



# ENHANCING SURVEILLANCE: INTERCONNECTEDNESS AND CLUSTERS— BACKGROUND PAPER

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## I. HOW DO GLOBAL LINKAGES AFFECT THE VOLATILITY AND SYNCHRONIZATION OF BUSINESS CYCLES <sup>1</sup>

*This note provides an overview of the theoretical and empirical literature on the implications of greater trade and financial integration for the volatility and synchronization of business cycles. Theoretical models offer varying predictions depending on the extent and nature of integration (e.g., inter- vs. intra-industry trade), types of shocks (e.g., industry-level vs. common shocks), and the levels of economic and financial development (e.g., the ability to diversify risk). Empirical research reports no systematic relationship between the intensity of trade and financial linkages and output volatility. Most empirical studies suggest that trade integration has a positive impact on synchronization, but the role of financial integration remains debated.*

### A. Theoretical Implications

1. **Varied effects.** Theoretical models have different implications about how global integration should affect volatility of output and other macroeconomic aggregates. The same is true for co-movement of different macro variables. We review the literature on each of these separately.

#### ***Volatility and Synchronization of Output in Theory***

2. **Context matters.** There is no consistent theoretical prediction across different models about how trade and financial linkages affect output volatility (Hirata, Kose, and Otrok, 2012). The effects of trade and financial integration depend, in different models, on the level of development, the nature of shocks, and the pattern of specialization.

3. **Trade integration.** International trade linkages generate both demand and supply-side spillovers across countries, which can increase the degree of business cycle co-movement. For example, on the demand side, an investment or consumption boom in one country can generate increased demand for imports, boosting economies abroad. On the supply side, a positive shock to output in tradable goods leads to lower prices; hence, imported inputs for other countries become cheaper.

4. **Impact of specialization.** Both classical and “new” trade theories imply that increased trade linkages lead to increased specialization. How does increased specialization affect the degree of co-movement? The answer depends on the nature of specialization (intra- vs. inter-industry) and the types of shocks (common vs. country-specific). If stronger trade linkages are associated with increased inter-industry specialization across countries, then the impact of increased trade depends on the nature of shocks. If industry-specific shocks are more important in driving business cycles, then co-movement is expected to decrease (Krugman, 1993). If common shocks, which might be

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<sup>1</sup> Prepared by Ayhan Kose (RES).

associated with changes in demand and/or supply conditions, are more dominant than industry-specific shocks, then this would lead to a higher degree of business cycle co-movement (Frankel and Rose, 1998).

5. **Financial integration.** The effects of financial integration on cross-country correlations of output growth are also ambiguous in theory. Financial integration could reduce cross-country output correlations by stimulating specialization of production through the reallocation of capital in a manner consistent with countries' comparative advantage. However, financial linkages could result in a higher degree of business cycle synchronization by generating large demand-side effects as the changes in equity prices affect the dynamics of wealth. Furthermore, contagion effects that are transmitted through financial linkages could also result in heightened cross-country spillovers of macroeconomic fluctuations (Claessens and Forbes, 2001).

6. **Diversification and risk sharing.** Financial integration allows relatively capital-poor emerging market economies (EMs) and other developing economies (ODEs) to diversify away from their narrow production bases, thereby reducing their output volatility. At a more advanced stage of development, however, trade and financial flows could allow for enhanced specialization (Imbs and Wacziarg, 2003). This could make advanced countries and EMs more vulnerable to industry-specific shocks and thereby could lead to higher output volatility (see Kalemli-Ozcan, Sørensen, and Yosha, 2003). That leaves open the question of whether financial integration promotes better risk sharing across countries, which we discuss next.

### ***Consumption Risk-Sharing in Theory***

7. **Consumption smoothing.** Basic theory has the strong prediction that, because financial integration should help countries diversify away country-specific shocks, it should result in more stable consumption patterns and stronger co-movement of consumption growth across countries. Since consumers and, by extension, economies are risk-averse, basic theoretical models predict that consumers should desire to use international financial markets to insure against income risk, thereby smoothing the effects of temporary idiosyncratic fluctuations in income on consumption. In particular, if output fluctuations are not perfectly correlated across countries, in a world with complete markets trade in financial assets can be used to delink national consumption levels from the country-specific components of output fluctuations. In turn, this should make consumption growth less volatile relative to income growth. And from a cross-country and time series perspective, increasing financial linkages should lead to lower and declining relative volatility of consumption growth (Lewis, 1999).

8. **Model-specific features matter.** While the benefits of international risk-sharing could be quite large, the magnitudes do depend on various model-specific features. In particular, the welfare gains in these models depend on the volatility of output shocks, the rate of relative risk aversion, the risk-adjusted growth rate and the risk free interest rate. These benefits are expected to be greater for EMs and ODEs as they are intrinsically subject to higher volatility because their production structures are less diversified than those of advanced economies. Recent research suggests that EMs

and ODEs can indeed reap large benefits from international risk-sharing arrangements (Prasad et al., 2003).

## B. Empirical Evidence

We organize our review of the empirical literature in parallel with our survey of the theoretical literature.

### ***Business Cycle Synchronization***

9. **Impact of integration.** Recent empirical studies are in general unable to provide a concrete explanation for the impact of stronger global linkages on the co-movement of business cycles. Some of these empirical studies employ cross-country or cross-region panel regressions to assess the role of global linkages on the co-movement properties of business cycles in advanced countries (Kose and Yi, 2006). While Imbs (2004) finds that the extent of financial linkages, sectoral similarity, and the volume of intra-industry trade all have a positive impact on business cycle correlations, Baxter and Kouparitsas (2005) document that international trade is the most important transmission channel for business cycle fluctuations. The results of Kose, Prasad, and Terrones (2003b) suggest that both trade and financial linkages have a positive impact on cross-country output and consumption correlations.

10. **Diverse conclusions.** Empirical studies do not provide a definite answer on how co-movement varies in response to changes in the volume of trade and financial flows. Findings on the temporal evolution of business cycle synchronization in response to increases in financial integration are diverse. Differences in country coverage, sample periods, aggregation methods used to create country groups, and econometric methods employed seem to contribute to these varying conclusions. Some studies find evidence of declining output correlations among advanced economies over the last three decades (Heathcote and Perri, 2004; Stock and Watson, 2003).

11. **Stronger links.** However, other studies document that business cycle linkages have become stronger over time. Kose, Otrok, and Whiteman (2008), employing a Bayesian dynamic factor model, find that for advanced countries business cycle correlations on average have risen since 1960. Using a longer sample of annual data (1880–2008), Bordo and Helbling (2011) also document that the degree of synchronization among advanced countries has increased over time. The evidence for a European business cycle and increasing business cycle co-movement in the EU area has also been mixed. For instance, Artis, Krolzig, and Toro (2004) find evidence of a European business cycle while Canova, Ciccarelli, and Ortega (2007) argue that, since the 1990s, there is no evidence of a specific European cycle (Hirata, Kose, and Otrok, 2011).

12. **AMs and EMs.** There has been a recent debate about the temporal evolution of the degree of synchronization of business cycles in advanced economies and emerging market countries. This debate focuses on the ability of EMs, especially emerging countries in the Asia-Pacific region, to decouple from a potential slowdown in the United States (Helbling et al., 2007; Kose and Prasad,

2010). Although there are many studies analyzing the decoupling potential of emerging economies using various methodologies, their results have not been conclusive so far.

13. **The case against decoupling.** Some studies employ simple correlations to make a case against the decoupling potential of emerging markets. For example, Flood and Rose (2009) use GDP data for 64 countries over the period 1974–2007. After de-trending these series using various filters, they analyze rolling-window correlations across advanced countries and developing economies and conclude that, while the average level of cross-correlations changes over time, there is no strong evidence that these correlations have become statistically significantly lower in the later parts of their sample. In a related study, Walti (2009) reports that the extent of co-movement of cycles across advanced countries and EMs has not changed much since the early 1980s.

14. **The case for decoupling.** Other studies provide evidence supporting the possibility of decoupling of business cycles in emerging markets from those in advanced countries. For example, Kose, Otrok, and Prasad (2012) examine the sources of macroeconomic fluctuations in the advanced and emerging market countries using dynamic factor models and the series of output, consumption, and investment for the 1960–2008 period. Their findings indicate that there has been a substantial convergence of business cycles among advanced economies and among emerging markets over time, but there has also been a concomitant divergence of business cycles *between* these two groups of countries. Mumtaz, Simonelli, and Surico (2011) also employ a dynamic factor model and report findings confirming the decoupling of business cycles using data for a group of 36 countries over a 75-year period. Other studies also provide support for the decoupling hypothesis (Dooley and Hutchison, 2009; Rossi, 2009; Fidrmuc and Korhonen, 2010).

