IMF Working Paper

Trade Linkages, Balance Sheets, and Spillovers:

The Germany-Central European Supply Chain

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European Department

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Abstract

Germany and the Czech Republic, Hungary, Poland, and Slovakia (the CE4) have been in a
process of deepening economic integration which has lead to the development of a dynamic
supply chain within Europe—the Germany-Central European Supply Chain (GCESC).
Model-based simulations suggest two key policy implications: First, as a reflection of
strengthening trade linkages, German fiscal spillovers to the CE4 and more broadly to the
rest of the euro area, have increased over time, but are still relatively small. This is explained
by the supply chain nature of trade integration: final demand in Germany is not necessarily
the main determinant of CE4 exports to Germany. Second, increased trade openness in both
Germany and the CE4 implies a greater exposure of the GCESC to global shocks. However,
owing to its strong fundamentals—including sound balance sheets and its safe haven status—
Germany plays the role of a regional anchor of stability by better absorbing shocks from
other trading partners instead of amplifying their transmission across the GCESC.

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Executive Summary

A dynamic supply chain is thriving in the center of Europe. The deepening economic integration between Germany and Czech Republic, Hungary, Poland, and Slovakia (henceforth, the CE4) has been associated with the development of a vibrant supply chain, and will henceforth be referred to as the German-Central European Supply Chain (GCESC).

Motivated by these developments, this paper comprises two parts, focusing on two broad questions:

- The first part concentrates on the implications of greater economic interconnectedness owing to the establishment of the supply chain. How has deeper supply chain integration affected the nature of spillovers over time stemming from various global and regional shocks? What role is there for policies?

- The second part of the paper highlights how German fundamentals can affect spillovers to the supply chain. Along with its central position in the supply chain—in part owing to its safe haven status and robust balance sheets—does Germany act as an anchor of stability by helping the region better cope with external shocks?

This paper provides quantitative answers to these questions using model-based simulations. In particular, policy implications are gleaned from a six-region version of the IMF's Global Integrated Monetary and Fiscal model (GIMF).

The model-based simulations yield several policy implications, and can be summarized as follows:

- **German fiscal stimulus is likely to have a relatively small impact on the CE4**—and more broadly, to the rest of the euro area. As a reflection of strengthening trade linkages, German spillovers to the CE4—including those related to fiscal policy—have increased over time, but remain relatively limited. This is explained by the supply chain nature of trade integration: final demand in Germany is not necessarily the main determinant of CE4 exports to Germany.

- **Germany and the CE4 are now more exposed to global shocks**, as a result of greater trade openness, as Germany and the CE4 have integrated with the world, as well as with each other.

- **Germany plays the role of a regional anchor of stability**, however, by better absorbing shocks from other trading partners instead of amplifying their transmission across the GCESC, owing to its strong fundamentals—including sound balance sheets and its safe haven status.

I. INTRODUCTION

A dynamic supply chain is thriving in the center of Europe. As discussed by the International Monetary Fund (IMF, 2013), geographic proximity, cultural similarities, and labor cost differentials are factors which have led many German firms to shift large parts of their production to the Czech Republic, Hungary, Poland, and Slovakia (hereafter, the CE4). The deepening economic integration between Germany and the CE4 has been associated with the development of a vibrant supply chain, and will henceforth be referred to as the German-Central European Supply Chain (GCESC).

Motivated by these developments, this paper comprises two parts, focusing on two broad questions:

- The first part concentrates on the implications of greater economic interconnectedness owing to the establishment of the supply chain. How has deeper supply chain integration affected the nature of spillovers over time stemming from various global and regional shocks? What role is there for policies?

- The second part of the paper highlights how German fundamentals can affect spillovers to the supply chain. Along with its central position in the supply chain—in part owing to its safe haven status and robust balance sheets—does Germany act as an anchor of stability by helping the region better cope with external shocks?

This paper provides quantitative answers to these questions using model-based simulations. In particular, policy implications are gleaned from counterfactual simulations generated using the IMF's Global Integrated Monetary and Fiscal model (GIMF). A six-region version of GIMF is utilized, including Germany, the euro area excluding Germany, the CE4, and remaining countries.

The model-based simulations yield several policy implications, and can be summarized as follows:

- **German fiscal stimulus is likely to have a relatively small impact on the CE4**—and more broadly, to the rest of the euro area. As a reflection of strengthening trade linkages, German spillovers to the CE4—including those related to fiscal policy—have increased over time, but remain relatively limited. This is explained by the supply chain nature of trade integration: final demand in Germany is not necessarily the main determinant of CE4 exports to Germany.

- **Germany and the CE4 are now more exposed to global shocks**, as a result of greater trade openness, as Germany and the CE4 have integrated with the world, as well as with each other.

- **Germany plays the role of a regional anchor of stability**, however, by better absorbing shocks from other trading partners instead of amplifying their transmission across the GCESC, owing to its strong fundamentals—including sound balance sheets and its safe haven status.

- **More generally, sound balance sheets have positive benefits domestically and in terms of spillovers**. With more fragile balance sheets, domestic shocks result in lower growth both at home and abroad. Therefore strengthening household, corporate, and sovereign balance sheets is important for countries and their trading partners—especially those with even tighter trade links owing to a supply chain arrangement.

The remainder of the paper is structured as follows: The next section provides an overview of the IMF's GIMF model and its calibration. Section III focuses on the main results of the paper and comprises two parts. The first part assesses the implications of deepening trade integration in the context of the GCESC, while the second part concentrates on illustrative counterfactual scenarios which highlight the role of balance sheets in amplifying the impact of growth shocks and the attendant spillovers. The final section concludes by summarizing the main results and underscoring the key policy implications.

II. MODEL

The main policy implications of the paper are derived from simulations using the IMF's Global Integrated Monetary and Fiscal model (GIMF). This section comprises two parts, with the first providing an overview of GIMF, with further details relegated to the Appendix. The idea is to provide enough intuition to understand the gist of the simulations, while leaving most of the details to Kumhof and others (2010) and Anderson and others (2013). The second part of this section provides a summary of the parameterization of GIMF, primarily focusing on the calibration of the trade matrix and key balance sheet indicators.

A. Overview

GIMF is a multi-region dynamic stochastic general equilibrium (DSGE) model with optimizing behavior by agents. As shown in Figure 1, GIMF has several sectors with multiple optimizing agents. Households have finite planning horizons, and some are liquidity constrained, generating non-Ricardian features which imply non-neutrality in spending- and revenue-based fiscal measures, making GIMF suitable to analyze fiscal policy issues. Firms are owned domestically, and employ capital and labor to produce tradable and nontradable intermediate goods. An annual version of the model is used, which significantly reduces the computation burden the simulations require.[2]

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[2] This version of GIMF abstracts from oil prices, but could be added along the lines of Elekdag and others (2008) or Kumhof and Muir (2012) to investigate the implications of terms of trade shocks on the GCESC.

Weaker balance sheets can magnify the domestic impact of shocks, but also amplify the spillovers across borders. The health of household, corporate, and sovereign balance sheets matter in GIMF, in part, owing to incomplete asset markets. In particular, there is a financial sector a la Bernanke, Gertler and Gilchrist (1999), which incorporates a procyclical financial accelerator, with the cost of external finance facing firms rising with their indebtedness. Greater corporate leverage implies a more procyclical external finance premium, and therefore a more powerful financial accelerator. In this way, shocks can drive up the real cost of investment quite rapidly, resulting in a sharp contraction of economic activity.[3]

Fiscal and monetary policies play an important role in economic stabilization. This is because of finite planning horizons, liquidity-constrained households, and other real and nominal frictions. For example, government debt is only held domestically, as nominal, non-contingent, one-period bonds denominated in domestic currency. The only assets traded internationally are nominal, non-contingent, one-period bonds denominated in U.S. dollars that can be issued by the U.S. government and by private agents in any region. Equity is not traded in domestic financial markets; instead, households receive lump-sum dividend payments.

B. Calibration

A six-region version of GIMF is utilized. These regions are (i) Germany, (ii) CE4, (iii) the euro area excluding Germany, (iv) the United State, (v) an emerging Asia block, and (vi) the rest of the world, where the CE4 (the Czech Republic, Hungary, Poland, and Slovakia) would be taken together as a region. While the CE4 is taken as a single entity, in reality differences across these four countries should be recognized. For example, despite having the largest GDP, Poland is also the least open CE4 economy.

The model is calibrated to realistically account for the changes in the trade ties across the GCESC. Each region in GIMF exports and imports both final (consumption and investment) and intermediate goods. In this way, the changing trade relationship between Germany, the CE4, and other key trading partners can be appropriately captured in the model. Relative prices, including exchange rates, are also modeled, and in part, influenced by policies in the short run.

The strength and nature of the trade channel linking the GCESC has changed over time. A summary of GIMF's trade matrix is shown in Table 1. It compares the state of trade linkages in 1996 with that in 2011 (the benchmark calibration), and highlights a few interesting developments, with details relegated to the Appendix:

- First, exports as a share of GDP has increased in Germany and in the CE4. In other words, both regions have become much open, and therefore integrated with the global economy.

