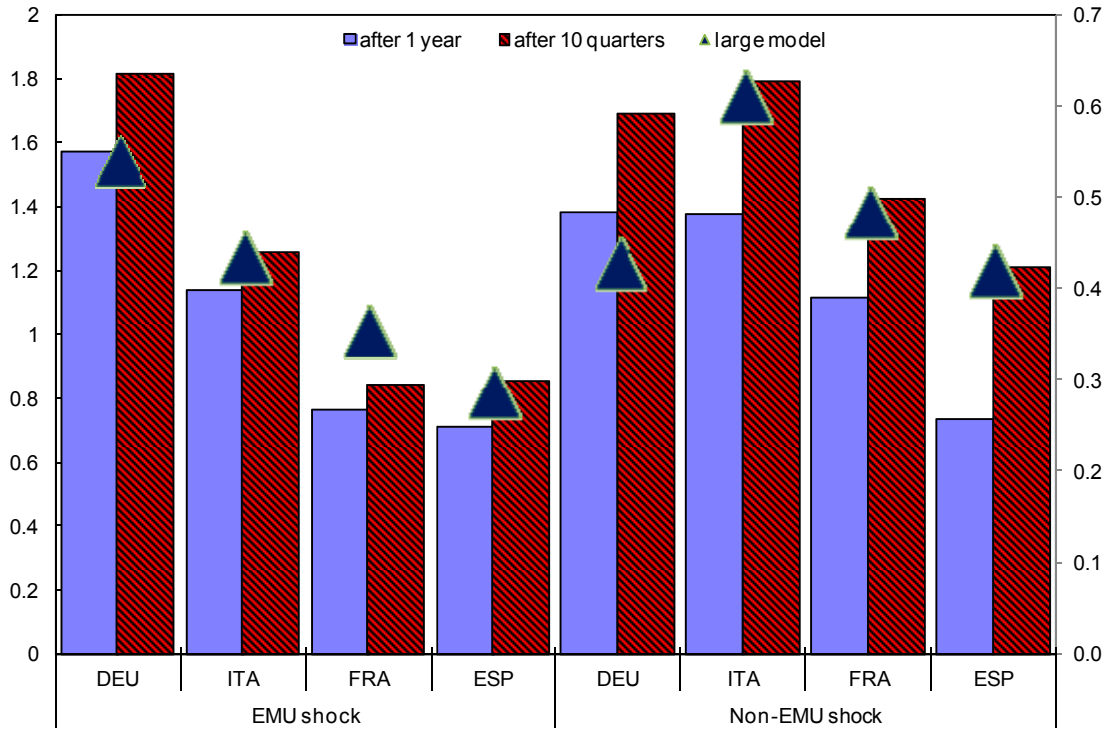
[16] While estimates from the smaller model are directly obtained for "EMU" and "Non-EMU" shocks, the corresponding values from the baseline VAR (large model) is obtained by weighting the responses to the single countries' shocks which constitute the EMU and the non-EMU group in the country specific VARs.

[17] However, it should be noted that the small country-specific VARs overestimate the impact, due to the aggregation bias which tends to increase the persistence of the shocks and thus overestimate the response.

Sensitivity to a 1 percent Growth Shock in the Large European Countries



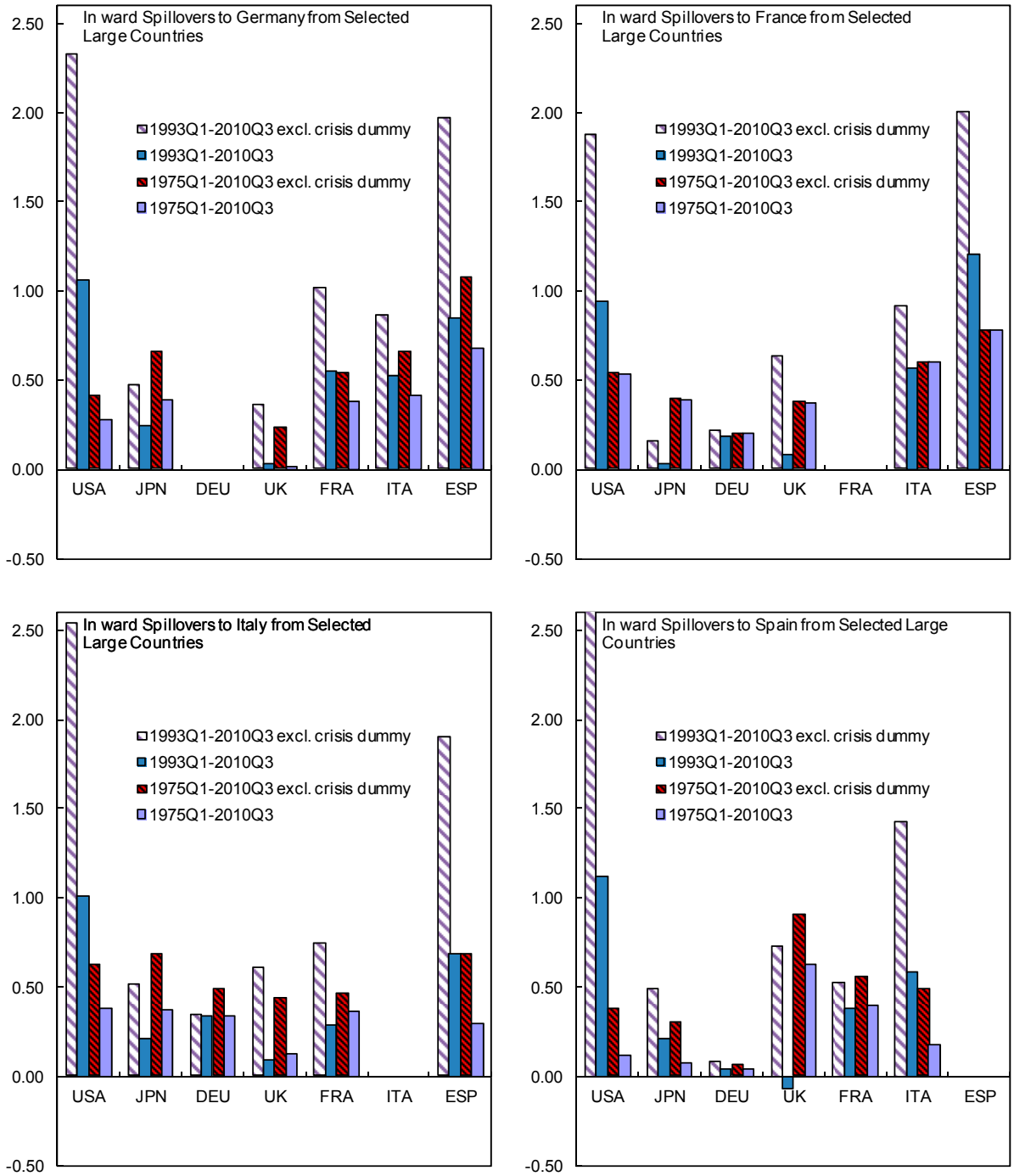
Within the EMU, inward spillovers from Germany, Italy, and France to the other large EMU members are relatively stable across the two sample periods and robust to the inclusion of the crisis dummy (i.e., likely to persist even outside of crisis times). Specifically, we find that:

- Germany's effect on the other three large euro area countries ranges at the lower end for Spain and France, causing output to rise by 0.1–0.2 percent, although Italy's growth rate rises by around 0.4 percent in response to a 1 percent growth shock in Germany.

- France affects Italy and Germany roughly by the same order of magnitude, yielding an increase in growth by 0.4 percent in normal times and above 0.5 percent in crisis times. The effect on Spain is only marginally higher.

- A 1 percent growth shock in Italy causes German and French growth to increase by 0.4 percent and Spanish growth by 0.2 percent in the baseline estimation. The effect increases by an additional 0.2 percent for Germany and France and 0.3 percent for Spain in crisis times. In the more recent period, Spain's sensitivity to Italy's growth shocks has increased to a higher level than its sensitivity to growth shocks in Germany or France.

Inward Spillovers to the four large Euro Area Countries



- Spain has been an important source of growth shocks for other large euro area countries. Under the baseline regression for the full sample, a 1 percent shock to Spain's growth increases GDP growth in Germany by 0.7 percent, in France by 0.5 percent, and in Italy by 0.3 percent. This position is reaffirmed in the regression

for the more recent episode which shows a general increase in the importance of Spain's growth spillovers. In particular, positive spillovers from Spain have become more important for France and Italy in recent years consistent with increasing trade and financial integration following EMU and euro adoption, as well as a domestic demand and property boom in Spain, both in part fuelled by unsustainable increases in corporate and household indebtedness.[18]

C. Domestic and Foreign Growth Contributions in Crisis and Recovery

While the impulse responses measure the *potential* impact of growth spillovers across countries, they do not provide insight on the *actual* effect of idiosyncratic growth shocks originating in one country on other countries over time. The latter reflects both the size of the impulse response and the country-specific growth shock in the originating country. We investigate this question using a decomposition of the individual countries' growth rate into the contribution from other countries over time. The results are summarized in Table 3, which provides estimates of the G7 individual countries plus Spain's contribution to the other countries' growth in the long-run (i.e., in the absence of idiosyncratic shocks), and in the next series of graphs which show the evolution of the growth rate from 2005:Q1 to 20010:Q3 for all countries in the sample, splitting a country's growth rate into its own contribution (orange bar), the cyclical contribution stemming from each G7 member and Spain, and the long run growth rate (gray bar). The height of the individual bars represents the overall contribution at each moment in time.

We first examine the long-term impact of each country on the other countries in the sample (gray bar). The long-run decomposition in Table 3 shows that the U.S. has been the largest positive contributor to long-term growth in other countries. The U.S. matters particularly for the Anglo-Saxon countries and the smaller Northern European countries. Long-run spillovers from Japan and Spain have also been positive and relatively important, with Spain more relevant for European countries. Canada and France provide relatively minor long-run growth support to other countries, although spillovers from France are particularly relevant for the GIP. By contrast, long-run external growth spillovers from Germany are close to zero, and the U.K. and Italy's long-run spillovers have been small and negative. In the case of Italy, this reflects relatively weak GDP growth over the period (similar to Germany) while the result for the U.K. could reflect the U.K.'s dependence on U.S. prospects.