### ***Volatility of Output and Consumption***

15. **No systematic empirical relationship.** Existing evidence, using a variety of regression models with different country samples and time periods, reports no systematic empirical relationship between the intensity of trade and financial linkages and output volatility. Some studies report that the ratio of consumption growth volatility to income growth volatility actually increased during the recent period of globalization for emerging market economies (Kose, Prasad, and Terrones, 2003b). Importantly, they find that the volatility of consumption rose (perhaps because of crises experienced by some of these economies) by *more* than income volatility did. This result runs counter to the theoretical prediction that financial integration allows countries to share income risk and smooth consumption. These authors also report that increasing financial integration is associated with rising relative volatility of consumption, albeit only up to a threshold. Beyond a certain level of financial integration, an increase in integration actually reduces the relative volatility of consumption.

16. **Ambiguous evidence.** Other studies, such as Bekaert, Harvey, and Lundblad (2006), find that, following equity market liberalizations, there is an outright decline in consumption volatility. Using both micro and macro datasets, Kalemli-Ozcan, Sorenson, and Volosovych (2010) examine the links between “deep” financial integration, a concept based on the idea of foreign ownership, and



business cycle volatility. They report that there is a positive association between foreign ownership and the volatility of a firm's various outcomes, a result that extends to aggregate data as well. Differences across these studies could arise from variations in the definitions of financial integration, the measures of consumption volatility, data samples, and methodologies. Nevertheless, the evidence so far is ambiguous.

17. **EMs.** Why have financial flows been associated with an increase in the relative volatility of consumption in emerging market economies? One explanation is that positive productivity and output growth shocks in these countries led to consumption booms that were willingly financed by international investors. These consumption booms were accentuated by the domestic financial liberalization that many of these countries undertook at the same time that they opened up to international financial flows, thereby loosening financing constraints at both the individual and national levels. When negative shocks hit these economies, however, they rapidly lost access to international financial markets, depressing consumption. Consistent with this, a growing literature suggests that the procyclical nature of capital flows explains the adverse impact of international financial integration on consumption volatility in these economies. One manifestation of this procyclicality is the phenomenon of "sudden stops" of capital inflows (Calvo and Reinhart, 1999).

### ***Consumption and Income Risk-Sharing***

18. **International consumption risk sharing.** There is a rich empirical literature directly studying various dimensions of international consumption risk sharing, also in response to changes in financial integration. This literature may be divided into three categories.

- The first category includes studies focusing on the patterns of international correlations to determine the degree of consumption risk sharing (Kose, Prasad, and Terrones, 2003a, 2009; Ambler, Cardia, and Zimmermann, 2004). The results of these studies indicate that the theoretical predictions regarding perfect risk sharing do not have much empirical support for three reasons (Backus, Kehoe, and Kydland, 1992). First, empirical studies indicate that the correlations between the consumption paths of various countries are relatively low. Second, consumption correlations are lower than those of output. Third, correlations between consumption and domestic output are generally higher than those between consumption and world output.
- The second category tests more formally the hypothesis of perfect risk sharing with the help of regression models. In addition to the basic stylized facts reviewed above, researchers have employed more rigorous methods to test the risk sharing implications of models with financial integration. These tests generally use some versions of reduced form solutions (or first order conditions) of models and focus on the links between various measures of domestic consumption and world consumption (Cochrane, 1991; and Mace, 1991). For example, Lewis (1996) finds that the hypothesis of risk sharing is rejected for countries with few or limited capital controls. Relative to these countries, the correlations between domestic consumption and

output are higher for countries with more restrictions, which suggests less risk sharing by countries in the latter group.

- The third category of studies employs various regression models to measure the extent of risk-sharing and the impact of financial flows on the degree of risk sharing. For example, Sørensen, Yosha, Wu, and Zhu (2007) analyze the relationship between home bias and international risk sharing. They document that the extent of international risk sharing has risen during the late 1990s, while home bias in debt and equity holdings has declined in advanced countries.

19. **Modest degree of international risk sharing.** However, Kose, Prasad, and Terrones (2009), using a variety of empirical techniques, conclude that there is at best a modest degree of international risk sharing, and certainly nowhere near the levels predicted by theory. In addition, only advanced countries have attained better risk sharing outcomes during the recent period of globalization, with developing countries, by and large, shut out of this benefit. Even EMs, which have witnessed large increases in cross-border capital flows, have seen little change in their ability to share risk (Giannone and Reichlin, 2006; Moser, Pointner, and Scharler, 2004). The composition of flows appears to be an important factor behind the modest degree of risk sharing in EMs, as portfolio debt—the dominant form of capital inflows to these economies—does not seem to be conducive to risk sharing.

20. **Inconclusive findings.** Although the implications of financial integration for business cycle volatility and co-movement have substantial implications for stability and welfare, the existing theoretical studies and empirical evidence are thus far inconclusive on this issue. In particular, financial integration does not always reduce the amplitude of business and financial cycles, and may actually increase it. While risk-sharing benefits of integration are apparent in theory, it is hard to find conclusive empirical evidence in support of these benefits. Why is it so difficult to obtain sharp results about the implications of financial integration for volatility and co-movement? One potential reason could be the changes in the nature of shocks as cross-border linkages become more intensive, which we discuss next.

### C. Changing Nature of Shocks and Linkages

21. **Integration and shocks.** Increased integration could also affect the dynamics of co-movement by changing the nature and frequency of shocks.

- First, stronger trade and financial linkages may necessitate and lead to a higher degree of policy coordination which, in turn, raises the correlations between shocks associated with nation-specific fiscal and/or monetary policies. This could have a positive impact on the degree of business cycle synchronization (Darvas, Rose, and Szapary, 2005; Flood and Rose, 2009).
- Second, shocks pertaining to changes in productivity could become more correlated, if rising trade and financial integration leads to an increase in knowledge and productivity spillovers across countries (Kose, Prasad, and Terrones, 2009). More financially integrated economies are

able to attract relatively large foreign direct investment flows, which have the potential to generate productivity spillovers.

- Third, increased financial integration and developments in communication technologies lead to faster dissemination of news shocks in financial markets. This could have a positive impact on the degree of business cycle synchronization if, for example, good news about the future of the domestic economy would increase domestic consumption through its impact on wealth, and if consumers in other countries, who hold stocks in the domestic country, raise demand for goods in their countries.

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## II. BUSINESS CYCLE SYNCHRONICITY—A MULTI DIMENSIONAL SCALING APPROACH<sup>1</sup>

*Against the backdrop of theory and empirics that to date have found no unambiguous link between interconnectedness and output synchronization, this note provides some simple stylized facts on output synchronization across groups of countries. It does so utilizing a technique known as multidimensional scaling (MDS) to map business cycle synchronicity across countries. Such maps can highlight cases where there may be tensions between the synchronicity of business cycles and macroeconomic policies (e.g., for those in monetary unions). They also draw attention to countries whose business cycles may be highly synchronized but that may not belong to an easily identifiable region. Finally, MDS mapping can help visualize how the synchronicity of business cycles has changed over time to detect whether some countries have become more or less integrated with others in a group of interest.*

### A. Introduction

1. **An economic, not geographic, map.** This note utilizes multidimensional scaling to construct a business cycle synchronicity map. A business cycle synchronicity map is a visual representation of real GDP growth correlations among a group of countries. Countries whose business cycles are more correlated (synchronous) will be located closer to each other on the map and less correlated countries will be located further away. Thus, economic relations, rather than geographic distance, determine countries' proximity to each other.
2. **Advantages.** The non-metric multidimensional scaling (MDS) is an example of an ordination technique, a class of statistical methods designed to order objects such that similar objects are ordered closer to each other. Other examples of ordination techniques include principal components analysis and correspondence analysis. Some previous examples of the use of MDS include Mar-Molinero and Serrano-Cinca (2001) to model bank failure, and, most relevant for the purposes of this note, Camacho et al. (2006) to study the existence of the European business cycle. One advantage of the MDS methodology is that it requires limited assumptions on the underlying data, which makes the analysis reasonably robust to alternative assumptions. The method aims to provide a visualization for a set of high-dimensional data by giving each data point a location in a two or three-dimensional map.