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[3] For further details on the financial accelerator mechanism—especially in the context of small open economies—see Elekdag and others (2006) and Elekdag and Tchakarov (2007) and the reference therein.

- Second, exports to each other have increased dramatically. Note the rapid growth of CE4 exports to Germany from 1996 to 2011.

- Third, and relatedly, as a reflection of deeper regional trade integration, intermediate exports across the GCESC have increased substantially.[4] The growth in intra-supply chain trade owing to the exchange of intermediate goods implies that final demand in Germany is not necessarily the main determinant of CE4 exports to Germany. This insight will be crucial when interpreting how spillovers across the region have evolved over time.

Figure 1. A Two-Country Representation of GIMF
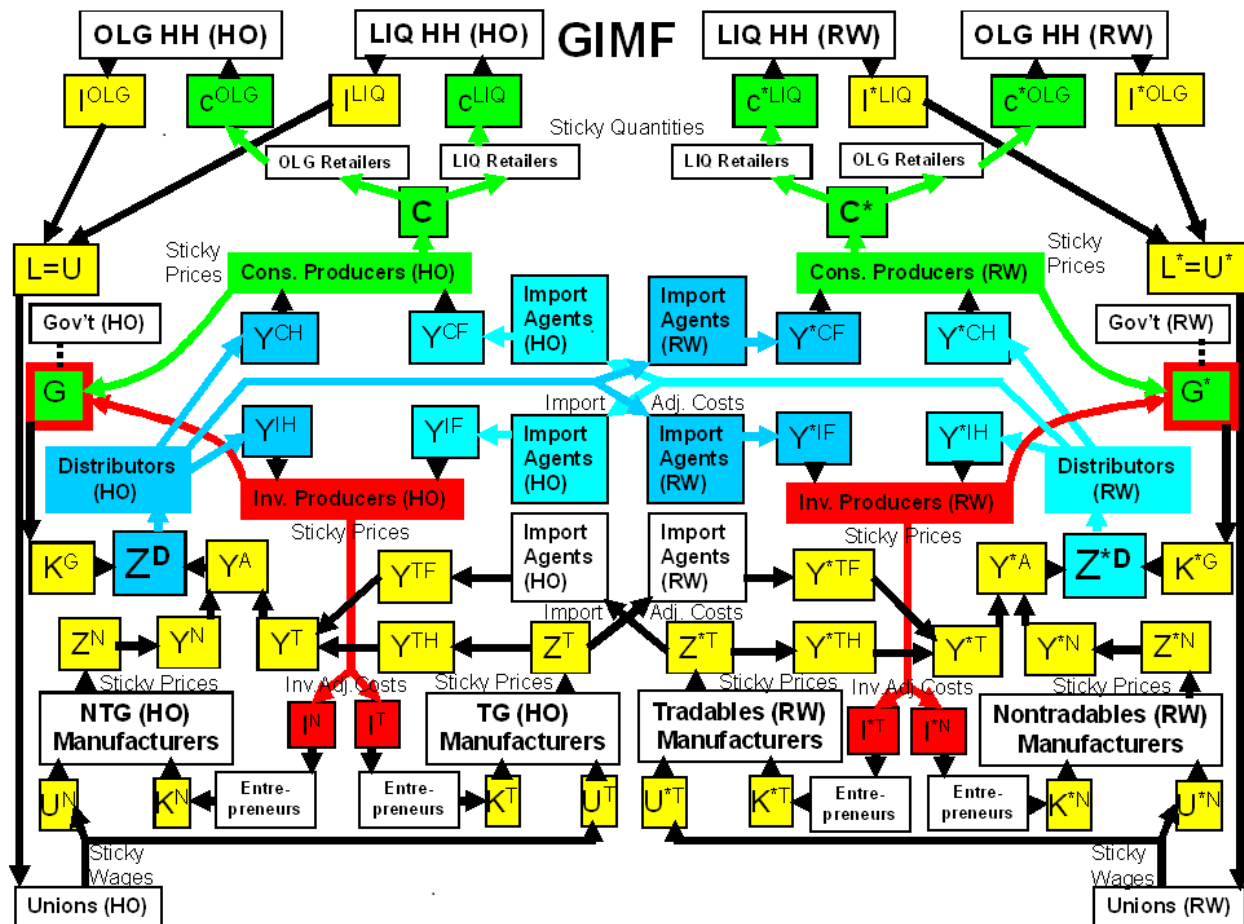
Source: Kumhof and others (2010).

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[4] While not shown, in 2011, Germany exports a substantial amount of intermediate goods to the rest of the euro area (5.3 percentage points of GDP). It should be noted however, that these goods are not necessarily associated with a vertical integration, while the intermediate exported to the CE4 most likely are closely related to the GCESC as emphasized in IMF (2013).

Table 1. Summary of the Trade Matrix: 1996 versus 2011

(Exports in percent of nominal GDP unless otherwise stated)

	1996		2011	
	CE4	**Germany**	**CE4**	**Germany**
Total exports	30.1	24.3	52.8	47.7
to CE4		1.4		4.5
to Germany	8.4		16.6	
Final goods	21.4	17.8	38.9	35.0
to CE4		0.9		2.8
to Germany	6.0		11.2	
Intermediate goods	8.7	6.5	13.9	12.3
to CE4		0.5		1.6
to Germany	2.4		5.4	
Size (In percent of world GDP)	0.9	8.0	1.4	5.1

Sources: IMF Direction of Trade Statistics; United Nations ComTrade; and authors' calculations.

An alternative calibration is used to assess the role of sound German balance sheets. In order to gauge the implicit stabilization benefits to the GCESC owing to strong German fundamentals—including sound balance sheets and its safe haven status—an illustrative scenario is developed which simulates the German economy with more fragile balance sheets as discussed below. Specifically, households are calibrated to be more liquidity constrained, corporate more leveraged, and the government more indebted along the lines of regional economies with less robust fundamentals. Weaker corporate balance sheets, for example, strengthen the financial accelerator mechanism as discussed above, and thereby make the economy more sensitive to shocks. At the same time, a loss of Germany's safe haven status is assumed, and given the backdrop of more fragile balance sheets, implies higher sovereign yields, in turn, raising those in the corporate sector.

III. RESULTS

This section presents the main results of the paper and comprises two parts: The first part concentrates on the implications of the evolving strength and nature of the trade channel linking the GCESC with each other, and with its main trading partners. It gauges how German spillovers to the CE4, and to the rest of the euro area, have changed over time. The second part assesses the extent to which, owing to its strong fundamentals—including sound balance sheets and its safe haven status—Germany plays the role of a regional anchor of stability by better absorbing shocks from other trading partners instead of amplifying their transmission across the GCESC.

A. Spillovers: How Has the Supply Chain Changed Them?

Aggregate Demand Shocks

Spillovers associated with aggregate demand shocks vary across regions and have changed over time. Figure 2 shows the peak impact to a 1 percent aggregate demand (private consumption and investment) shock originating either in Germany, or the non-European blocks of the model (Emerging Asia, the U.S., and remaining countries). This shock is motivated by the collapse of world trade during the global financial crisis of 2008-09. It shows the percent deviation of real GDP from baseline in Germany and in the CE4 region. The shocks are simulated using the trade matrix calibrated to match trade flows occurring in 1996 or 2011. In sum, a regional (German) or global (non-European blocks) aggregate demand shock is simulated under two calibrations of the trade matrix.[5]

An aggregate demand shock of similar magnitude yields a smaller contraction in German output in 2011 relative to 1996. To be clear, what is under consideration is the domestic impact of an aggregate demand shock on real GDP originating in Germany. One factor behind this result is that German openness has increased over the period spanning 1996 to 2011. Indeed, over this period, the export-to-GDP ratio has risen to around 48 percent from 24 percent (Table 1). Because Germany is more open in 2011, the economy is characterized by more "leakage" and therefore a lower domestic impact. At the same time, the demand shock brings about a slowdown which puts downward pressure on inflation, and is therefore characterized by a depreciation of the real effective exchange rate. In 2011, a smaller change in relative prices is associated with a larger increase in net exports, and thereby helps stabilize real GDP to a greater extent.

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[5] The appendix briefly discusses a canonical supply shock, that is, a disturbance to total factor productivity.