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[18] While the subsequent deflation of the property bubble and private sector deleveraging has resulted in negative dynamic contributions of Spain to other countries' growth during the 2008-09 global recession, we find that on average over the long run Spain has been one of the major sources of positive growth spillovers to other countries especially in Europe (see section IV.B). However, the potential positive impact of Spain in future episodes could be lower than suggested by historical results if the ongoing process of unwinding of Spain's imbalances is protracted and undermines durably Spain's growth prospects.

Table 3. Long- run growth spillover (1975Q1-2010Q3)

		Spillover from:									Average
		USA	JPN	DEU	UK	FRA	ITA	ESP	CAN	Others	growth
Spillover to:	USA		0.4	0.0	-0.2	-0.1	-0.1	0.3	0.1	0.0	3.0
	JPN	0.5		-0.1	-0.1	0.0	-0.1	0.5	0.1	0.0	2.2
	DEU	0.7	0.6		-0.1	0.1	-0.2	0.6	0.1	0.0	1.5
	UK	1.5	0.3	0.0		0.1	-0.1	0.7	0.2	0.0	2.1
	FRA	0.8	0.4	-0.1	-0.1		-0.1	0.5	0.2	0.0	1.9
	ITA	0.9	0.6	-0.2	-0.2	0.1		0.4	0.2	0.0	1.5
	ESP	0.7	0.3	0.0	-0.3	0.1	-0.1		0.2	0.1	2.1
	CAN	2.1	0.3	0.0	-0.2	-0.2	-0.1	0.4		0.0	2.7
	NLD	1.3	0.3	-0.2	-0.2	0.0	-0.1	0.6	0.2		1.9
	BEL	0.7	0.4	-0.1	-0.1	0.1	-0.2	0.5	0.2	-0.1	1.6
	SWE	1.4	0.2	0.1	-0.4	0.1	-0.2	0.6	0.2	0.0	2.1
	AUT	0.5	0.2	-0.2	-0.1	0.2	-0.1	0.5	0.1	-0.5	1.3
	CHE	0.8	0.4	0.0	-0.2	0.1	-0.3	0.5	0.1	-0.1	1.4
	GRC	0.8	0.1	-0.3	-0.1	0.3	-0.1	0.8	0.1	-0.3	1.7
	POR	0.2	0.5	-0.2	-0.1	0.4	-0.2	0.9	0.2	-0.7	1.7
	FIN	1.6	0.4	0.2	-0.6	0.3	-0.2	0.7	0.4	0.5	2.8
	IRL	2.3	0.1	-0.1	-0.4	0.2	-0.2	1.1	0.4	-0.7	3.6

The dynamic contribution analysis—focusing on the recent period including the global financial crisis—highlights for all countries the dominant contribution of external growth shocks and the relatively low contribution of domestic shocks to the overall GDP growth. This is particularly true for the smaller open economies such as the Netherlands, Austria, Belgium, and Finland. Even for the U.S., the results suggest that synchronized downturns in Japan and the European advanced countries contributed to amplify the depth of the U.S. recession in 2008–09. The finding that external spillovers have been large and significant in the recent period may be regarded as comforting since it implies that the model captures most of the likely sources of global growth spillovers, and thus generates a limited idiosyncratic error component, which in turn implies a relatively high explanatory power.[19]

Turning to a finer analysis of growth contributions pre-, during, and post-crisis, the main findings are as follows:

- The boom period before the crisis is reflected in the significant domestic contribution to each country's GDP growth which cannot be accounted for completely by growth fluctuations in other countries (orange bar). In terms of outward spillovers, the U.S. and Spain have been major sources of positive growth support in the pre-crisis period, with the U.S. mattering most for Canada, the U.K., and Ireland. France played an important role for some countries in the run-up to the crisis, notably the southern peripheral countries, as well as Belgium, Austria, and Finland. Germany has initially weighed negatively on most countries' growth but in the latter half of the pre-crisis

[19] The average (adjusted) R-squared value of the reduced form equations for the baseline model is around 0.6 (0.4). Including the crisis dummy implies an increase by 0.04 in explanatory power in both cases.

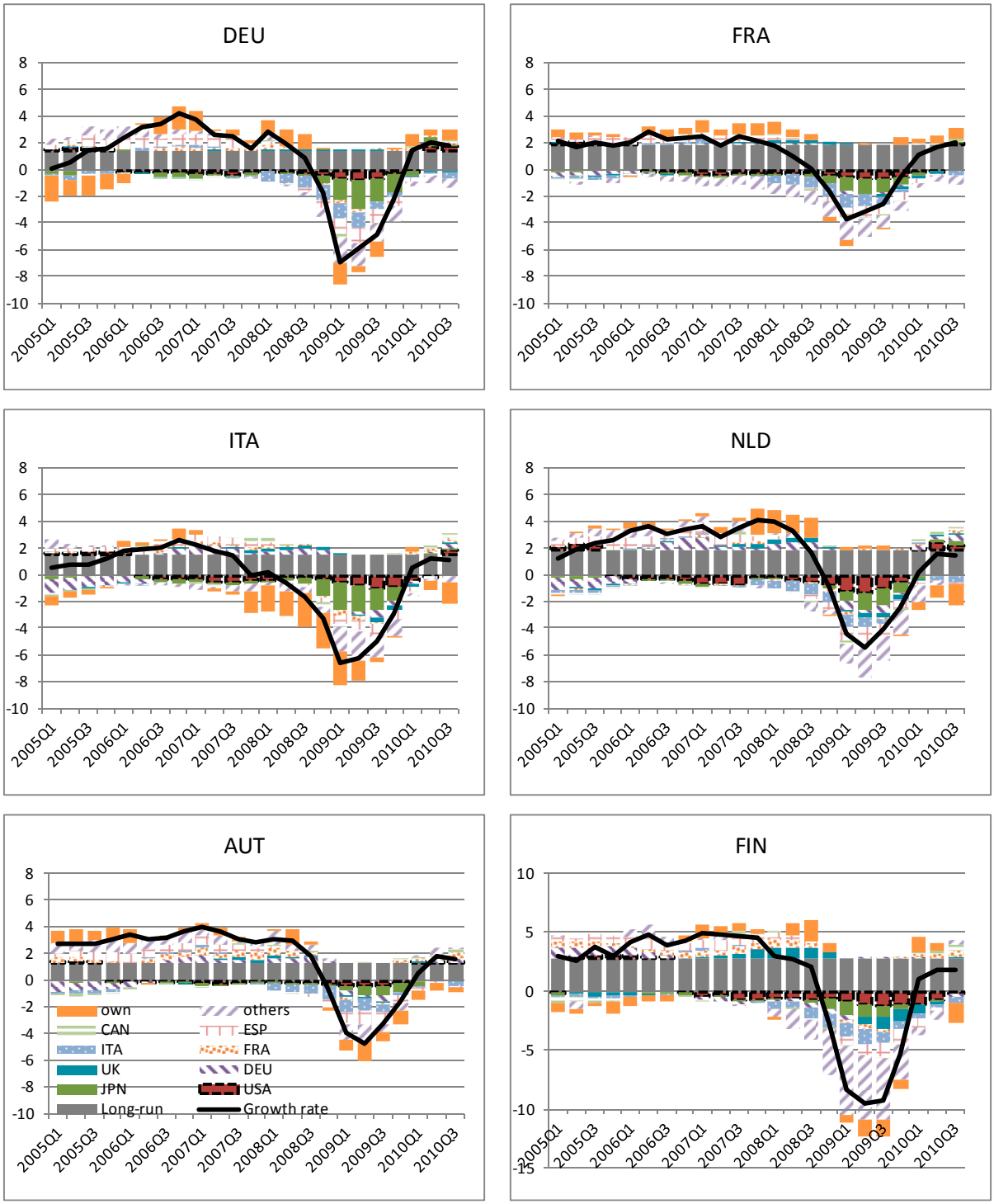
period contributed positively in particular to GDP growth in the Netherlands, Italy, Greece and Austria—although at lower levels than this is the case for the contribution from the U.S., Spain, Italy, or France. Italy and the U.K. have contributed negatively to growth in other European countries in the years preceding the crisis.

- During the crisis, large negative domestic contributions to growth are observed in Italy, the U.S., Japan, Sweden, Ireland, the U.K., and since the first quarter of 2010 in Greece. Japan has generated negative spillovers for virtually all countries in the sample, reducing German output growth by over 1.5 percentage points, Italian growth by 1.4 percentage points, and U.S. growth by 1.2 percentage points. The effect on other countries has been less strong. Similarly, the U.S. shock has affected growth in almost all countries in 2009, with the strongest effect on Anglo-Saxon countries—Canada and Ireland (-2 percent) and the U.K. (-1.5 percent)—but also significant effects on European economies led by the Netherlands (-1 percent). Italy also had a strong negative spillover effect during the crisis on several European countries, most severe for Switzerland, but also significant for growth in the peripheral countries. Germany's negative external spillovers have dragged down growth primarily in neighboring countries, with the strongest impact on the Netherlands. The U.K. has primarily been relevant for Finland, Sweden, Spain, and Ireland, dragging down GDP growth in these countries especially toward the later part of the crisis.
- The recovery in turn is led by the U.S. and Japan, which account for most of the countries' positive external support to growth in 2010 (through the third quarter).[20] This is supported by additional positive domestic growth momentum in Germany, France, Canada, Switzerland, and Sweden. By contrast, the recovery has been hampered by continued negative domestic growth contributions in Italy, Spain, and Ireland, and falling dynamic support from domestic demand in the Netherlands, Greece, and Portugal.