### B. Methodology

3. **Growth correlations.** We use the correlation of annual GDP growth rates as a measure of synchronicity of business cycles. The MDS algorithm begins by constructing an  $N$  by  $N$  distance matrix, where  $N$  is the number of countries in the analysis. To obtain a global picture, the analysis here focuses on two country groups: the largest 100 and 140 economies (see Figures 1 and 2). This matrix contains *dissimilarity* measures, i.e., measures of how dissimilar are the business cycles

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<sup>1</sup> Prepared by Philip Liu and Sergejs Saksonovs (SPR).

between two countries. We define the dissimilarity measure as *one minus the correlation coefficient of two series of real GDP growth*, over the sample period 1995–2010.<sup>2</sup>

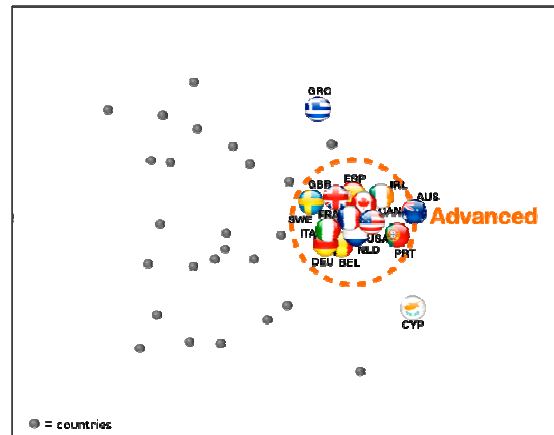
4. **Projecting to 2-D.** The MDS algorithm optimally reduces the N-by-N synchronicity matrix into an N-by-2 matrix of coordinates such that the relative distances between them most accurately represent the relative synchronicity of business cycles. We choose a two-dimensional representation because it is easiest to interpret visually. Starting from an initial (possibly random) arrangement of the countries, the algorithm then regresses the actual dissimilarities on the distances in the two-dimensional map and *minimizes the sum of squared differences between dissimilarities and the distances predicted by the regression* (known as stress). The ideal solution would yield a regression with a perfect fit that is a two-dimensional map, which accurately represents the distances of the original matrix of dissimilarities. In practice, the ideal solution is not obtainable, but one can characterize the goodness of the approximation using the stress number. The MDS algorithm can be easily implemented using Matlab’s Statistics Toolbox or other statistical software.

### C. Results and Policy Implications

5. **Clusters of correlated economies.** Global business cycle synchronicity maps reveal interesting intra and inter-regional clusters. Figures 1 and 2 show, respectively, business cycle synchronicity maps for the 100 and 140 largest economies. The results are also robust to an alternative method of representing dissimilarities between countries known as t-Distributed Stochastic Neighbor Embedding. A few interesting observations arise from the analysis:

- **Advanced economies.** The core advanced economies (AE), EU countries, the U.S., the U.K., and Canada, form a tight cluster. While Ireland and Portugal are situated close to the advanced economy core, Greece is further away from its euro area neighbors than some non-euro area countries. This illustrates the persistently asynchronous business cycles among certain euro area members despite common exchange rate and monetary policy. *Such tensions between policy actions and macroeconomic fundamentals as shown for the case of Greece could serve as useful warning signal in Fund surveillance.*

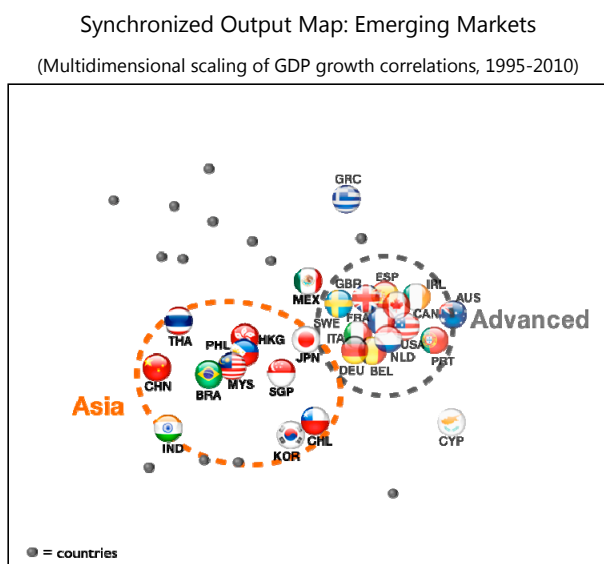
Synchronized Output Map: Advanced Economies  
(Multidimensional scaling of GDP growth correlations, 1995-2010)



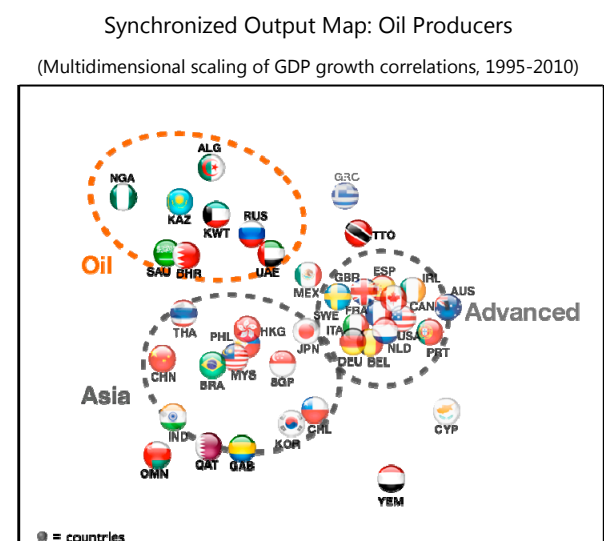
<sup>2</sup> Note that insignificant correlations are also included in calculating the distance matrix. The standard error of a correlation coefficient is a function of the number of observations and the magnitude of the coefficient itself. Lower correlations are more likely to be “insignificant”. Thus, that the further away countries are on the map, the more tenuous the relationship between them. Nevertheless we keep the actual values of the correlations so that proportionate distances between other countries with significant correlation coefficients are reflected adequately.

- East Asia.** Separately, East Asian supply chain countries (Hong Kong SAR, Philippines, Malaysia, Taiwan, Province of China, Korea, Singapore, Vietnam, and Japan) are situated between China and the AE core, but they themselves do not form a tight cluster like the AE core. This illustrates that *surveillance needs to take into account a variety of countries as possible sources of growth shocks, while at the same time convergence among Asian emerging markets is not nearly as significant as among the advanced economies.*

- Latin American EMs.** It is notable that most of the large Latin American EMs (except Mexico) are situated closer to the Asian EM cluster than to the AE core. This possibly *reflects increased importance of commodity trade with China, the precise composition and extent of which may merit further exploration.* It also sheds light on the stylized facts on AE and EM business cycle synchronicity as outlined in Note I. While AE business cycle synchronization has been close, EMs' cycles have been somewhat less synchronized than AEs, although more synchronized with each other. This could be for a variety of factors, as discussed in Note I.



- Commodity exporters.** For the oil producers, there is some weak clustering around Saudi Arabia. However, the majority of oil producers are fairly scattered around the AE and Asian/Latin American cluster. This highlights two interesting observations. First, while most of the oil producing countries face similar terms of trade shocks and have a common exchange rate policy that is pegged to the U.S. dollar, the map illustrates *their business cycles are not that similar, suggesting another instance of tension between policy and fundamentals to be further explored in surveillance.* Second, we also see that most of the oil producers are situated closer to the large Asian EMs (China and India) than the AE core, *suggesting the former's increasing importance as a source of demand.*





- **Low income countries (LICs).** Finally, there is no observable clustering among LICs, which reflects the importance of idiosyncratic shocks (political cycle and weather pattern, etc.) to these countries business cycles.

## D. An Application to Common Currency Areas

6. **Euro Area.** Since euro adoption, business cycles within the Euro Area (EA) have become largely synchronized, around a core comprising Germany, France, Italy, and some northern European countries (see Figure 3, upper panels). However, peripheral countries such as Greece, Ireland, Portugal, and Spain have remained located well outside that EA core in terms of business cycle synchronicity and unit labor cost convergence. Recent entrants into the European Union have also moved closer to the Euro Area, reflecting increased trading ties.