Figure 2. Aggregate Demand Shock
(Real GDP, percent deviation from baseline)
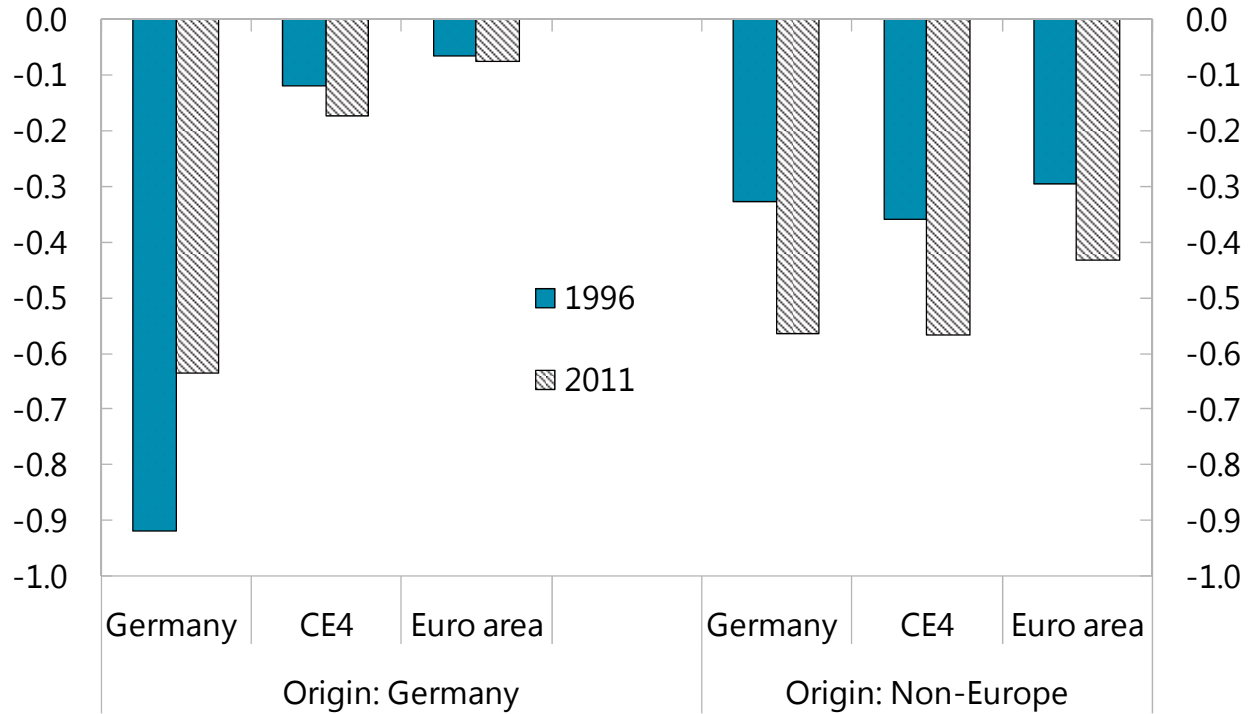
Source: IMF staff calculations.

German spillovers to the CE4, while still relatively small, have increased over time. In terms of spillovers, notice the larger impact on CE4 real GDP owing to an aggregate demand shock originating in Germany in 2011 as contrasted to 1996. A key determinant driving this result is greater economic integration owing to the supply chain. While greater integration has strengthened the trade channel to an extent, spillovers are still limited because greater intra-supply chain trade occurred to a large degree through the exchange of intermediate goods. This implies that final demand in Germany is not necessarily the main determinant of CE4 exports to Germany.

German spillovers to the rest of the euro area remain quite negligible. The transmission of German aggregate demand shocks to the rest of the euro area are small, and have not changed over time because of two reasons: First, the extent of trade between Germany and the rest of the euro area has not increased as much as it has between members of the GCESC. Second, while the CE4 is small in terms of economic size relative to Germany, the rest of the euro area is much larger. Therefore, the impact of a German shock is much smaller as a share of GDP in the rest of the euro area.

Because the GCESC has become more open, spillovers from the rest of the world are now much larger. For non-European demand shocks (which with a modest exaggeration could be termed "the rest of the world"), real GDP in both Germany and the CE4 dips below baseline by more in 2011 than in 1996. This is because both economies have become more open, and are thus more susceptible to fluctuations in global economic activity (Table 1). The larger downturns are compounded by indirect effects because intra-European economic activity slows down, and thus acts as an additional drag on growth.

More generally, spillovers to the CE4 from the rest of the world are greater than those from Germany. Given deepening regional integration one would expect that German shocks would have a larger impact on the CE4 (and the rest of the euro area more broadly) relative to shocks from the rest of the world. However, as highlighted in Figure 2, this is not the case. The differing impacts of the shocks originating in either Germany or the rest of the world are especially pronounced in 2011. There are three principal reasons underpinning these differences:

- First, and most importantly, while Germany accounts for five percent of global GDP in 2011, the rest of the world makes up about 80 percent of worldwide output. Because the rest of the world is economically larger, its impact on global GDP will be proportionate, and bring about a deeper recession.

- Second, and as discussed above, Germany, the CE4, and the rest of the euro area are now much more open economies, and thereby more sensitive to global business cycle fluctuations.

- Third, and relatedly, as noted above, deeper regional integration in the context of the GCESC was characterized by a substantial increase in the trade of intermediate goods. This implies that a greater share of CE4 exports is now dependent on final demand in the rest of the world relative to Germany—another reason why the CE4 is more exposed to global growth shocks.[6]

In sum, greater trade openness has increased the economies of Germany and the individual CE4 countries to global shocks. In fact, for Germany, when measured in terms of final demand (by explicitly accounting for domestic value added content of exports), while the European Union is still its largest trading partner, exposures to China and the United States are larger than what gross trade statistics suggest as noted in IMF (2013). While growth in Germany and the CE4 is likely to have benefitted from closer trade ties to these relatively faster growing

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[6] As emphasized by IMF (2013), using value added exports suggests that even a greater share of CE4 final demand is coming from the rest of the world in contrast to Germany.

regions, the GCESC countries have also become more sensitive to global trade downturns as witnessed by the experience of 2008/09.[7]

Fiscal Stimulus Shocks

Given its implications for policy, fiscal stimulus shocks are considered. As before, shocks originating in Germany or the non-European regions (Emerging Asia, the U.S., and remaining countries) are considered for two separate calibrations of the trade matrix (1996 or 2011). The fiscal policy shock under consideration is a debt-financed two-year 1 percentage point increase in government consumption in order to stimulate domestic demand. In other words, this is another type of aggregate demand shock, and so would have similar properties to the shock discussed above (Figure 2).

Figure 3. Fiscal Stimulus Shock
(Real GDP, percent deviation from baseline)
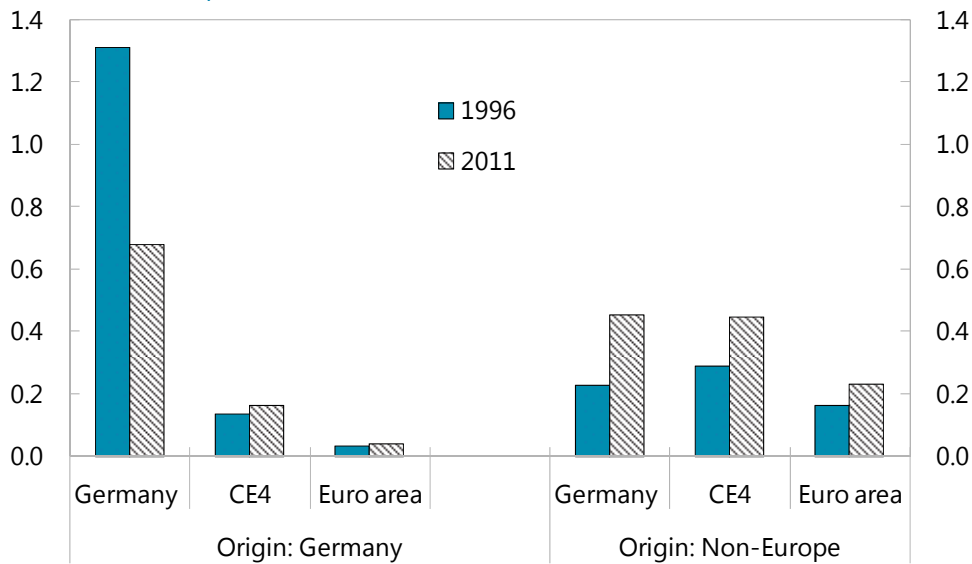
Source: IMF staff calculations.

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[7] Although not modeled in GIMF, increasing exposure to the outside world has been accompanied by concentration risk in certain sectors such as automobiles. An external shock that had a large differential impact on the automobile sector (such as an energy shock), could have a disproportionately large impact on GCESC countries.