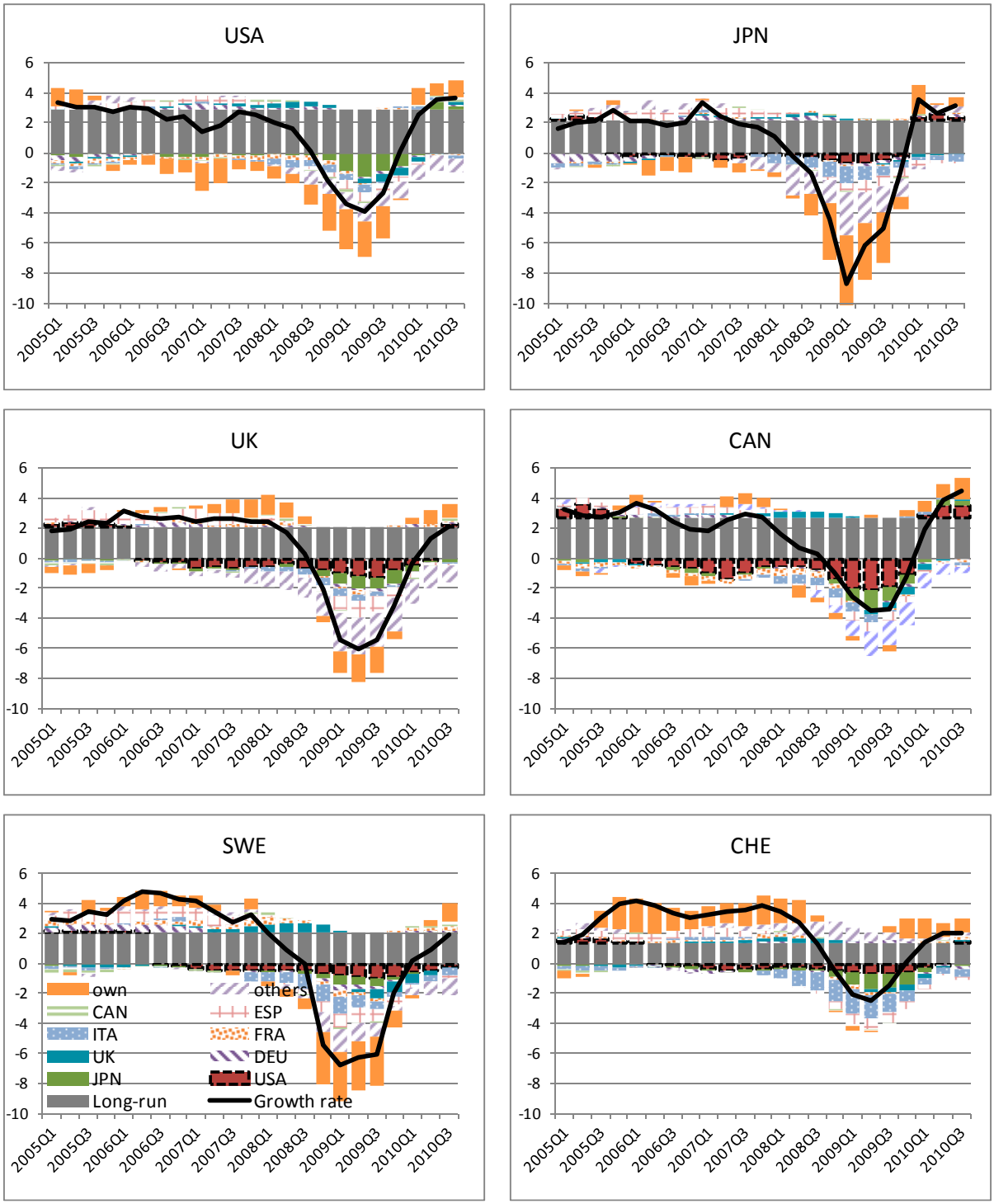
Both the analysis of growth contributions and the impulse response functions yield broadly similar conclusions, however the former provides a more nuanced description of the spillovers, by quantifying how growth contributions change over time in terms of their magnitude and the relevance of individual countries. It confirms the role of the U.S. and Japan as important sources of spillovers on a global scale, while Spain is primarily relevant for Europe. France, Italy and Germany are also relevant on a European-wide scale although their impact appears to be regionally concentrated, focused on the smaller neighbors in the case of Germany and concentrated on southern European countries in the case of France and Italy. The U.K. in turn appears mostly relevant for the northern European economies and for Spain.

[20] While the cyclical contributions of US and Japan growth dynamics on other countries are generally small (red and green bars, respectively), both countries provide the bulk of the long-run growth rate support (gray bar).

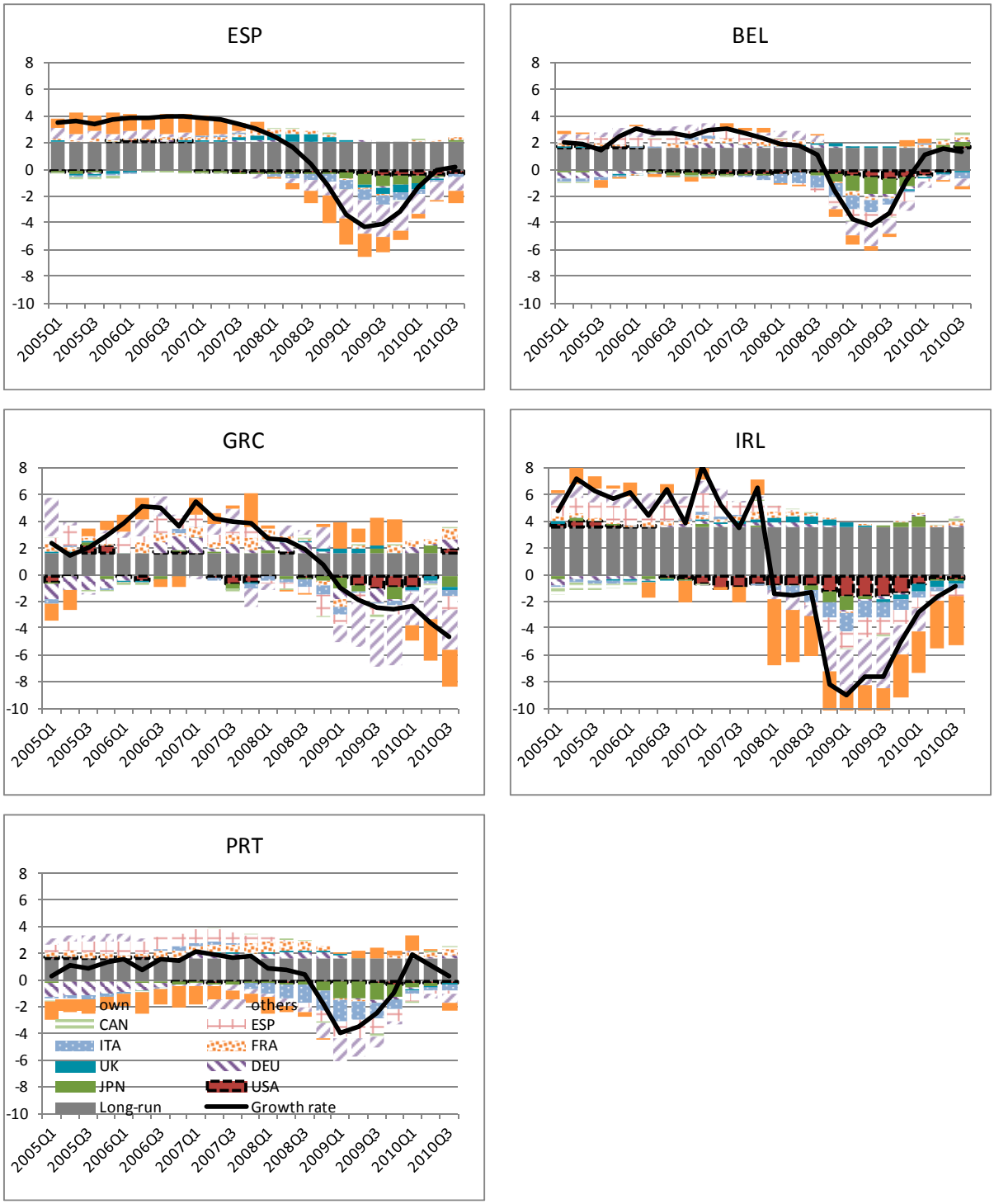
Growth Contribution in Crisis and Recovery



Growth Contribution in Crisis and Recovery (contd.)



Growth Contribution in Crisis and Recovery (contd.)



D. Channels of Growth Spillover Transmission

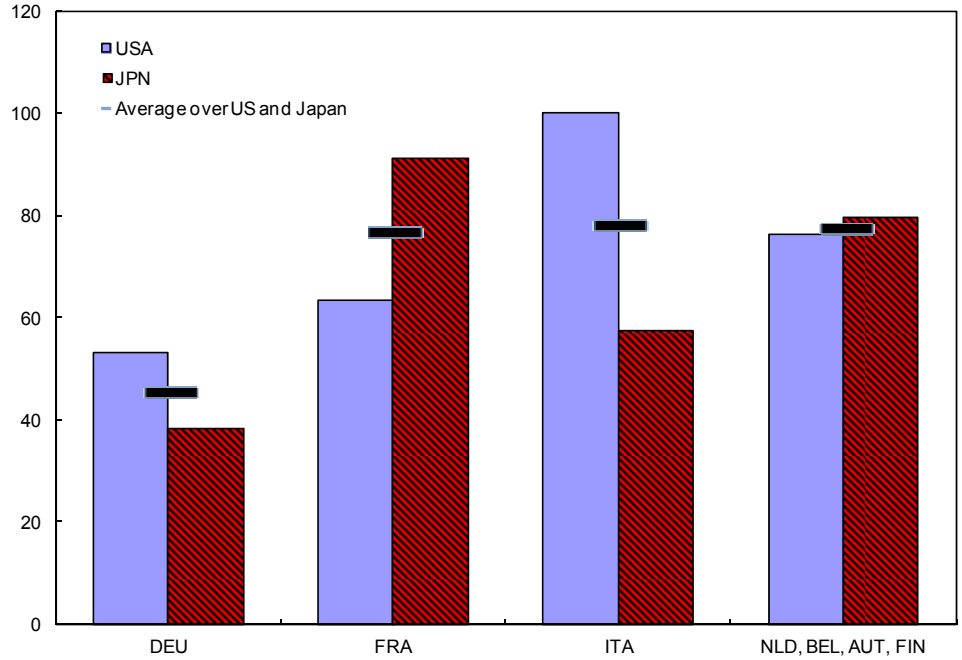
The pattern of spillovers identified in the previous two sections hinges on the relevance of regional linkages, consistent with the regional dimension of cross-border linkages highlighted in Section II.A. This section attempts to quantify the importance of trade as a transmission mechanism for growth spillovers, based on country VARs that include real exports as an additional variable. We also seek to shed light on the shock transmission mechanisms underlying the outsized impact of the U.S. and Japan on advanced European countries by presenting empirical evidence on the size of third-country transmission effects based on counterfactual analysis. While financial channels are not directly analyzed in this study, both the finding that third-country effects tend to be larger during times of financial distress and the result that trade effects plays only a limited role in the international transmission of shocks to European countries suggest that this would be a fruitful avenue for future research.[21]

Third-Country Transmission

In a first approach we analyze to which extent third-country effects are relevant for the transmission of shocks. In particular, we identify the countries which are more directly affected by global shocks versus those for which the impact of shocks is mostly channeled through third-country effects and which thus tend to be affected only with a lag. Further, if third-country effects are important, countries less relevant as a source of shocks may still play a central role as transmitter and amplifier of shocks to other countries through either trade or financial linkages and thus also matter on a systemic level.