- **Structural fissures through the EA core.** Despite largely convergent macroeconomic policies, close trade and financial links, structural fissures run right through the EA core. On some measures, such as unit labor costs, France and Italy are far removed from Germany (see Figure 3, lower LHS panel). On current account balances, Germany forms one group with Austria and the Netherlands, while Belgium, Italy, and France join Greece, Ireland, Portugal, and Spain to form another (see Figure 3, lower RHS panel). The split in current account dynamics reflects the divergence in the countries' national saving-investment balance and this reveals deeper structural differences among core EA countries.

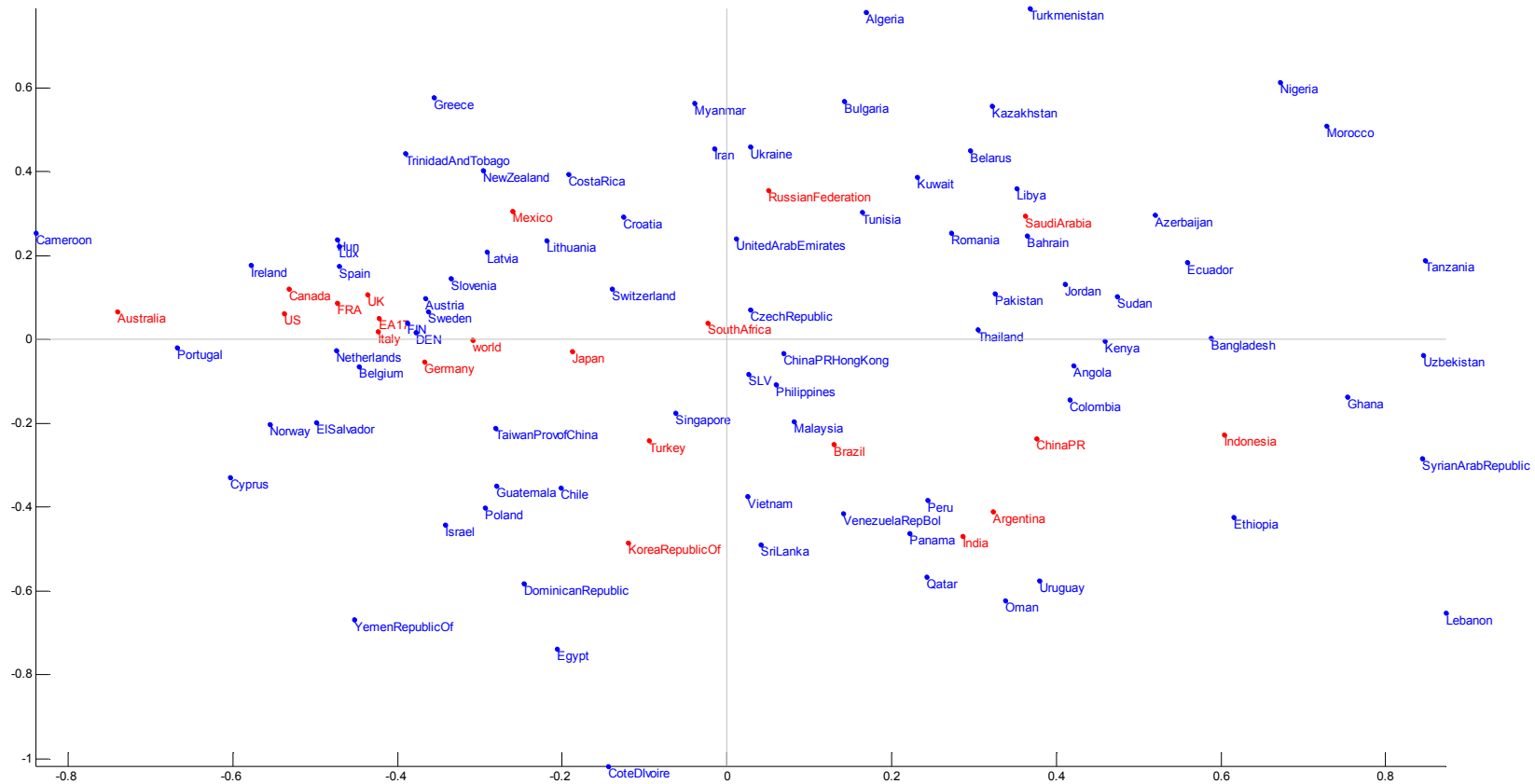
7. **West and Central African Monetary Union.** The synchronicity map of West and Central African Monetary Union (which also have a fixed exchange rate between each other) shows that West African Monetary Union is slightly more homogeneous (see Figure 4). Note that the map is centered on the World real GDP series to analyze not only how close the countries are relative to each other, but also how they relate to the world business cycle. It is notable how the Central African Monetary Union splits up into two sub-clusters which are relatively distant from each other. Such patterns may merit further exploration in surveillance activities, as they call attention to possibly divergent macroeconomic outcomes against the backdrop of a common exchange rate policy.

8. **Eastern Caribbean Union.** The synchronicity map for Eastern Caribbean Union shows that the correlations between the member countries have increased considerably in the last 5 years, presumably due to the economic crisis (see Figure 5). In the earlier map in particular, there again seem to be two sub-clusters rather than one. Surveillance can further delve into the implications of such patterns, including the roles of natural disasters, fiscal space, and differences in income.

## References

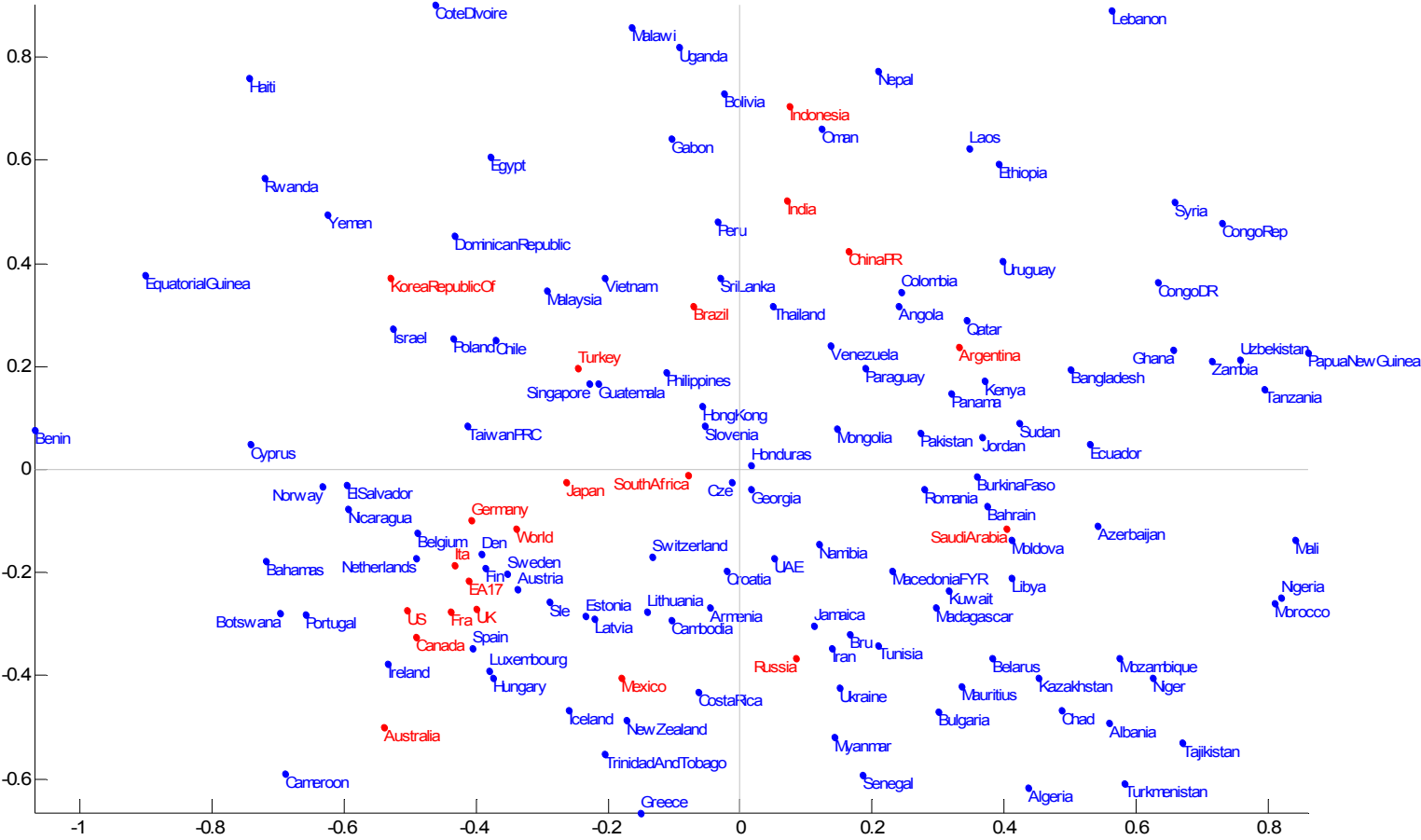
- Camacho, Maximo, Perez-Quiros, Gabriel., Saiz, Lorena (2006). "Are European Business Cycles Close Enough to be Just One?". *Journal of European Dynamics and Control*, Vol. 30, pp. 1687–1706
- Mar-Molinero, Cecilio., Serrano-Cinca, Carlos (2001), "Bank Failure: A Multidimensional scaling Approach". *European Journal of Finance*, Vol. 7, pp. 165–183.