The growth impact of a domestic fiscal stimulus has changed over time. While an increase in domestic government consumption used to raise real GDP above baseline by about 1.3 percent in 1996, in 2011 the impact has declined to a deviation from baseline of around 0.7 percent. As before, because of the increased openness of the German economy, the economy overall, is subject to a greater degree of leakage.[8]

German fiscal stimulus is associated with small spillovers. While rising over time, the increase in German government consumption appears to have a relatively small impact on the CE4 and the rest of the euro area. As shown in Figure 3, the simulations suggest that the maximum impact of the fiscal stimulus on the CE4 results in a real GDP deviation from baseline of about 0.13 percent and 0.16 percent in 1996 and 2011, respectively.
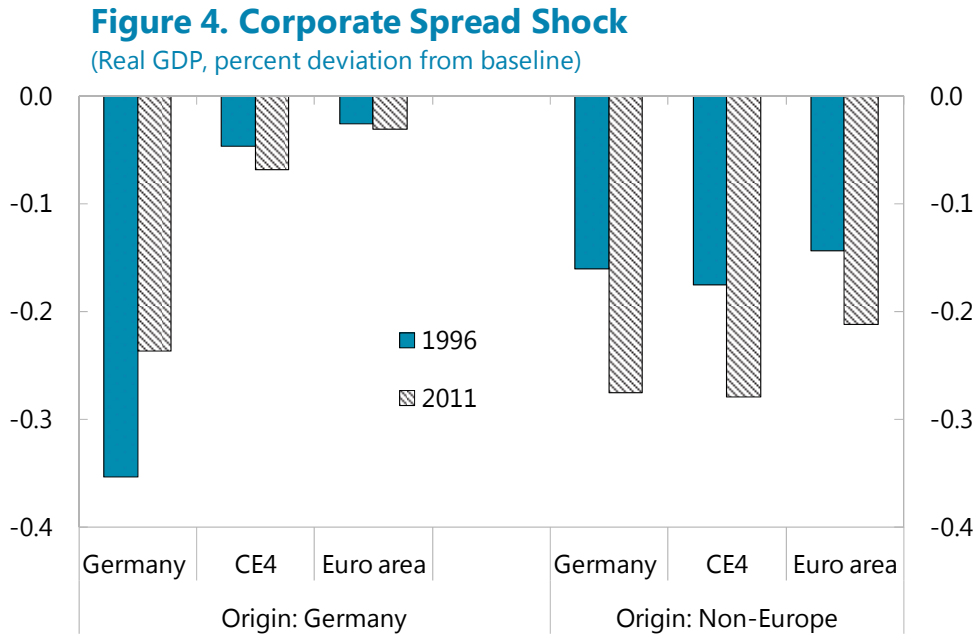
Limited fiscal spillovers stemming from a German stimulus is a key policy implication of this paper. As highlighted above, small fiscal spillovers are explained by the supply chain nature of the regional trade integration: final demand in Germany is not main determinant of CE4 exports to Germany. This finding is in line with other studies, including Ivanova and Weber (2011), and echoes those presented in Coenen and others (2012). As noted in Ivanova and Weber (2011) and underscored here, despite greater regional integration, trade links are weak for countries that are relatively small compared to Germany (for example, Greece, Portugal), while the countries with relatively stronger trade ties (including Italy and Spain) are also the ones that closer to Germany in economic size. However, as before, because the members of GCESC are more open, they are more sensitive to a concerted global fiscal stimulus, that is, a simultaneous increase in government spending by the non-European regions as shown in the right-hand side of the figure.

Financial Shocks

Financial shocks are broadly similar to the aggregate demand shocks discussed above, with the exception that their impacts on real GDP tends to linger. The shock under consideration in Figure 4 is a 100 basis point exogenous increase in the corporate external finance (risk) premium. Higher spreads bring about a contraction in aggregate demand as higher borrowing rates increase the opportunity cost of investment and thereby suppress capital expenditures by firms. In turn, weaker economic activity impairs corporate balance sheets, increases their risk profile and triggers an endogenous increase in the external finance premium. The extent to which this reduces investment depends, in part, on the degree of corporate leverage, and thus determines the strength of the financial accelerator mechanism. While not obvious from the summary bar charts, even though this shock is similar to that to aggregate demand, the effects on GDP are more protracted as the shocks requires an adjustment of corporate balance sheets, that is, a process of deleveraging. Weaker corporate balance sheets—

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[8] The sectoral (that is, traded versus nontraded) composition of government spending in the scenarios has not changed.

owing to higher debt ratios, for example—can amplify shocks by an even greater extent, and for much longer, and therefore even seemingly small shocks can bring about a disproportionate contraction in output.

Figure 4. Corporate Spread Shock
(Real GDP, percent deviation from baseline)

Source: IMF staff calculations.

Summary

The results thus far could be recapped as follows: As a reflection of evolving nature of trade linkages, owing to an important degree to the establishment of the GCESC, spillovers from Germany to the CE4, have increased over time, but are still quite small. The limited fiscal spillovers are explained by the supply chain nature of the regional trade integration: final demand in Germany is not main determinant of CE4 exports to Germany. This result has important policy implications. For example, fiscal stimulus in Germany is likely to have a relatively small impact on the CE4—and more broadly, to the rest of the euro area. Greater trade openness in both Germany and the CE4 implies greater exposure of the GCESC to global shocks.

B.   Spillovers: What if German Balance Sheets Were More Fragile?

The main goal of this subsection is to highlight how German fundamentals can affect spillovers to the supply chain. The question to be addressed is as follows: Along with its central position in the supply chain—in part owing to its safe haven status and robust balance sheets—does Germany act as an anchor of stability by helping the region better cope with external shocks? It will therefore be useful to first take stock of key German fundamentals, including its balance sheets.

The German economy's balance sheets appear to be generally healthy. As a measure of balance sheet soundness—which is certainly not exhaustive or necessarily comprehensive—consider the debt-to-GDP ratio across sectors as shown in Figure 5. The balance sheets of the German non-financial corporate sector and especially households appear robust. At the same time, Germany's safe haven status supports the relative soundness of its public sector balance sheet (Figure 6). In fact, while the debt-to-GDP ratio in Germany increased after the global financial crisis, currently it is still lower than other large European economies. At the same time, the growing and persistent divergence in sovereign spreads between Germany and other economies in the region is noteworthy (and roughly around 500 basis points). This dynamic has been associated with the steep uptrend in household and corporate lending spreads for some large economies in the region (Figure 7), and clearly are a drag on consumption and investment growth.

Figure 5. The Role of Balance Sheets: Debt-to-GDP Ratios Across Sectors
(Percent of GDP)
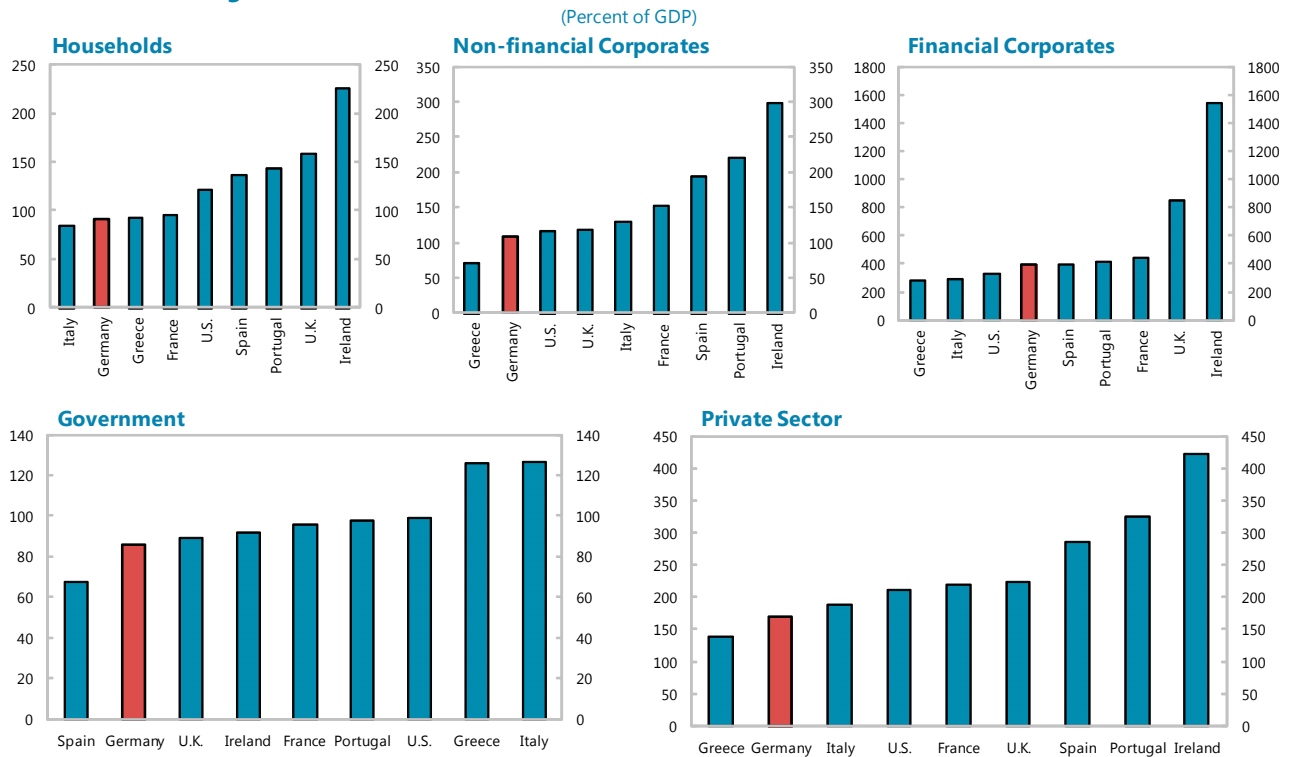
Source: OECD

An illustrative scenario is developed which simulates a German economy with more fragile balance sheets. An alternative calibration of the model is considered with weaker German household, corporate, and sovereign balance sheets. For example, the sovereign debt-to-GDP ratio is increased by 30 percentage points to match the indebtedness of large European economies. Similarly, corporate leverage ratios are also increased to match higher level prevailing in the region. At the same time, the share of liquidity constrained households is also raised to replicate economies with less efficient capital markets (which may reflect heightened financial stress or, for example, overextended household balance sheets). This illustrative scenario also assumes a loss of Germany's safe haven status, implying higher sovereign yields, and an attendant increase in corporate borrowing rates. Specifically, corporate spreads are assumed to increase by about 350 basis points, of which 150 basis points is transitory and 200 basis points more persistent owing to a structurally different economy (which is no longer a safe haven).