[21] In an earlier version of the paper, we attempted to test for the relevance of financial transmission channels by following the approach of Bayoumi and Swiston (2009), i.e. by including global financial variables (such as the US equity prices, interest rates, and US and German credit spreads) as additional control variables. The US credit spread was found to be the most significant variable, with an impact similar to that of including the crisis dummy (i.e. reducing estimated outward spillovers from the US and other large countries); however, the spread variable had not statistically significant effect once the crisis dummy is also included, suggesting that this channel of transmission is only relevant during times of crisis.

Relative Importance of Third-Country Effects for Inward Spillovers to Selected European Countries from the US and Japan[1]



[1)] Based on the regression inclduing no crisis dummy. Inclduing the dummy causes all value to drop slightly. NLD, BEL, AUT, FIN referes to the GDP PPP weighted average response.

The relevance of third country effects is calculated as the fraction of the inward spillover from a shock in a given country which is transmitted via other countries after one year. The lower this indicator of third country effects, the more directly sensitive the country is to the impact of a given external shock. Conversely, the higher the indicator, the more likely it is that the country will only respond with a lag since the entire spillover effect needs more time to trickle down via trade or financial channels. Since the measure of third country transmission is only meaningful in cases in which a significant impact is observed, we calculated third county effects only for such constellations.

Germany stands out as a country which tends to respond swiftly and directly to shocks to growth in the U.S. or Japan. For France, Italy and the small core euro area members, similar shocks are channeled to a larger extent via third countries before they impact growth in the home economy. The relatively high values of the third-country indicator for the non German euro area suggest that inter-linkages between euro area countries are highly relevant in the transmission of shocks to Europe from outside the euro area. Combined with the relative directness with which Germany reacts to shocks in the U.S. and Japan, this finding suggests that Germany acts as an important transmitter and amplifier of shocks originating outside the euro area to other euro area members.

When looking at the relevance of third country effects for intra-European shocks, the regional patterns are again noticeable. Growth shocks from Italy and Spain affect Dutch

growth primarily via third countries, while growth shocks from Germany affect Dutch growth mostly directly and hardly via third countries. Switzerland's growth is directly affected by growth shocks in Italy and Belgium's growth is most directly affected by French growth shocks. Austrian growth is most directly affected by France and Germany, less directly by Italy and the least by Spain. Italy's growth is most directly affected by Germany followed by France and then Spain. Interestingly, Germany's impact on Greece and Portugal appears to be less direct than the impact of France and Italy on these two countries which are comparable to the impact of Spain on Portugal. This confirms the relevance of France and Italy for the southern peripheral countries. Finally it is worth noting that in crisis times third country effects appear to play a larger role confirming earlier results on the importance of confidence and asset price spillover effects during times of financial distress.[22]

An important caveat to the counterfactual analysis should be noted. It is subject to the Lucas (1976) critique in the sense that the deep parameters underlying the reduced form estimates are likely to be different under the counterfactual scenario. However, several authors have argued that the change in the deep parameters may be too small to have a major implication for the reduced form estimates of the VAR in the context of various policy changes.[23] Nevertheless, this problem may be reflected to some extent in certain estimates of the relevance of third country effects in our simulations, as for instance the rather low role of third country effects for the transmission of Italian shocks to Sweden.

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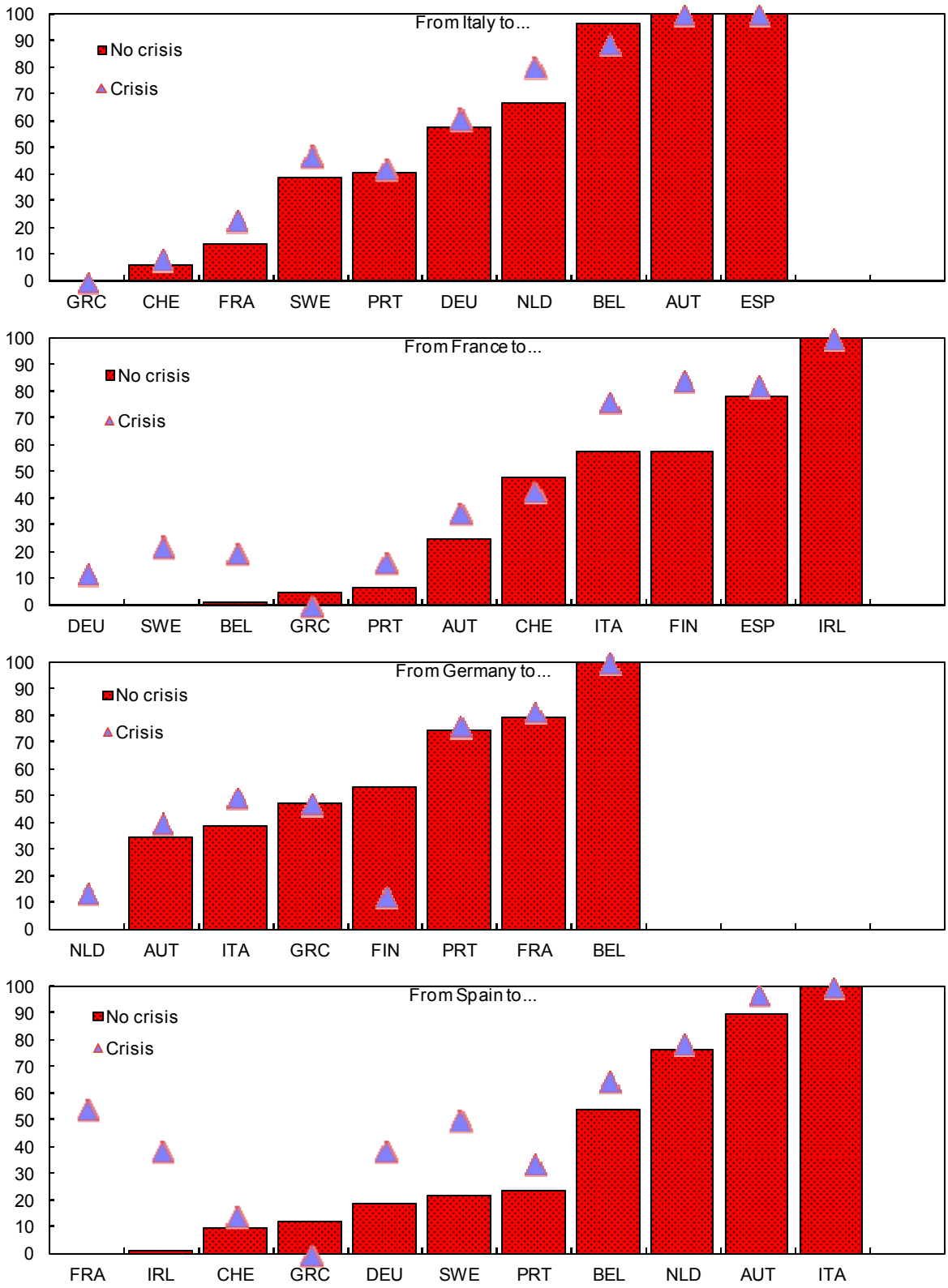
[22] Although the VAR modeling framework does not allow testing directly for asymmetry in the pattern of spillovers, the importance of third country effects during times of financial distress could explain why negative spillovers originating during a crisis tend to be empirically larger than either positive or negative spillovers outside of crisis times: unlike "normal" spillovers, "crisis" spillovers tend to be amplified to a greater extent by confidence and asset price effects.

[23] See for instance Rudebusch (2005) for the case of monetary policy.

Relative Importance of Third-Country Effects for Spillovers from the four Large European Countries to Selected European Countries



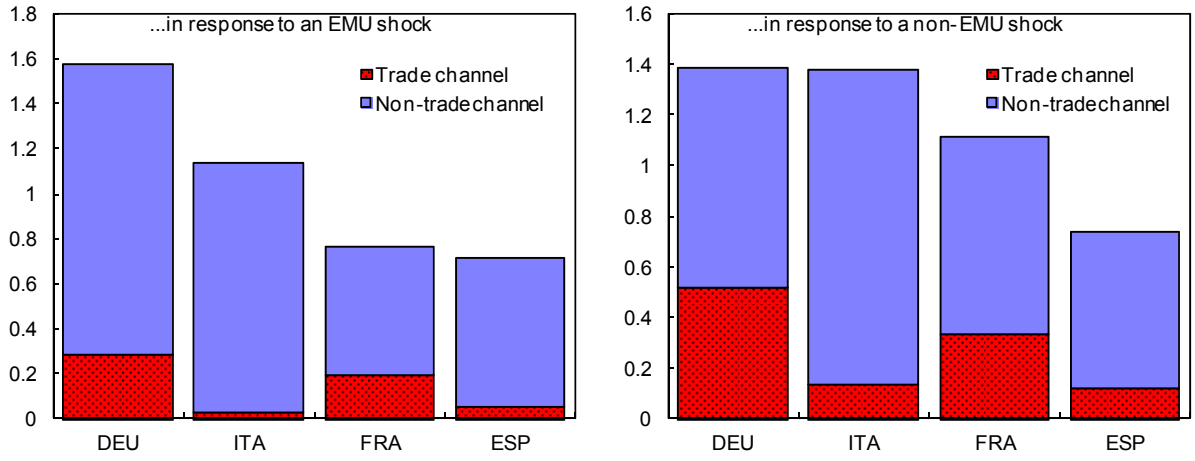
Trade Channel Transmission

The second counterfactual analysis is based on the small country VAR specification which reduces the variables of interest to four variables. The estimation is repeated for each country in the sample, in the case of both EMU and non-EMU shocks.