Figure 1: Map of Business Cycle Synchronicity Using Multi-Dimensional Scaling (MDS) (1995-2010) 1/  
(Red dots denote G20 countries)



1/ Countries that are located closer together on the map have a higher degree of synchronization. Some country names have been shortened to improve readability of the chart.

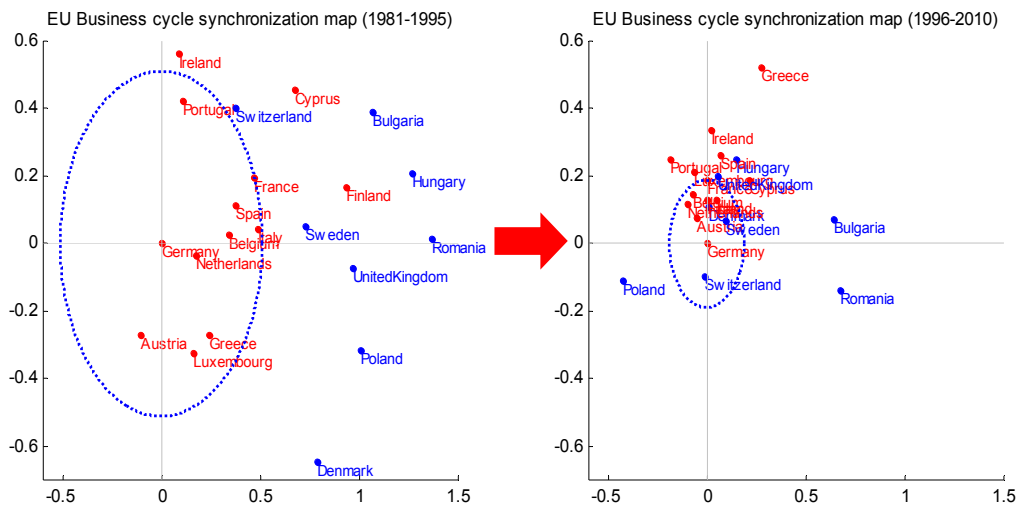
Figure 2: Map of Business Cycle Synchronicity Using MDS for 140 Countries (1995–2010) 1/  
 (Red dots denote G20 countries)



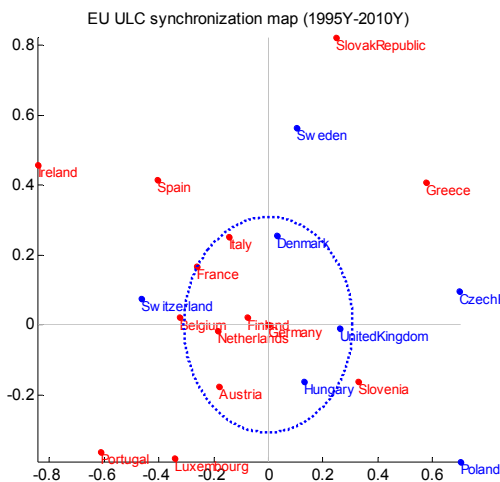
1/ Countries that are located closer together on the map have a higher degree of synchronization.

Figure 3. European Business Cycles Synchronization and Macro-imbalances

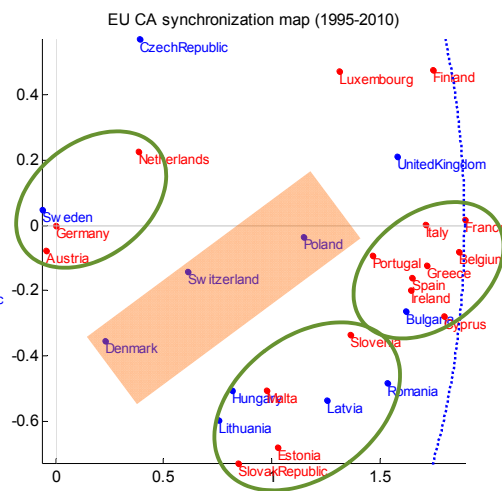
Since the adoption of the Euro, European business cycles have moved closer centered around Germany, while peripheral countries remained outside the EA core.



At the same time, unit labor costs in peripheral countries have not converged to the EA core.



...and divergence in current account dynamics within the EU suggests that structural imbalances remain deep.



Source: WEO and Staff calculations.

1/ The synchronization maps are computed based on the MDS method, where countries that are located closer together on the map have a higher degree of synchronization.

Figure 4. West (blue) and Central African Monetary (red) Union

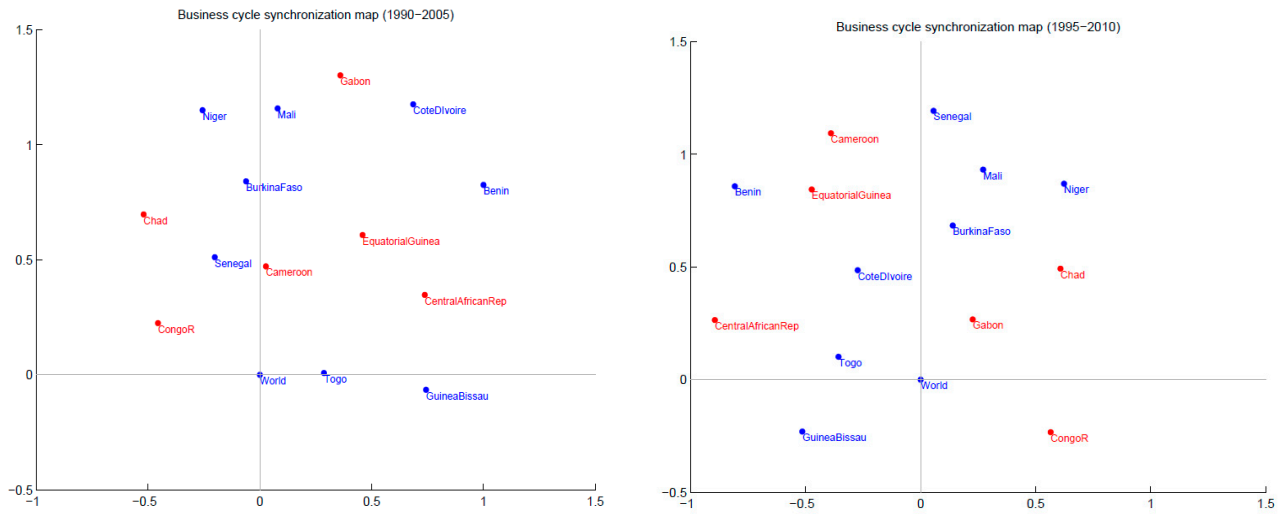
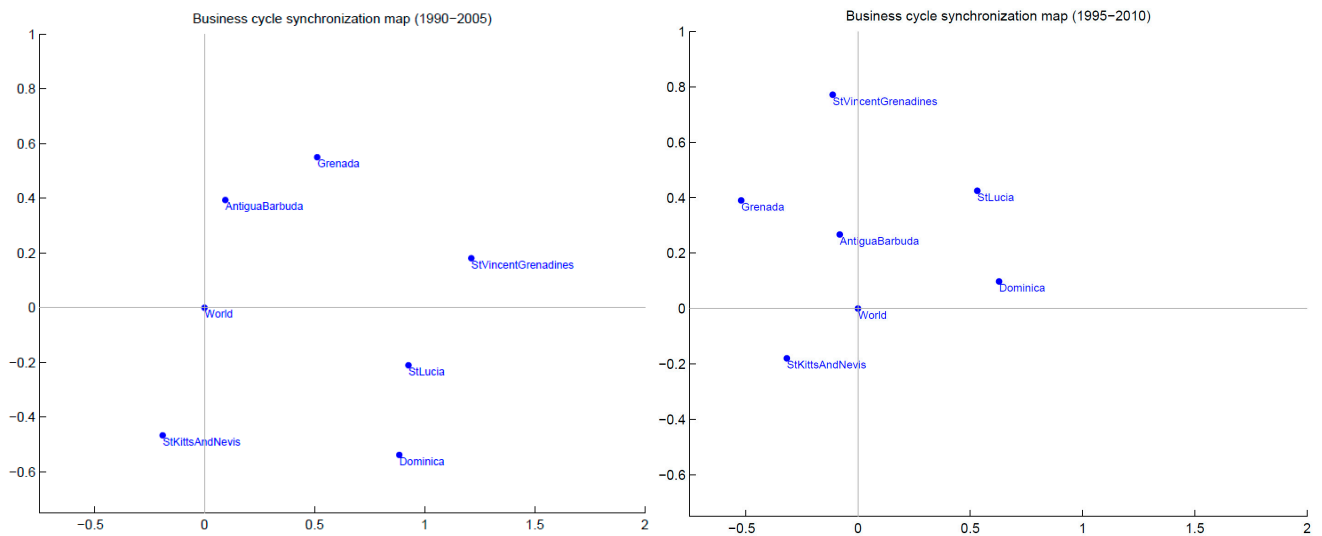