Figure 6. Selected European Economies: Sovereign Debt and Yields

Government Debt
(Percent of GDP)

Sovereign Yields
(Long-term government bond yields in percent)
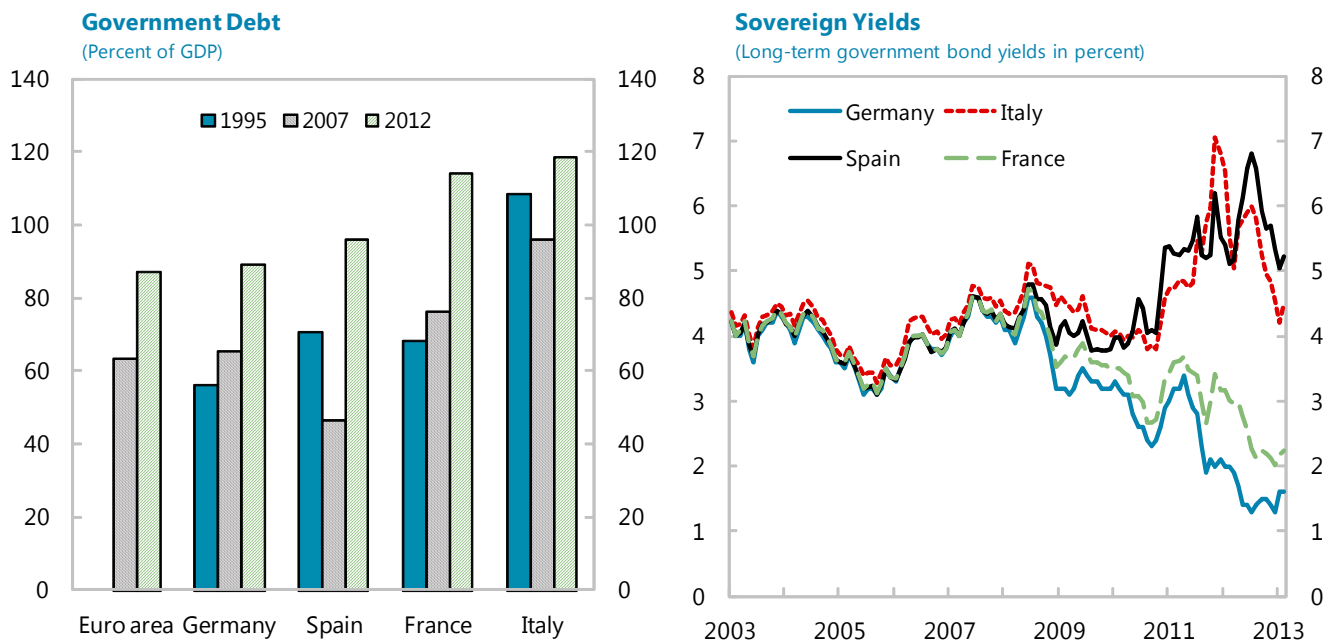
Source: Haver Analytics.

Figure 7. Lending Spreads in Italy and Spain Relative to Germany

Spreads: Loans <1 mil, Maturity 1-5 years
(Percent)

Spreads: Loans >1 mil, Maturity 1-5 years
(Percent)

Spreads: Consumer Loans, Maturity 1-5 years
(Percent)

Spreads: Housing Loans, maturity >10 years
(Percent)
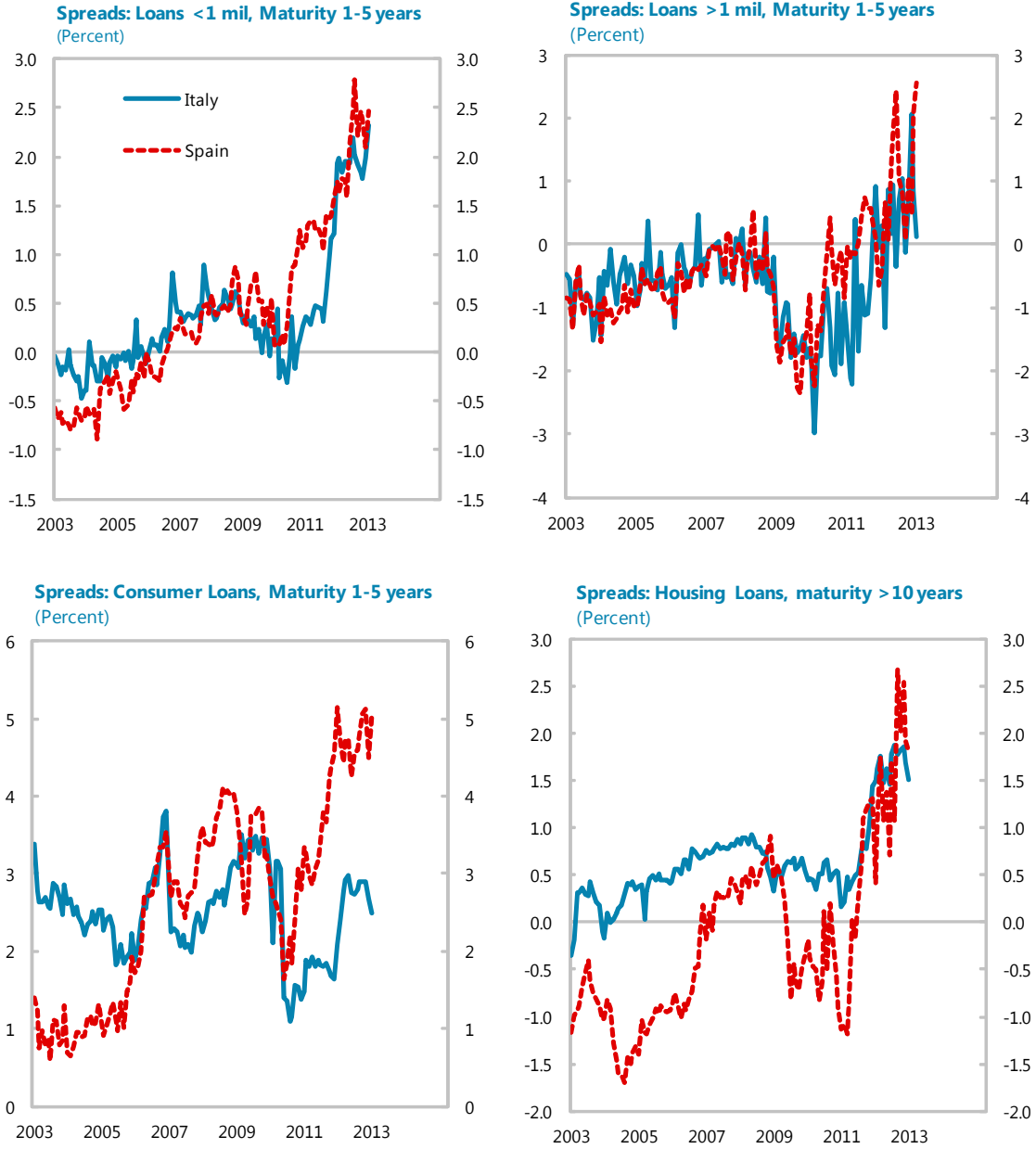
Sources: Haver Analytics; and IMF staff calculations.

The simulations suggest that Germany plays the role of a regional anchor of stability. As before, an aggregate demand shock originating in either Germany or the rest of the world (non-European blocks) is simulated, as shown in Figure 8. The negative impact on real GDP triggered by the domestic shock is much larger when balance sheets are more fragile in Germany. As discussed above, one cause is because of a stronger financial accelerator mechanism. The loss of safe haven status which was assumed to raise sovereign and thereby corporate yields is compounded by higher corporate leverage ratios, making the German economy much more sensitive to shocks, which is further exacerbated by elevated corporate credit spreads (increased external finance premium), a higher stock of government debt, and a greater share of liquidity constrained households. The larger economic contraction in German is also transmitted across borders as evident by more pronounced declines in real GDP in the CE4 and the rest of the euro area.[9] In turn, this wider European slowdown then has feedback effects on the GCESC countries.