The results shown for the four largest countries in the euro area highlight in all cases the dominance of non-trade channels, especially for shocks originating within the EMU.
The finding that trade is relatively less important as a transmission mechanism for inward spillovers is somewhat surprising, given the high degree of trade links within the EMU. This result, however, is consistent with the increased relevance of monetary and credit channels and other links which are crucial within a monetary union, but not between two currency blocks.[24]

Compared to other large EMU members, Germany exhibits the highest reliance on trade effects for inward growth spillovers, with a share of growth spillovers from non-EMU countries' shocks due to trade of close to 40 percent. The respective value for France is around 30 percent, for Spain 15 percent, and for Italy only 10 percent. A similar pattern emerges for EMU shocks, although France appears to rely proportionally more on trade effects than Germany for EMU shocks. However, France's overall sensitivity to shocks in the EMU is much below that of Germany (see Section IV.A).

Relative Importance of Trade Channel for Inward Spillovers for Large EMU members



[24] See Vitek (2010) for model simulation-based evidence of strong transmission of supply shocks via non-trade channels in a monetary union.

Not surprisingly, trade accounts for around 50 percent of the spillovers for the small open economies such as Belgium, Sweden, Austria, and Ireland in the case of non-EMU shocks. For EMU shocks, the respective values for Austria and Belgium drop by about 20 percentage points, for Sweden by about 40 percentage points, and for Ireland there is only a minor drop of 5 percentage points. Thus it remains the case also for smaller economies in Europe that trade effects are more relevant for non-EMU shocks than for EMU shocks.

E. Determinants of Spillover Size

This section analyzes to which extent the size of the outward spillovers originating from a given country is related to size (measured by PPP-adjusted GDP) and to the existence of autonomous domestic drivers of growth. While size is a natural a priori determinant of spillovers, we also conjecture that countries that are relatively more sensitive to external shocks are more likely to receive large inward spillovers, but less likely to generate large outward spillovers; by contrast, countries that rely more on domestic drivers of growth are more likely to generate large outward spillovers.

To identify the presence of autonomous sources of domestic demand growth, we look at two dimensions: 1) the average contribution of trade to GDP, and 2) the co-movement of GDP growth and net exports. The former gives us an indication about the relevance of the external sector for overall GDP growth. The latter helps to understand whether GDP growth and net exports move in tandem or whether net exports and GDP growth move in opposite directions. In the latter case, a country is a potential spillover risk (positive or negative) for other countries, since its growth relies to a greater extent on autonomous domestic demand fluctuations, while in the former the country is more likely to import spillovers through trade and other links, and possibly re-export them to others by serving as a third country (transmitter), rather than act as an independent engine of growth.

Countries which exhibit a positive average net contribution of trade to GDP include Japan, Germany, Netherlands, Belgium, Sweden, Austria, Switzerland, Finland, and Ireland and those which do not, include the United States, the United Kingdom, France, Italy, Spain, Canada, Greece, and Portugal (Table 4).[25] In terms of relevance of external demand for overall GDP growth, Germany is the leading country, followed by Ireland, Switzerland, Japan, Austria, Sweden, Finland, Belgium and the Netherlands. In the last decade, exports have become the major engine of growth for Japan, Austria, and particularly for Germany.

[25] Note that this concept is not identical to whether a country is a net exporter or net importer, since it refers to the change in the net trade position rather than the level.

Table 4. Contribution of domestic and external demand to GDP growth (1996Q1[§]- 2010Q3)

	Average GDP growth rate	of which due to Domestic demand	External demand	External demand in % of GDP growth
United States	2.	2.	-0.2	-7.3
Japan	0.	0.	0.	49.0
Germany	1.	0.	0.	59.8
United Kingdom	2.	2.	-0.2	-8.9
France	1.7	2.0	-0.3	-12.9
Italy	0.	1.	-0.3	-22.4
Spain	2.	3.	-0.5	-14.1
Canada	2.	3.	-0.5	-16.6
Netherlands	2.	2.	0.	11.6
Belgium	1.	1.	0.	13.8
Sweden	2.	2.	0.	21.2
Austria	2.	1.	0.	37.5
Switzerland	1.	1.	0.	49.3
Greece	2.	2.	-0.1	-3.8
Portugal	1.	2.	-0.5	-20.9
Finland	2.	2.	0.	15.8
Ireland	4.	2.	1.	57.9

Source: Eurostat, national authorities and, IMF staff calculation

[§] Due to rounding and statistical discrepancies, values do not necessarily add up.

Regarding the co-movement of external demand and GDP growth, the countercyclical pattern of domestic and external contribution to growth indicates the greatest spillover risk in the case of the U.K., the U.S., Canada, Spain, Portugal, and Greece (Table 5). These countries have a high negative correlation between the contribution of domestic and external demand and a high positive correlation between domestic demand and GDP. This represents a pattern under which high domestic demand drives growth and worsens the net trade position due to increased domestic demand.

Germany, Japan, Austria, and Finland illustrate the opposite, export driven, growth pattern (Table 5). These countries exhibit a positive correlation between the external contribution to growth and GDP and a positive relation between the domestic contribution and the external contribution to GDP. Higher external demand accelerates growth which in turn stimulates domestic consumption and investment. For the Netherlands, Sweden, France, and Belgium the patterns appear less pronounced according to these indicators.

Table 5. Correlation of contributions with GDP growth (1996Q1 - 2010Q3)

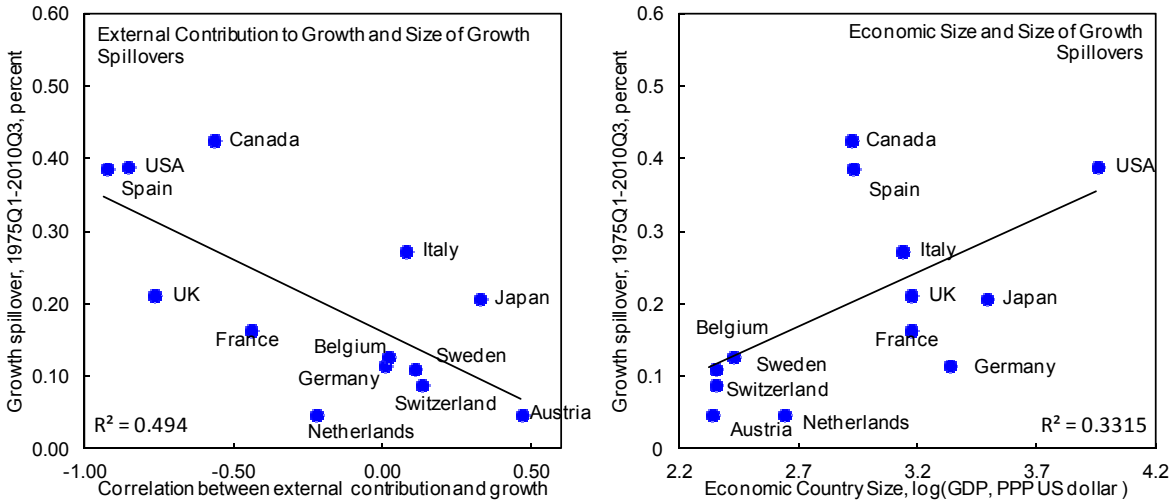
	Correlation between		
	domestic and external	external and GDP	domestic and GDP
United States	-0.9	-0.8	1.0
Japan	0.3	0.6	0.
Germany	0.0	0.7	0.7
United Kingdom	-0.8	-0.6	1.
France	-0.4	-0.1	0.9
Italy	0.1	0.4	0.9
Spain	-0.9	-0.8	1.
Canada	-0.6	0.1	0.7
Netherlands	-0.2	0.1	1.
Belgium	0.0	0.4	0.9
Sweden	0.1	0.5	0.9
Austria	0.5	0.8	0.9
Switzerland	0.1	0.8	0.6
Greece	-0.9	-0.6	0.
Portugal	-0.8	-0.6	0.9
Finland	0.4	0.7	0.9
Ireland	-0.5	-0.3	1.0

Source: Eurostat, national authorities and, IMF staff calculation

When plotting the correlation between external contribution to growth and GDP against the weighted outward spillovers from the main (baseline) regression, the link between the presence of domestic drivers of growth and the relevance of a country as a source of growth spillovers to other countries is confirmed.[26] While we also find evidence of a positive relationship between a country's size and the estimated outward spillover, the presence of clear outliers such as Canada and Spain (larger spillovers than predicted by size alone), or Germany (smaller spillovers than expected based on size) suggest that size alone fails to explain spillover risk.

[26] The relationship holds also when excluding the crisis dummy. Regressing the size of the outward spillover on a constant, the log size of the country, and the correlation between GDP growth and the external contribution to growth yields a positive significant effect for the former and a negative significant effect for the latter. Increasing the size of the country by 10 percent increases the outward spillover by 0.1 percentage points and reducing the correlation of external demand and GDP growth from +0.5 to -0.5 increases the size of outward spillovers by 0.14 percentage points, The smallest four counties are excluded from the graph. While Finland confirms the pattern, Greece, Portugal and Ireland are too small to generate significant growth spillovers.

Correlation of Outward Spillovers, Size and Export Driven Growth



V. Conclusion

The divergent growth recovery paths in Europe in the aftermath of the 2008–09 financial crisis has brought the question of growth spillovers again to the forefront as spillovers from faster growing countries could provide positive growth impetus to the slower growing countries, whose recovery is hampered by domestic demand constraints. Furthermore, against the background of renewed sovereign debt concerns in the euro area, negative growth shocks originating in the crisis countries could spill over to other countries via trade linkages or extensive cross-border asset ownership.

Our empirical analysis suggests that growth spillovers can indeed explain a significant fraction of the variation in output growth for some euro area members, in particular the small open economies. In terms of origin of the spillover, we find that the U.S. remains the key source of growth spillovers also in this recovery. Despite the increased correlation of Germany with several other countries, its impact remains primarily contained to its smaller neighbors, while France and Italy are more relevant for the southern peripheral countries. Both Japan and Spain also appear to be a significant source of potential growth spillover risk to European countries, although the positive spillover impact of Spain in future episodes could be much smaller than indicated by our results if domestic demand growth is durably hampered by the ongoing unwinding of long-standing imbalances. To some extent, a similar caveat applies to the U.S. results, in light of uncertainties surrounding the sustainability of the current U.S. recovery.