Figure 5. Eastern Carribbean Currency Union



Sources: WEO; and Fund staff calculations.

### III. CLUSTER ANALYSIS: FRAMEWORK AND APPLICATION<sup>1</sup>

*To map the architecture of cross-border trade and financial interconnectedness, this note uses a cluster analysis method called Cliques Percolation. This method characterizes today's interconnected system as one that comprises a "core" set of economies, "clusters" or groups such as the Asian supply chain within which economies are closely connected to each other, and "gatekeepers", which are individual economies or themselves clusters of economies that connect various parts of the system to one another. Gatekeepers can play important roles in propagating shocks. Understanding this architecture is a step toward better analyzing the transmittal and spillover of shocks and events and toward assessing how the system could be made more robust to shocks.*

#### A. Motivation

1. **A systemic perspective.** Analyzing the cross-border propagation of shocks and of the systemic impact of policies is complex. While bilateral trade and financial connections are comprehensible, formally analyzing the chain of relations—direct and indirect—across a large number of countries is virtually intractable. There is a dimensionality problem related to the density of country-to-country relationships (across sectors, types of goods, and assets, etc.). Production chains and financial markets are deeply intertwined; as such, aggregation without double counting, or inappropriately specifying traditional models so as to avoid over or under estimation becomes daunting. Hence, traditional models have tended to simplify by studying the problem from the lens of a single country unit against the rest of the world or an aggregated basket of partners. They have rarely focused on understanding the structure of the flows between countries as a whole, the role of particular countries or flows in amplifying or dampening shocks, and most importantly how policies in certain countries can propagate and become systemic.
2. **Framework.** Network analysis, or graph theory—in particular centrality and cluster analysis—provides a theoretic framework which can help shed light on the complexity arising when trade and financial flows are viewed in the context of an aggregate network. Graph theory allows us to construct and analyze networks where any number of vertices are joined by edges. The edges between any two vertices can be directed (i.e., explicitly denoting a flow from one vertex to another) or weighted (i.e., reflecting some value relative to other edges). Taking trade and financial flows as networks, each country is a vertex ( $v$ ), and the flow of any type of goods, service, or financial contract from one country to another constitutes an edge ( $e$ ) which can be treated as either directed or weighted. Moreover, graph theory allows us to construct and analyze multigraphs, i.e. where more than one edge joins the same two vertices (multiple trade and financial links).
3. **Structure of the note.** The remainder of this note is organized as follows. Section B below briefly explains how we have built a network of aggregated trade and financial flows. Section C then develops the first steps in understanding the structure of the network, and shows the need for

<sup>1</sup> Prepared by Karim Youssef (SPR).

cluster analysis. Section D further develops the concept of clusters and explains the importance of appropriately choosing the identification technique, as well as our chosen methodology. Section E presents the results and explains the implications of a cluster analysis driven understanding of the aggregated trade and financial flows network. Section F presents some potential applications of cluster analysis to Fund surveillance.

## B. A Network of Global Trade and Financial Flows

### ***Building Blocks and Graph Construction***

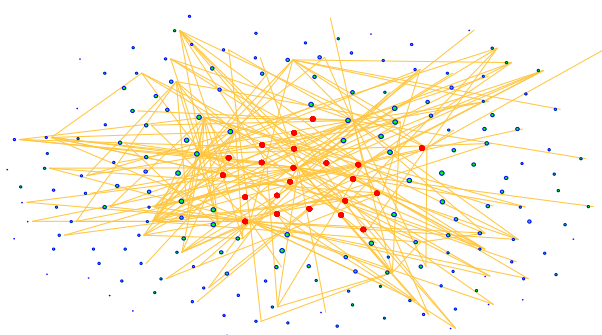
4. **Data.** We begin by constructing a series of  $n \times n$  matrices ( $A$ ) each respectively containing bilateral relationships for aggregate trade flows, consolidated and locational cross-border banking exposures (as collected by the Bank for International Settlements), as well as cross-border portfolio and direct investment exposures (from the Fund's Coordinated Portfolio Investment Survey and Coordinated Direct Investment Survey, respectively). All data are taken at end-2009. The  $i$  and  $j$  entries in each respective  $A$  matrix reflect the raw values corresponding to the bilateral interaction between every two countries. In the case of trade,  $A$  contains the sum of exports and imports recorded bilaterally (hence  $A_{ij} = A_{ji}$ ), while elsewhere the values reflect the gross claims of one country on another (hence  $A_{ij} \neq A_{ji}$ ).  $A$  contains 0 values on the diagonal (as internal trade and financial flows are not considered in our analysis).

5. **Transforming the data.** The entries of each  $A$  matrix are subsequently transformed into  $(w_{ij})$  which represents the weight of the trade or financial flow between  $i$  and  $j$  in all flows out of  $i$  to the rest of the world. In cases where  $w_{ij} \neq w_{ji}$  and neither one is zero, the weights are averaged to take the relative importance of the link for both countries. The upper triangular part of each matrix is taken to reflect the weighted edges between each two countries. The respectively weighted  $A$  matrices are then concatenated into a two dimensional array, wherein each entry represents the non-zero elements of the weighted  $A$  matrices. Finally, as the concatenated array will contain multiple edges between most country pairings, we coalesce the repeated edges by taking their geometric average. This results in a structure  $G = (V, E)$  where  $G$  is a connected and weighted graph consisting of a vertex (country) set  $V = \{d_1, d_2, \dots, d_n\}$ , and an edge set  $E \subset V \times V$  (representing the weight of aggregated flows between countries) such that each edge  $\{i, j\}$  corresponds to a set of two adjacent vertices  $d_1, d_2$  in  $V$ , and a  $w_{ij}$ .

### ***The Structure of an Aggregated Trade and Financial Flows Graph***

6. **A dense center.** As expected, the network representing trade and financial flows displays a high density of interactions. However, the distribution of edges between vertices does not seem to be uniform across the entire network. In particular, there seem to be a very dense set of relationships occurring at the center of the network, which peter-out as we travel toward the periphery. Moreover, there are some peripheral vertices which are linked to other peripheral vertices directly (see Figure 1 below).

Figure 1. Global Trade and Financial Flows Graph



7. **Architecture and function.** Global trade and financial relationships are in large part associated with economic activity undertaken between, and through, countries at the “core” (red vertices in Figure 1). Moreover, this suggests that economic and financial conditions in the core are likely to have material impact on the remainder of the network. However, the variation in density and the seemingly different *functional* role of some vertices vis-à-vis others suggests that a level of complexity exists within this graph system which would need to be further understood. Our concern then becomes how to systematically deconstruct the graph system in such a way that—irrespective of its complexity—we are able to further understand the underlying structure and functional characteristics of its building blocks (i.e., the vertices and how they are inter-related). Toward that end, we explore below various techniques and metrics.