Figure 8. Aggregate Demand Shock
(Real GDP, percent deviation from baseline)
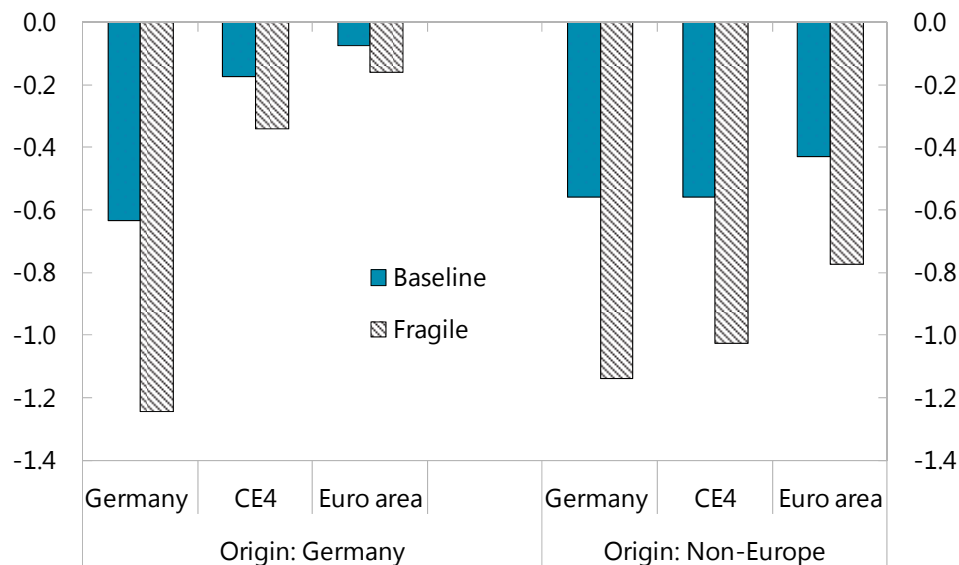
Source: IMF staff calculations.

When German fundamentals are weaker, global shocks are associated with larger regional spillovers. This is because Germany is the largest economy in the euro area, and at the same time, very open to trade. In fact, the German economy is about 30 percent greater than the second largest economy in the euro area, and while Germany's openness is around 98 percent (exports plus imports as a percent of GDP), the average ratio for the next three largest economies (France, Italy, and Spain) is around 60 percent. Therefore, a German economy with

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[9] While not modeled explicitly, shocks could be further amplified owing to confidence effects, thereby further depressing aggregate demand.

more fragile balance sheets is less able to absorb global shocks, and in turn, may actually amplify the transmission of the shocks across borders (especially to its closest trading partners).

These findings are robust to alternative calibrations. While the alternative calibration which underpins the illustrative scenario just discussed is guided by empirical facts, it nonetheless involved an element of judgment. Therefore, the degree of balance sheet fragility in Germany is decreased to assess to sensitivity of this simulation. For example, the temporary increase in corporate spreads is now only 100 basis points, rather than 150 basis points. In the end, the main message here is qualitative rather than quantitative: with weaker balance sheets, the simulated German economy's resilience is compromised.

Figure 9. Robustness: Aggregate Demand Shock
(Real GDP, percent deviation from baseline)
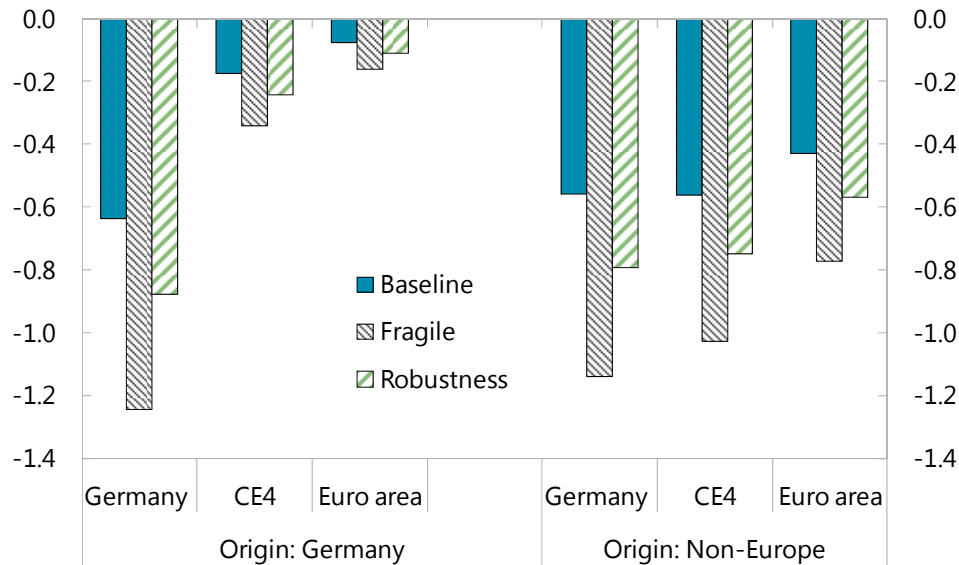
Source: IMF staff calculations.

Summary

These results can be summed up as follows: Germany plays the role of a regional anchor of stability by better absorbing shocks from other trading partners instead of amplifying their transmission across the CE4 and the rest of the euro area, more generally, owing to its sound balance sheets and its safe haven status. At the same time, sound balance sheets have positive benefits domestically and in terms of spillovers.

IV. CONCLUDING REMARKS

This paper investigates aggregate demand and policy spillovers in the context of the GCESC. The GCESC has changed the strength and nature of the trade channel across member countries. Because stronger trade linkages have been built to an important extent through the exchange of intermediate goods, German spillovers to the CE4, while having increased over time, remain fairly limited. This has important policy implications. For example, regarding fiscal policy, this paper finds that German stimulus is likely to have a relatively small impact on the CE4—and more broadly, to the rest of the euro area. This is explained by the supply chain nature of trade integration: final demand in Germany is not necessarily the main determinant of CE4 exports to Germany.

Germany and the CE4 have integrated with the world, as well as with each other. As a result of greater trade openness, Germany and the CE4 are now more exposed to global shocks. However, owing to its strong fundamentals—including sound balance sheets and its safe haven status—Germany plays the role of a regional anchor of stability by better absorbing shocks from other trading partners instead of amplifying their transmission across the GCESC.

More generally, sound balance sheets have positive benefits domestically and in terms of spillovers. With more fragile balance sheets, domestic shocks result in lower growth both at home and abroad. Therefore strengthening household, corporate, and sovereign balance sheets is important for countries and their trading partners—and likely even more so in the context of a supply chain arrangement.

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APPENDIX

This appendix comprises three parts. First, it briefly discusses spillovers associated with supply shocks simulated via higher productivity in a region. Second, it presents the actual impulse response functions triggered by aggregate demand shocks and therefore complements Figure 2 in the main text. Third, and finally, it presents several tables showing the calibrated parameters and the trade matrix in greater detail (thereby complementing Table 1 in the main text).

While simulated productivity shocks are minimally transmitted across borders, Germany generates beneficial medium-term spillovers to the region. As discussed in IMF (2013), in the context of the GCESC, there is evidence that income convergence in these for countries was higher than the average pace. Higher growth in these countries was associated with technology transfers as the rapid expansion of CE4 exports were largely driven by the knowledge-intensive sectors and financed by a relatively greater share of FDI inflows from Germany. However, as shown in the figure below, models like GIMF (which are stationary around stochastic or deterministic trends) find it challenging to capture medium- and longer-term dynamics associated with knowledge transfers and income convergence.

Appendix Figure 1. Persistent Productivity Shock
(Real GDP, percent deviation from baseline)
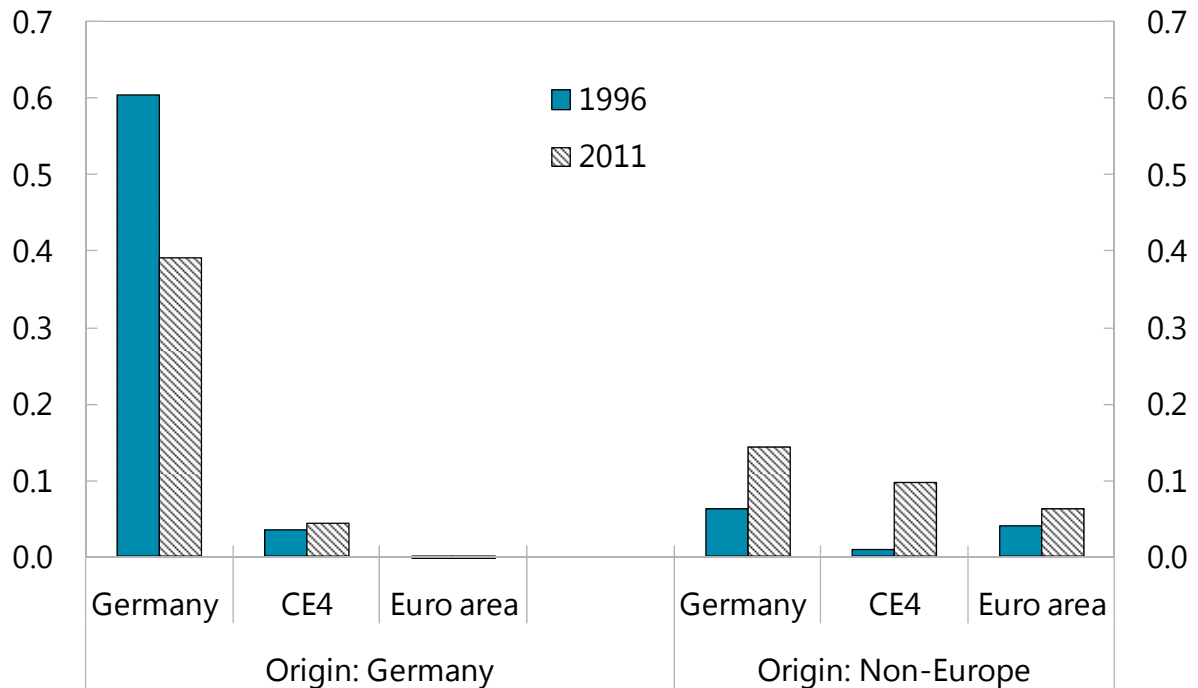
Source: IMF staff calculations.