Our analysis of transmission channels suggests that trade channels matter relatively less than financial and other non-trade channels. Trade effects seem to matter relatively more for German inward spillovers, compared to other large Euro area countries, reflecting Germany's relatively high trade exposures. For all euro area members, we find that growth shocks from

outside the EMU are to a relatively larger extent transmitted via trade compared to growth shocks originating within the EMU; the latter appear to be predominantly transmitted via monetary and financial linkages. We fail to find an increasingly important role for Germany as an independent source of growth shocks in the Euro area in recent years, reflecting its relatively large sensitivity to external shocks. Finally, the results suggest that growth spillover risks from the European crisis countries to the rest of Europe remain limited, although stronger effects could be expected if the debt crisis were to spread to larger countries such as Spain.

Our results are consistent with the premise that for countries to be an important source of growth spillovers, growth should rely to a greater extent on autonomous domestic sources. Germany fails to meet these criteria, as it is more sensitive to growth shocks in other countries than other large advanced countries and its GDP growth tends to closely follow the performance of its external sector. However, consistent with the view that Germany's imports are very sensitive to demand for German exports (due to the high import content of German exports), our results suggest that Germany may be acting as an important "third country" or transmitter of shocks, since it is more directly affected by external growth shocks than other large euro area countries and third country effects are found to account for much of the transmission of external shocks to the other euro area members.

While our results appear to be robust across variations of the sample and carry over to estimates restricted to the more recent period, some caveats remain. First, we cannot infer much about the role that the sample countries might play for other countries, which are not included in the sample. Second, the analysis is backward looking and does not allow for time varying relationships between the countries. And third, our approach does not allow us to uncover the particular source or nature of the country specific shock, masking potential variations stemming from supply as opposed to demand shocks which stand behind the growth shocks. All three caveats provide an interesting avenue for future research. Further exploring the financial transmission channels which likely underlie the finding that both spillover estimates and third country effects tend to become larger for most countries during periods of financial distress would also constitute a worthwhile avenue for future research.

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Appendix

Ordering of Spillovers between Countries

(in order of independence from other regions)

DEU	JPN	USA	FRA	UK	ESP	ITA	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
DEU	JPN	USA	FRA	ITA	ESP	UK	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
DEU	JPN	USA	UK	FRA	ESP	ITA	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
DEU	JPN	USA	UK	ITA	ESP	FRA	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
DEU	JPN	USA	ITA	FRA	ESP	UK	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
DEU	JPN	USA	ITA	UK	ESP	FRA	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	JPN	DEU	UK	ESP	ITA	FRA	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	JPN	DEU	ITA	ESP	UK	FRA	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	JPN	DEU	FRA	ESP	ITA	UK	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	JPN	DEU	UK	ESP	FRA	ITA	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	JPN	DEU	ITA	ESP	FRA	UK	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
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JPN	DEU	USA	UK	ITA	ESP	FRA	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
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USA	UK	DEU	FRA	JPN	ITA	ESP	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	UK	DEU	ITA	JPN	FRA	ESP	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	UK	JPN	FRA	DEU	ITA	ESP	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	UK	JPN	ITA	DEU	FRA	ESP	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	ITA	DEU	FRA	JPN	UK	ESP	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	ITA	DEU	UK	JPN	FRA	ESP	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
USA	ITA	JPN	FRA	DEU	UK	ESP	CAN	NLD	BEL	SWE	AUT	CHE	GRC	PRT	FIN	IRL
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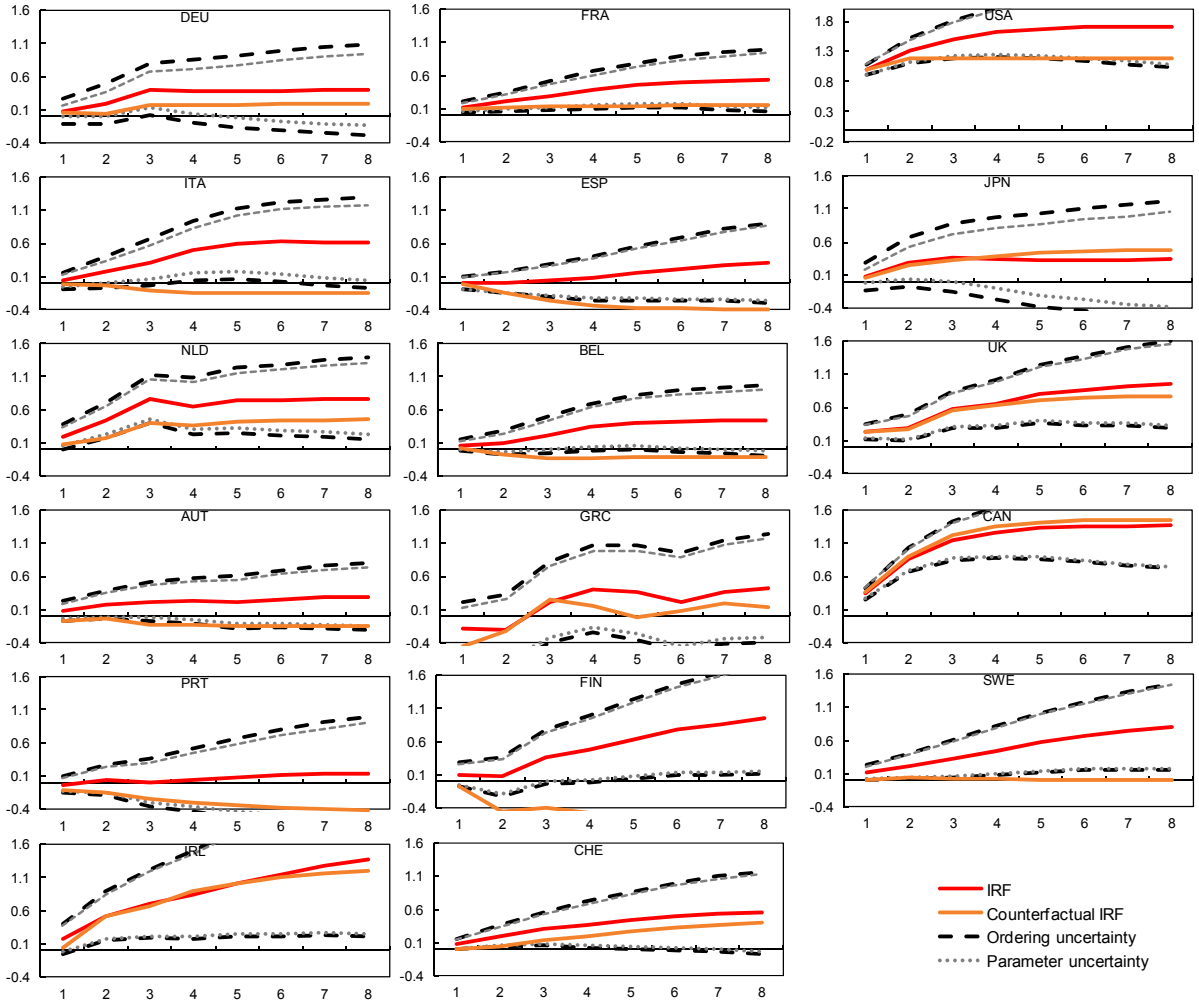
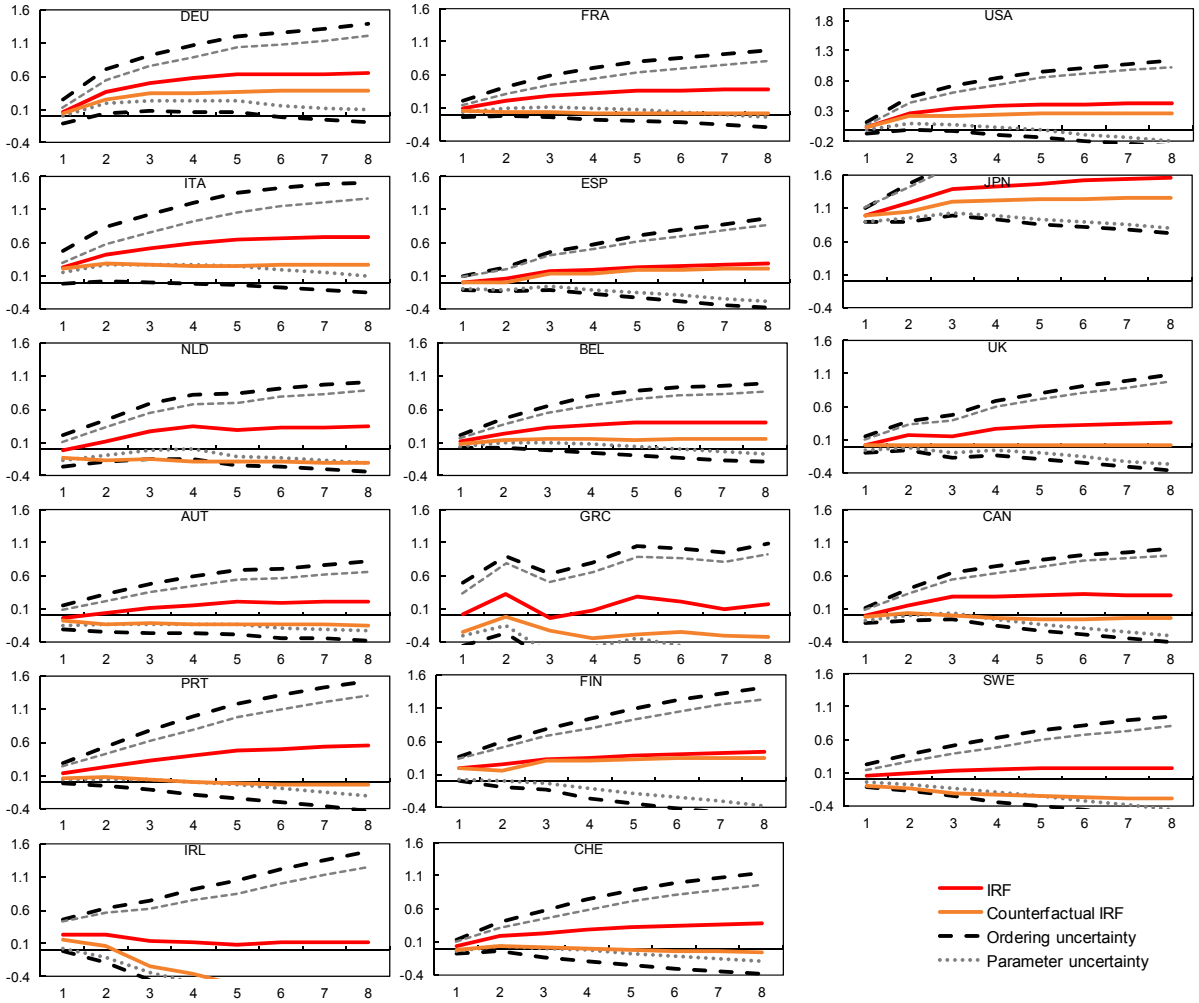
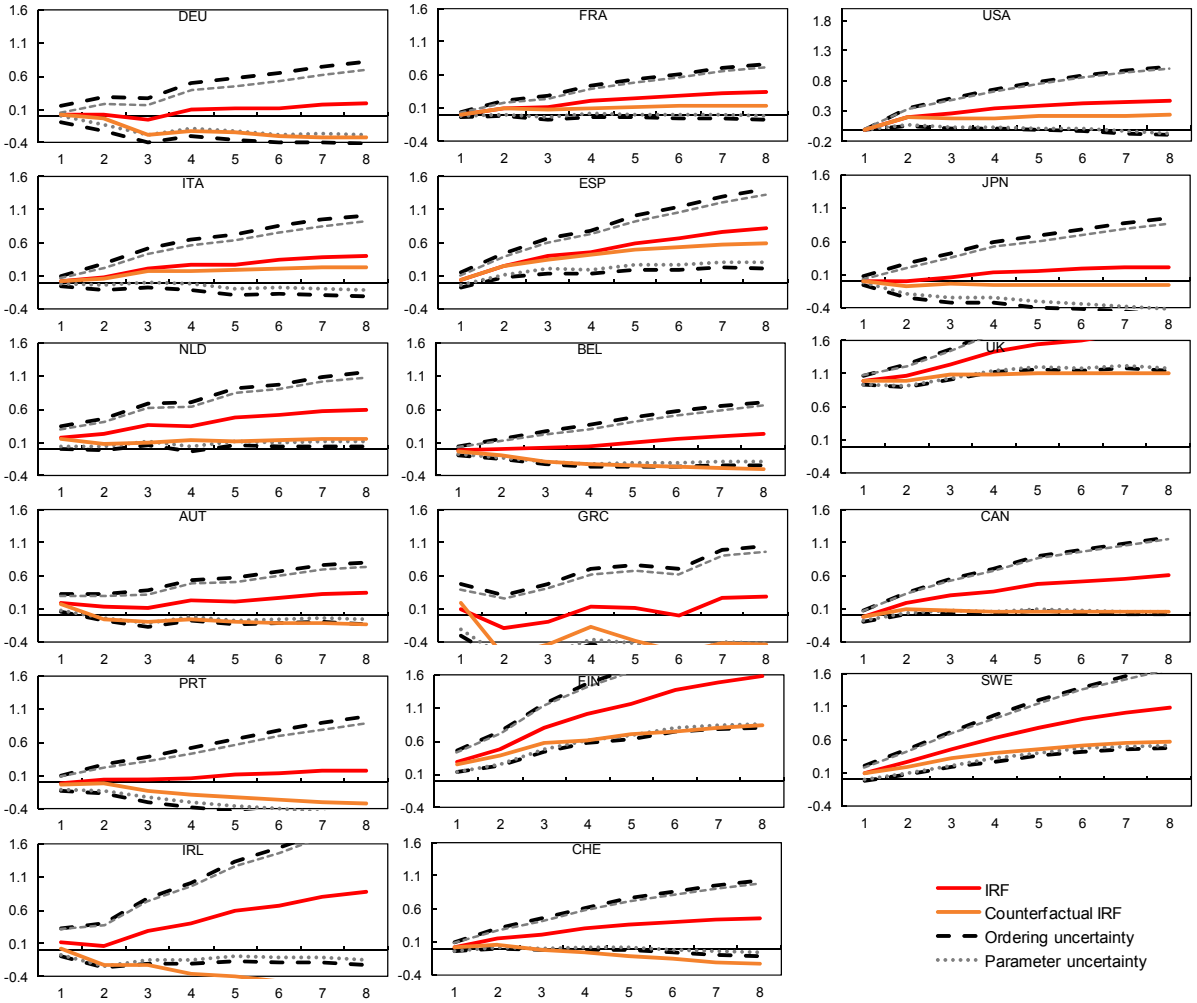
Response to a 1 percent growth shock in USA