### C. Quantifying and Rank-Ordering Centrality

8. **“Core” and “periphery”.** Understanding which vertices belong at the core of the graph and which are peripheral is a necessary first step. Further, uncovering the correct order of the most important vertices for the graph as a whole vis-à-vis other important vertices, is also crucial. Together, these two pieces of information will later allow us to understand how the dynamics of the complex relationships unfold from the core outward, and more importantly from one peripheral part of the graph—via the core—to another.

9. **Centrality measures.** A methodologically robust way of quantifying the relative importance of vertices in the graph is to calculate a series of centrality measures as detailed below:

- *Degree centrality:* quantifies the number of connections any given vertex has to all others in the network. A vertex degree can be computed respectively as the sum of: incoming links (in degree); outgoing links (out degree); or all links (degree).
- *Closeness centrality:* measures the mean of the shortest path in terms of the number of paths, between one vertex and all others.



- *Random walk betweenness centrality*: quantifies the importance of each vertex in relaying flows amongst all others. This can be approximated by the expected number of times that a random walk (or trade or financial flows) between any starting and ending vertex will pass through an intermediate set of vertices averaged over all starting and ending vertices.
- *Eigenvector centrality*: defines both the number and the quality of the connections any given vertex has within the network. Vertices with a large number of connections with lower connection weights may receive a lower eigenvector centrality value relative to points with fewer connections but with higher connection weights.

10. **Most central economies.** Based on the combination of these centrality measures, and for the available date used, we have identified the economies that display the highest centrality (higher than the 90th percentile for each measure). As evident in Table 1, the core of the trade and financial flows graph consists of 22 economies. In rank order of centrality, three distinct tiers appear at the core; the first two are dominated by Euro Area economies as well as Canada, China, Japan, Korea, Switzerland, the United Kingdom, and the United States. The final tier is largely made up of EMs along with Australia, Denmark, and Sweden.

Table 1. Most Central Economies in Trade and Financial Flows

Tier 1	Tier 2	Tier 3
China	Austria	Australia
France	Belgium	Denmark
Germany	Canada	India
Italy	Korea	Mexico
Japan	Netherlands	South Africa
United Kingdom	Spain	Sweden
United States	Switzerland	Taiwan, Province of China
		Thailand

11. **Unpacking the system.** What does centrality tell us that we do not already know? Understanding the core of the trade and financial flows graph, and how it is structured (i.e., who is at the core and in what ranking), confirms some existing priors, while revealing new results. Most importantly, it prompts us to address further issues concerning the complexity of the entire graph system. Revisiting Figure 1 above, along with the high centrality and core-tiering of specific economies, we can posit that the presence of some of these economies at the core reflects their high level of interaction in particular dimensions (trade, financial, or both) *of the data we use*. For instance:

- The presence of China along with several of its key trading partners at the core is indicative of its role in the Asian—and global—supply chains.
- The presence of key global financial intermediation centers reflects the importance of countries such as the United Kingdom, United States, and Switzerland in global financial flows, portfolio allocation, and management.
- Similarly, the presence of key EMs confirms the well known prior that, as such economies continue developing, they are becoming regional magnets for financial and trade flows.

- Overall, the core of the trade and financial flows graph in large part reflects many of the constituent economies in the Group of Twenty (G20).

12. **Some surprises.** Our measures of centrality also contain somewhat surprising results. Taking membership in the G20 as a representation of existing priors on identifying industrialized and developing countries that play the most systemically important role, we see that Argentina, Brazil, Indonesia, Saudi Arabia, Russia, and Turkey are absent, while Denmark, Sweden, Switzerland, Taiwan Province of China, and Thailand are part of the core. How can we explain the absence of oil exporting or significant emerging market economies from the core, while others (sufficiently proxied by other countries such as Austria-Germany and Belgium-France) appear? In addressing this, we are forced to seek a more nuanced understanding of the structural and functional properties of the trade and financial flows graph system. One meaningful way of doing this is via uncovering its underlying community (cluster) organization and the role of specific vertices within it.

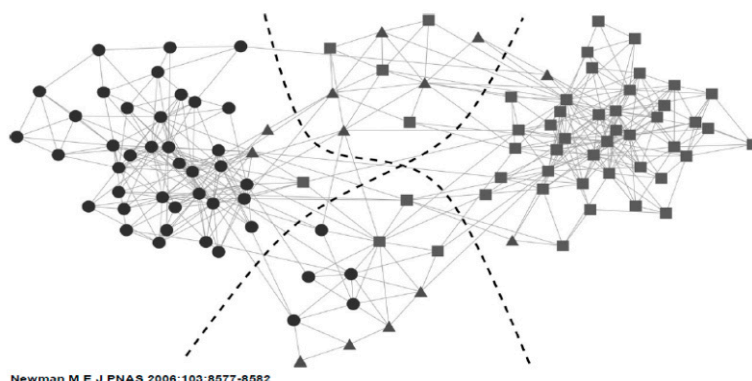
## D. From Networks (Graph) to Clusters

*Cluster analysis lends itself to systematically uncovering and interpreting the natural organization of the vertices (countries) represented in any graph. In our case, we are concerned with how to understand country groupings—whether in the core or periphery—and in particular which countries form cohesive communities.*

### **The Appropriate Cluster-Identification Methodology**

13. **Away from non-overlapping clusters.** Cluster identification is essentially a problem of finding an unknown number of cohesive groups that are the underlying building blocks of a broader graph system. This can be done by imposing constraints on a maximizing problem; however, such constraints risk producing results that ignore the very complexity we are seeking to understand. Most cluster identification methods rely on partitioning algorithms which identify separable non-overlapping, non-nested communities as shown in Figure 2 below. While such algorithms successfully underscore the cohesive or hierarchical nature of some sets of links between groups of vertices, the less dense regions of links *between* groups become irrelevant. Adjacency between groups is not a trivial feature in trade and financial flows. As will be explained in detail in subsequent sections, adjacency between clusters can be utilized to define overlaps in clustering.

Figure 2. Architecture of Separable, Non-Overlapping Communities



Newman M E J PNAS 2006;103:8577-8582

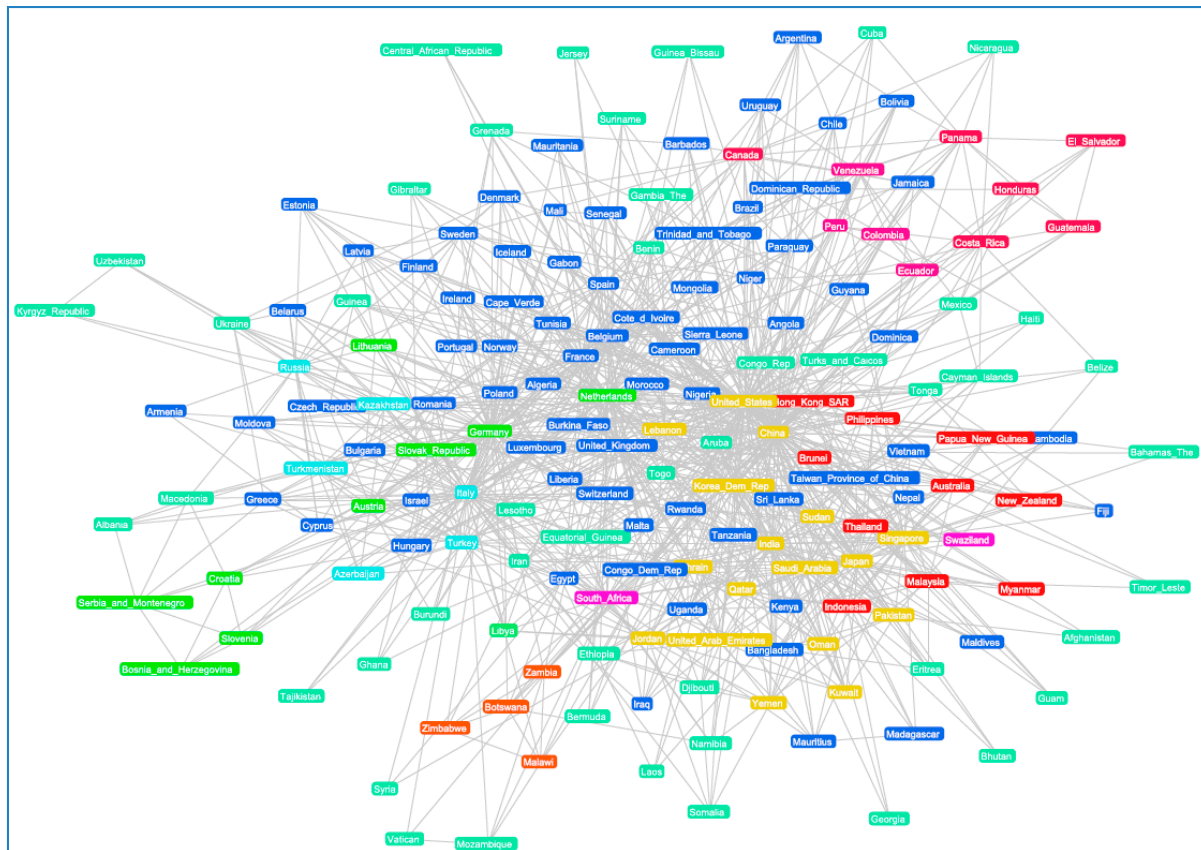
14. **Toward overlapping clusters.** While the tractability and efficiency of traditional partitioning algorithms are attractive, they are subject to some constraints on the number, size, or shape of the clusters to be identified. For example, such methods necessitate defining ex-ante the number of clusters into which the graph should be partitioned. In effect, the choice of the number of clusters to identify will have a non-trivial effect on the results; e.g., China would only be associated with the Asian supply chain economies and not with the United States, Germany would be associated only with large Euro Area economies and not with other EU economies. Hence, multiple valid solutions may be expected. As such, they are significantly limiting for our purposes of further understanding the underlying complexity of the graph system. Also, the partitioning usually focuses on cutting the graph system into clusters while minimizing the cost of edge elimination, thus, any single vertex can only belong to one cluster. This ignores the implications of overlapping or nested communities, and dilutes the potential for a richer understanding of the particular vertices which facilitate such overlaps and, therefore, of the set of interactions across economies.