As discussed in the main text, spillovers characterized by aggregate demand shocks have evolved over time and vary across regions. The peaks on the impulse response functions below were summarized in Figure 2 of the main text. The corresponding impulse response functions of the other shocks are similar (as discussed in main text), and therefore not shown, but available from authors upon request.

Appendix Figure 2. Aggregate Demand Shock
(Real GDP, percent deviation from baseline)
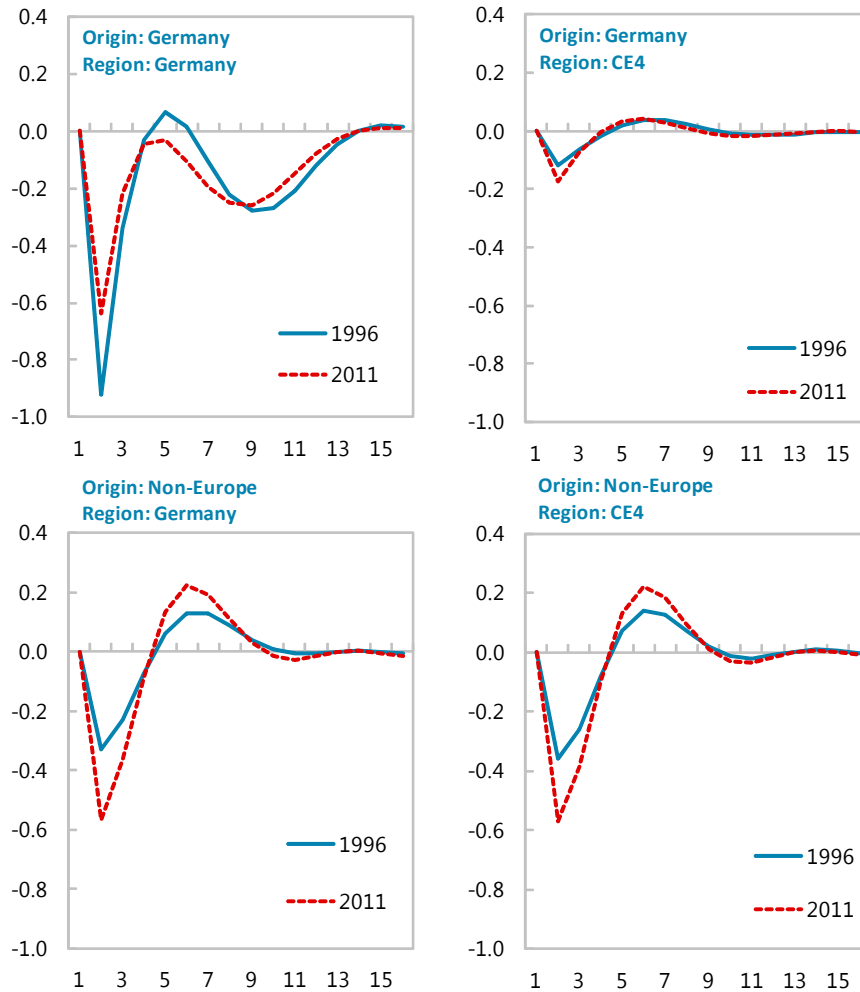
Source: Authors' calculations.

The remain of the appendix presents tables detailing parameter calibration and the specifics of the trade matrix. In what follows, AS, CE, DE, EA, US, and RC, denote Emerging Asia, the CE4, Germany, the euro area excluding Germany, the United States, and remaining countries, respectively.

Appendix Table 1. GIMF Trade Matrix Based on 1996 Data
(Percent of nominal GDP unless otherwise stated)

	AS	CE	EA	DE	RC	US
GDP (Percent of world nominal GDP)	8.4	0.9	15.1	8.0	41.8	25.7
Population Size (Percent of world)	44.8	0.9	2.6	1.2	45.8	4.6
Aggregate Exports	24.9	30.1	18.3	24.3	13.4	11.7
to Emerging Asia	...	1.5	1.4	1.6	2.9	2.0
to Central Europe 4	0.1	...	0.6	1.4	0.2	0.0
to Rest of the Euro Area	2.3	9.0	...	9.9	3.5	1.0
to Germany	1.5	8.4	5.4	...	1.8	0.6
to Remaining Countries	15.8	9.6	8.8	9.7	...	8.1
to United States	5.2	1.6	2.2	1.8	5.0	...
Final Goods	18.0	21.4	13.6	17.8	8.0	7.8
to Emerging Asia	...	1.1	1.0	1.2	1.5	1.1
to Central Europe 4	0.1	...	0.4	0.9	0.1	0.0
to Rest of the Euro Area	1.8	5.9	...	6.9	2.0	0.7
to Germany	1.2	6.0	3.9	...	1.2	0.4
to Remaining Countries	10.9	7.3	6.6	7.4	...	5.5
to United States	4.1	1.1	1.7	1.3	3.2	...
Intermediate Goods	6.8	8.7	4.8	6.5	5.4	3.9
to Emerging Asia	...	0.4	0.4	0.4	1.4	0.9
to Central Europe 4	0.0	...	0.2	0.5	0.1	0.0
to Rest of the Euro Area	0.5	3.2	...	2.9	1.5	0.3
to Germany	0.3	2.4	1.5	...	0.7	0.1
to Remaining Countries	4.9	2.3	2.2	2.3	...	2.5
to United States	1.1	0.5	0.5	0.4	1.8	...
Aggregate Imports	24.9	30.1	18.3	24.3	13.4	11.7
from Emerging Asia	...	0.7	1.3	1.6	3.2	1.7
from Central Europe 4	0.2	...	0.6	1.0	0.2	0.1
from Rest of the Euro Area	2.4	8.8	...	10.2	3.2	1.3
from Germany	1.6	11.9	5.2	...	1.8	0.5
from Remaining Countries	14.6	7.9	9.6	9.7	...	8.1
from United States	6.2	0.8	1.7	1.8	5.0	...
Final Goods	14.0	18.8	11.7	16.9	9.6	8.0
from Emerging Asia	...	0.5	1.0	1.3	2.2	1.3
from Central Europe 4	0.1	...	0.4	0.7	0.2	0.0
from Rest of the Euro Area	1.8	6.3	...	7.3	2.4	1.0
from Germany	1.2	7.7	3.7	...	1.4	0.4
from Remaining Countries	7.4	3.6	5.5	6.2	...	5.2
from United States	3.5	0.6	1.1	1.4	3.4	...
consumption goods	6.7	11.8	7.8	12.1	6.3	5.3
investment goods	7.3	7.0	3.9	4.8	3.3	2.7
Intermediate Goods	10.9	11.3	6.6	7.4	3.8	3.7
from Emerging Asia	...	0.2	0.3	0.3	1.0	0.4
from Central Europe 4	0.0	...	0.2	0.3	0.1	0.0
from Rest of the Euro Area	0.6	2.5	...	2.9	0.8	0.3
from Germany	0.4	4.2	1.6	...	0.4	0.1
from Remaining Countries	7.1	4.3	4.1	3.5	...	2.9
from United States	2.7	0.1	0.5	0.4	1.6	...

Source: Authors' calculations.