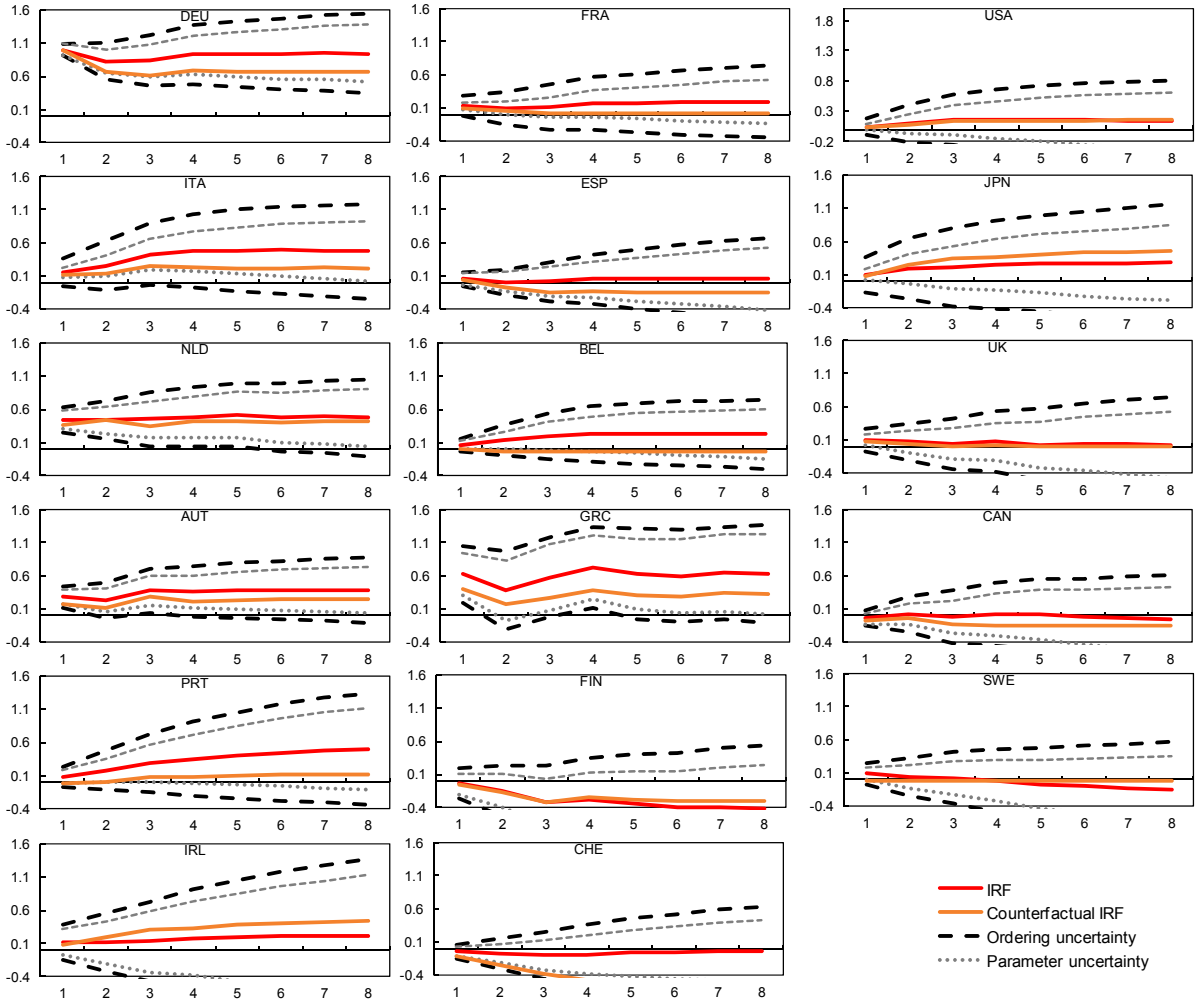
Response to a 1 percent growth shock in Japan