Appendix Table 2. GIMF Trade Matrix Based on 2011 Data
(Percent of nominal GDP unless otherwise stated)

	AS	CE	EA	DE	RC	US
GDP (Percent of world nominal GDP)	17.7	1.4	13.5	5.1	40.7	21.6
Population Size (Percent of world)	44.8	0.9	2.6	1.2	45.8	4.6
Aggregate Exports	26.1	52.8	27.0	47.7	19.2	15.7
to Emerging Asia	...	6.7	4.2	5.6	6.6	4.5
to Central Europe 4	0.1	...	1.7	4.5	0.6	0.1
to Rest of the Euro Area	2.0	15.4	...	19.1	4.5	1.3
to Germany	1.5	16.6	7.0	...	2.1	0.7
to Remaining Countries	18.3	13.0	11.7	16.4	...	9.2
to United States	4.2	1.1	2.4	2.1	5.5	...
Final Goods	19.2	38.9	19.3	35.3	8.2	10.2
to Emerging Asia	...	4.5	3.0	3.8	1.6	2.4
to Central Europe 4	0.1	...	1.1	2.8	0.3	0.1
to Rest of the Euro Area	1.5	11.6	...	13.8	2.2	0.9
to Germany	1.1	11.2	4.9	...	1.1	0.5
to Remaining Countries	13.0	10.8	8.6	13.3	...	6.3
to United States	3.5	0.8	1.7	1.6	3.0	...
Intermediate Goods	6.8	13.9	7.7	12.3	11.0	5.5
to Emerging Asia	...	2.1	1.3	1.8	5.0	2.0
to Central Europe 4	0.0	...	0.6	1.6	0.3	0.0
to Rest of the Euro Area	0.4	3.8	...	5.3	2.3	0.4
to Germany	0.4	5.4	2.1	...	1.0	0.2
to Remaining Countries	5.4	2.3	3.1	3.0	...	2.9
to United States	0.7	0.3	0.7	0.5	2.4	...
Aggregate Imports	26.1	52.8	27.0	47.7	19.2	15.7
from Emerging Asia	...	1.9	2.6	5.1	8.0	3.4
from Central Europe 4	0.5	...	1.6	4.5	0.4	0.1
from Rest of the Euro Area	3.2	16.5	...	18.5	3.9	1.5
from Germany	1.6	16.6	7.3	...	2.1	0.5
from Remaining Countries	15.2	16.6	13.5	16.8	...	10.3
from United States	5.5	1.2	2.1	2.8	4.9	...
Final Goods	10.4	33.0	16.5	30.4	13.9	10.1
from Emerging Asia	...	1.5	2.0	3.8	5.6	2.9
from Central Europe 4	0.4	...	1.2	3.0	0.4	0.1
from Rest of the Euro Area	2.3	11.1	...	12.9	2.8	1.1
from Germany	1.1	10.5	5.2	...	1.7	0.4
from Remaining Countries	3.7	9.1	6.6	8.5	...	5.7
from United States	3.0	0.8	1.4	2.2	3.3	...
consumption goods	5.8	21.2	11.7	20.7	9.1	7.3
investment goods	4.6	11.8	4.7	9.7	4.7	2.8
Intermediate Goods	15.7	19.8	10.6	17.3	5.4	5.7
from Emerging Asia	...	0.4	0.6	1.3	2.3	0.5
from Central Europe 4	0.2	...	0.4	1.5	0.1	0.0
from Rest of the Euro Area	1.0	5.4	...	5.6	1.0	0.4
from Germany	0.5	6.1	2.0	...	0.4	0.1
from Remaining Countries	11.5	7.6	6.9	8.3	...	4.6
from United States	2.5	0.3	0.7	0.7	1.5	...

Source: Authors' calculations.

Appendix Table 3. GIMF Macro Variables
(Percent of nominal GDP, unless otherwise stated)

	AS	CE	EA	DE	RC	US
Percent of World Nominal GDP						
1996 GDP	8.42	0.95	15.08	8.00	41.84	25.71
2011 GDP	17.67	1.39	13.50	5.13	40.67	21.64
National Expenditure Accounts						
Consumption	59.5	62.4	57.3	62.3	56.5	67.5
liquidity-constrained	21.6	17.8	10.2	11.2	16.8	11.2
forward-looking	37.8	44.6	47.1	51.1	39.7	56.3
Investment	23.0	16.1	17.6	16.6	19.0	12.4
Government Expenditures	17.6	21.5	25.1	21.1	24.5	20.1
on consumption	12.6	17.5	22.5	19.5	22.0	16.9
on investment	5.0	4.0	2.6	1.6	2.5	3.2
Net Exports	0.0	0.0	0.0	0.0	0.0	0.0
Factor Shares (percent of total)						
Tradables Production						
Capital	53.9	43.5	45.1	44.1	47.2	39.5
Labor	46.1	56.5	54.9	56.0	52.8	60.5
Nontradables Production						
Capital	38.5	26.9	29.0	27.6	31.7	21.7
Labor	61.5	73.1	71.0	72.4	68.3	78.3
Assets and Debt						
Government Debt	35.3	38.7	74.0	55.8	23.0	80.2
government deficit	1.6	1.7	3.3	2.5	1.0	3.9
Corporate Debt	94.1	65.9	72.0	67.9	77.7	50.7
tradables	45.4	34.2	36.7	35.0	38.7	27.8
nontradables	48.7	31.7	35.3	32.9	39.0	22.9
Capital Stock	183.5	128.5	140.5	132.5	151.6	99.0
investment	23.0	16.1	17.6	16.6	19.0	12.4
Total Wealth	791.9	906.7	994.4	1039.2	793.4	1035.3
private saving	24.6	17.8	20.9	19.1	20.0	16.3
financial wealth	130.1	105.1	146.7	124.3	101.2	131.6
human wealth	661.9	801.6	847.7	914.8	692.1	903.8
dividends	366.9	523.5	500.1	585.7	347.7	488.0
permanent income	295.0	278.1	347.6	329.1	344.4	415.8
Interest Rates (Levels in percent)						
Nominal Short-Term (INT)	5.0	5.0	5.0	5.0	5.0	5.5
Real Short-Term (RR)	3.0	3.0	3.0	3.0	3.0	3.0
Fiscal Sector						
Government Spending	25.5	20.2	39.6	38.9	30.9	24.8
Gov't Consumption	12.6	17.5	22.5	19.5	22.0	16.9
Gov't Investment	5.0	4.0	2.6	1.6	2.5	3.2
Transfers	8.0	-1.3	14.5	17.8	6.4	4.7
Tax Revenue	25.7	20.4	40.0	39.2	31.0	25.2
Labor	6.0	22.3	22.3	24.3	13.3	14.9
Corporate	3.5	2.2	2.2	2.2	3.5	2.7
Consumption	9.9	11.0	11.0	10.8	9.4	4.3
Lumpsum	6.3	-15.1	4.5	1.9	4.8	3.3

Source: Authors' calculations.

Appendix Table 4. GIMF Parameters

(Levels)

	AS	CE	EA	DE	RC	US
Elasticities of Substitution in Utility						
Intertemporal	0.5	0.5	0.5	0.5	0.5	0.5
Leisure and Consumption	0.81	0.84	0.82	0.84	0.79	0.80
Elasticity of Labor Supply	0.5	0.5	0.5	0.5	0.5	0.5
Other Structural Parameters						
Habit persistence	0.4	0.4	0.4	0.4	0.4	0.4
Probability of Survival	0.95	0.95	0.95	0.95	0.95	0.95
Income Decline Rate	0.95	0.95	0.95	0.95	0.95	0.95
Marginal Propensity to Consume	0.05	0.05	0.05	0.05	0.05	0.05
Capital Depreciation	0.1	0.1	0.1	0.1	0.1	0.1
Share of LIQ Households	0.5	0.4	0.25	0.25	0.4	0.25
Financial Accelerator						
Borrower riskiness (both sectors)	0.45	0.45	0.45	0.45	0.45	0.45
Cost of bankruptcy (both sectors)	0.36	0.36	0.36	0.36	0.36	0.36
Markups on Prices (in percent)						
Tradables and ntradables	20	20	20	20	20	20
Real Wages	10	10	10	10	10	10
Imports	2.5	2.5	2.5	2.5	2.5	2.5
All others	5	5	5	5	5	5
Elasticities of Substitution						
Home versus Foreign	1.5	1.5	1.5	1.5	1.5	1.5
Among Foreign	1.5	1.5	1.5	1.5	1.5	1.5
Tradable/Nontradable	0.5	0.5	0.5	0.5	0.5	0.5
Home Bias						
Consumption	0.767	0.750	0.917	0.876	0.839	0.964
Investment	0.544	0.621	0.903	0.868	0.815	0.935
Intermediate	0.525	0.632	0.890	0.871	0.825	0.953
Nominal Adjustment Costs						
Price of Imports	3.2	3.2	16.0	16.0	3.2	32.0
All other prices	32.0	48.0	48.0	48.0	32.0	32.0
Real Adjustment Costs						
OLG Consumption	2	2	2	2	2	2
All others	1	1	1	1	1	1
Policy Rules						
Monetary: weight on the						
lagged interest rate	0.30	1.00	0.30	1.00	0.30	0.30
inflation gap	1.00	0.00	1.50	0.00	1.00	1.00
weight on inflation:						
contemporaneous	0.25	0.25	0.25	0.25	0.25	0.25
1 period ahead	0.75	0.75	0.75	0.75	0.75	0.75
nom. exchange rate target	0.00	100000	0.00	100000	0.00	0.00
Fiscal: weight on the						
output gap	0.25	0.42	0.48	0.51	0.30	0.34

Source: Authors' calculations.