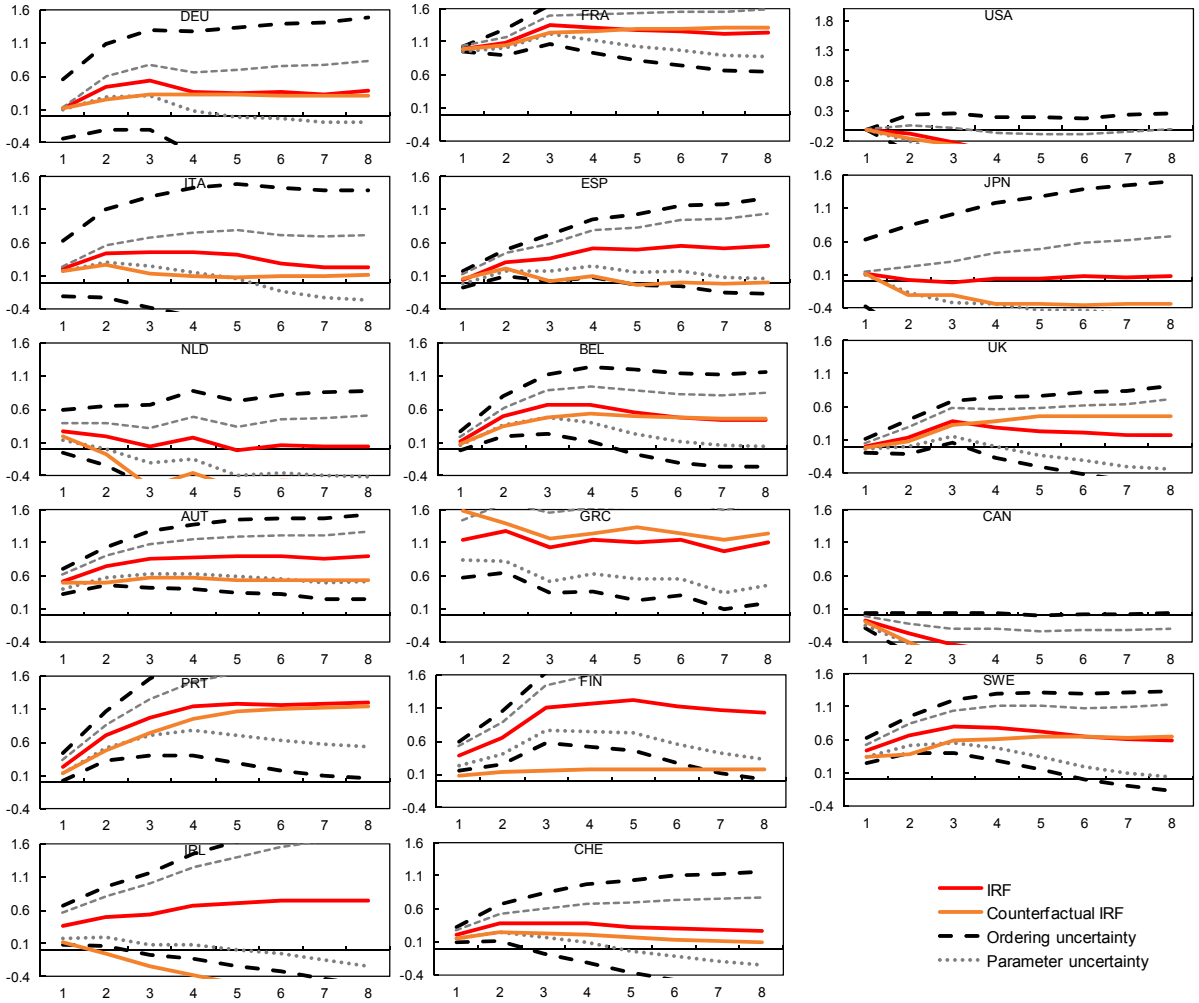
Response to a 1 percent growth shock in UK



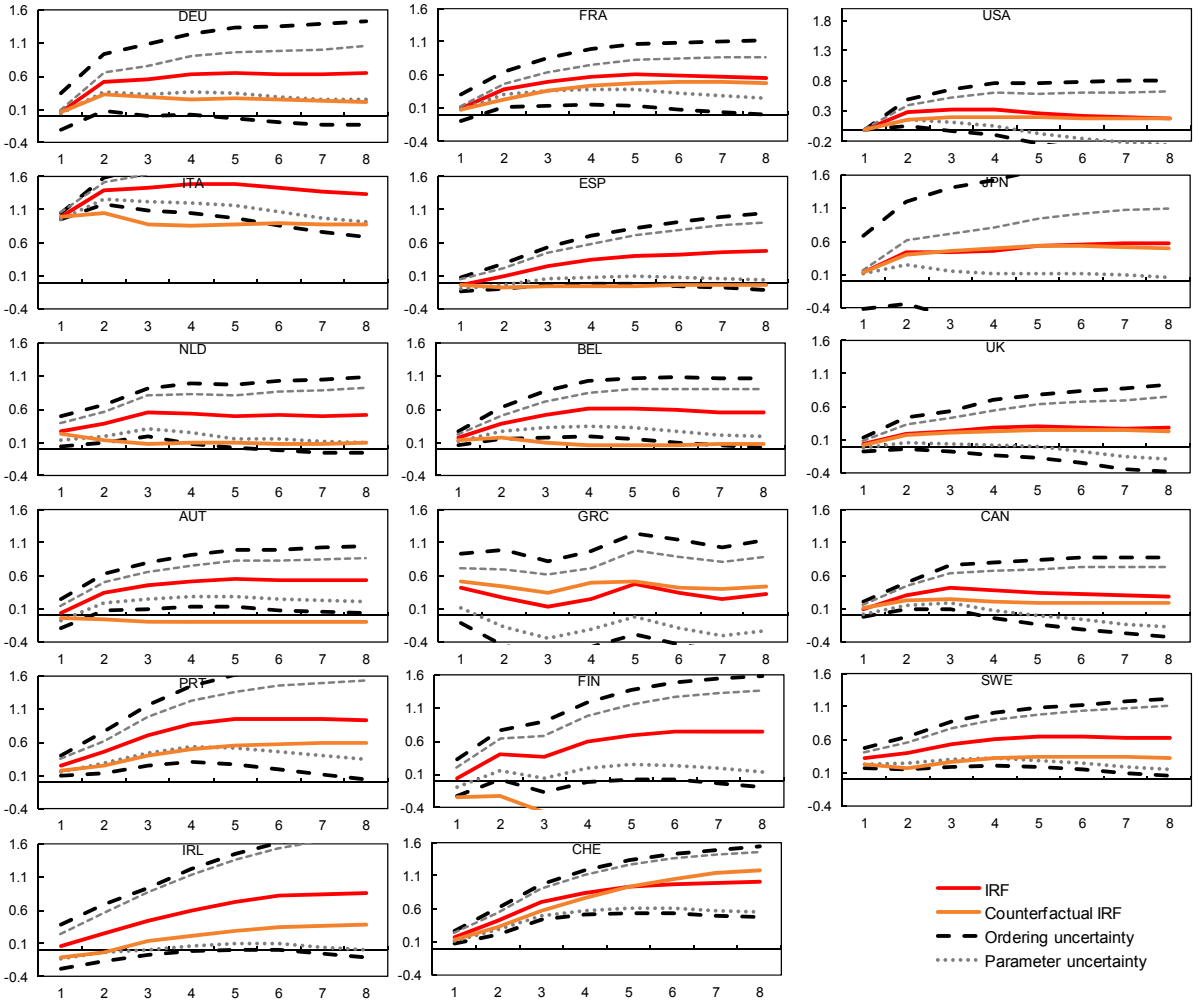
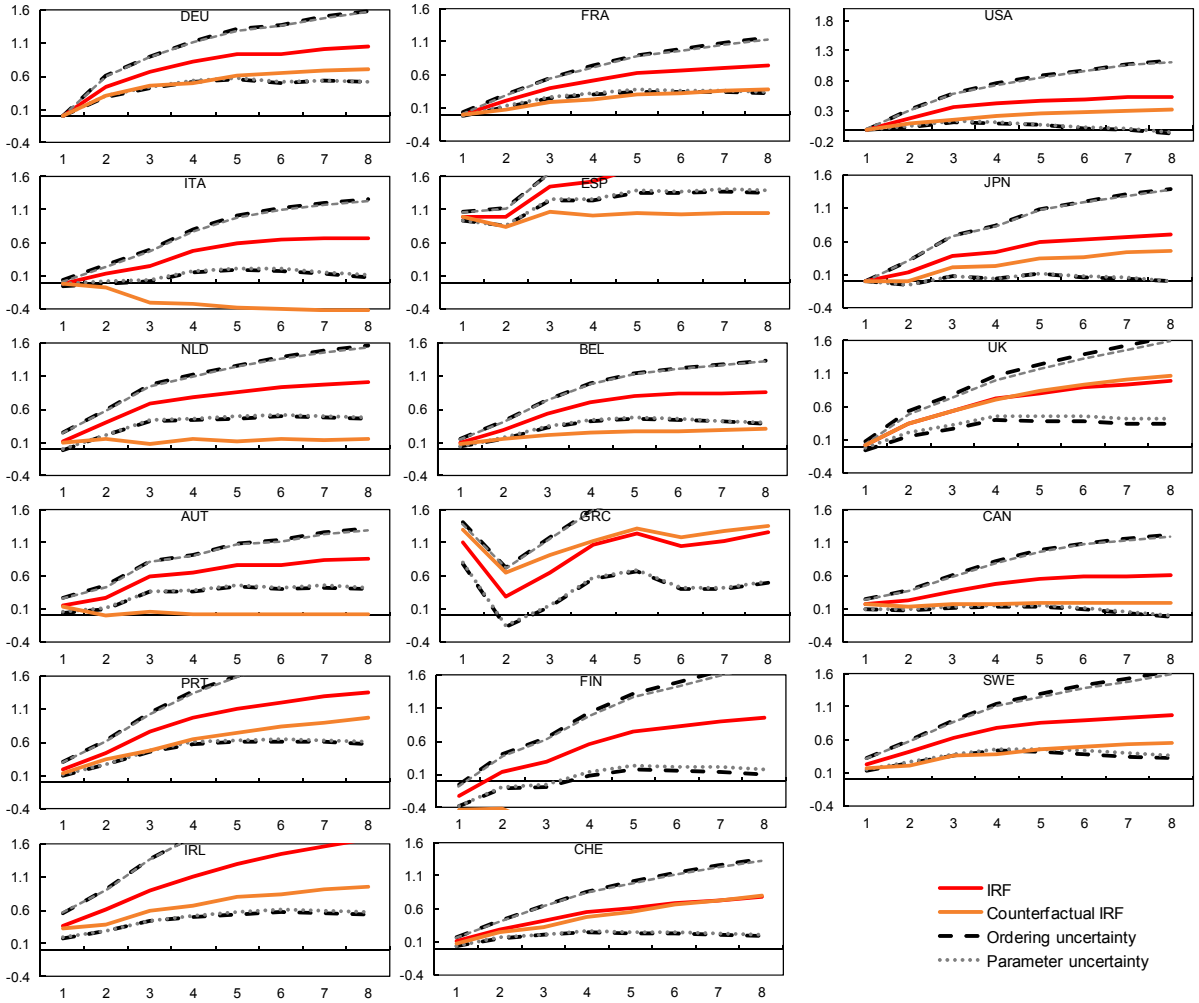
Response to a 1 percent growth shock in Germany



Response to a 1 percent growth shock in France



Response to a 1 percent growth shock in Italy



Response to a 1 percent growth shock in Spain