#### **Cluster Identification with Minimal Constraints**

15. **Clique percolation method.** A recently developed cluster identification algorithm called the Clique Percolation Method (CPM) provides a feasible way of identifying clusters without imposing the constraints mentioned previously. In other words, it allows us to identify an unknown number of potentially overlapping clusters (i.e., cohesive country groups) with varied membership size. *Utilizing CPM, we model the interaction amongst countries using global trade and financial flows to map out potential shock transmission paths between countries. Country groups which share very dense connections (based on trade, BIS, and portfolio flow data) are considered "clustered." Clusters share overlap regions which are facilitated by a specific country or group of countries' membership in multiple clusters. Membership in multiple clusters may allow countries to act as unique links through which the effects of economic or financial conditions may be transmitted from one cluster to another. Owing to their capacity to act as transmitters (and potentially amplifiers or mitigators) of shocks, countries comprising the cluster overlap regions are categorized as "gatekeepers."* The theoretical underpinnings of CPM are detailed in Annex 1. Box 1 provides a step-by-step demonstration of how clusters are identified.

16. **Richer network architecture.** A much richer differentiation among groups of countries emerges in Figure 3 relative to the earlier presentation. In the first instance, CPM clearly yields 11 distinct clusters of varying sizes. The graph is also now separable into two clearly identifiable core regions, one surrounding the United States and China, and one surrounding Italy and Germany. Moreover, we can also identify a group of countries such as France, The Netherlands, and the United Kingdom which seem to sit in between both core regions. The next section elaborates on key implications of cluster-based analysis and concepts.

Figure 3. Preliminary Clustering based on Clique Percolation Method



### Box 1: A Primer on Cluster Identification

This box provides a step-by-step guide on how clusters are identified. It is useful to begin with a few necessary glossary terms:

- A *graph* is a mathematical representation of a system. A convenient way of understanding the system is uncovering its underlying structurally cohesive building blocks or components (i.e. clusters or cliques).
- Strictly defined *clusters within a graph* are the set of complete sub-graphs in which all nodes are connected to one another.
- The number of member vertices in a cluster can be used to identify the “order” *k of the cluster* (i.e. a cluster of 3 vertices is a 3-clique).
- Clusters are adjacent if they share  $k-1$  vertices.
- A *cluster chain* is the union of adjacent clusters of a given cluster order.
- If two or more clusters are connected via a cluster chain they are considered *connected clusters*.
- *Maximally connected clusters* are uncovered by identifying the union of all connected clusters via template rolling (see Annex 1).

**Identifying maximally connected clusters.** This includes four steps. First, as discussed in Annex 1 we begin by identifying the following: (i) critical regime threshold associated with maximal cluster identification; (ii) edge weight threshold for reconstructing the graph system; and (iii) the appropriate order (i.e.  $k$ ) range for the graph system. Next, having identified the appropriate range for  $k$ , we begin with the largest value for  $k$  and extract the clusters associated with that cluster order (i.e. removing vertices and edges identified as clustered) until we either run out of vertices or clusters of that order. We then iteratively repeat this cluster enumeration process for other  $k$  values. Thirdly, for each  $k$  value we represent the identified overlapping clusters in a new graph matrix (similar to previously explained in section B). This is called the clique overlap matrix as it represents the overlapping clusters in the original graph system. The values in this matrix represent the number of common vertices amongst each cluster pairing. For each cluster order (i.e.  $k$ ) we reconstruct the overlap matrix to include only the overlap regions associated with the  $k$ -th order. Finally, after enumerating the cluster membership of each vertex in the graph along with the associated edges responsible for membership in the various clusters, we simply reconstruct the original graph system with the added benefit of identifying structurally driven overlaps and divisions.

## E. Cluster Analysis Results and Implications

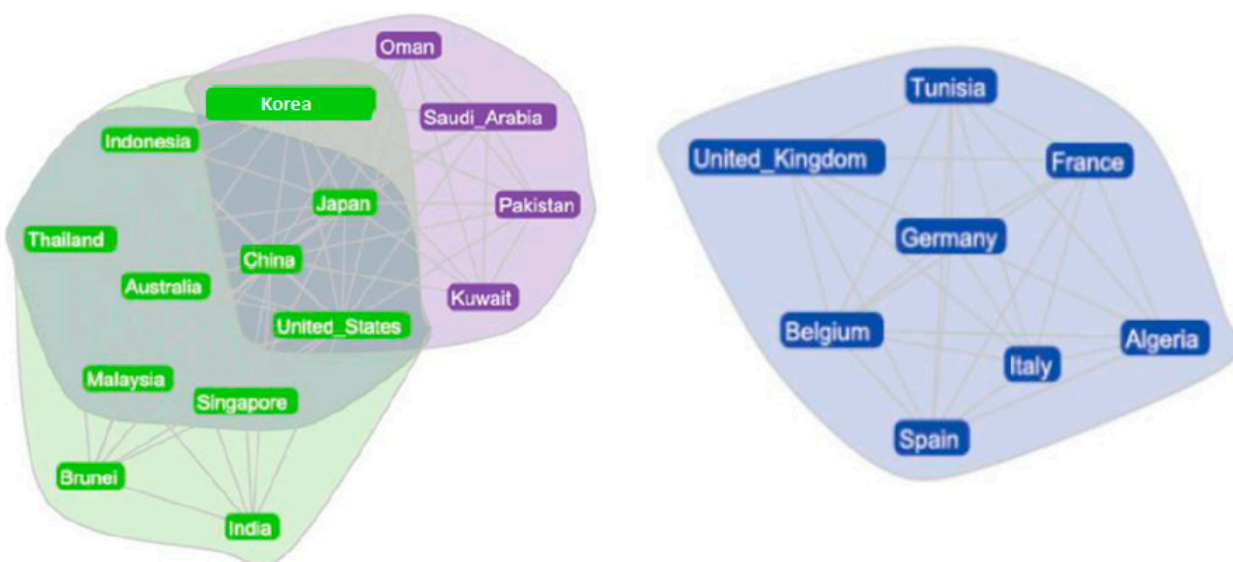
*Some economies serve as gatekeepers—linking different clusters and therefore transmitting (passing through, amplifying, or dampening) shocks. Groups of economies can together also play a gatekeeper role. The method allows for distinguishing individual gatekeepers and clusters of gatekeepers.*

### Gatekeeper Countries Versus Gatekeeper Clusters

17. **Cluster-to-cluster relationships.** CPM allows us to further understand cluster-to-cluster relationships. There is a threshold parameter,  $k$ , for defining cluster size (see Annex 1). For values of  $k$  between 5 and 8 which have been previously identified as the critical percolation region, a single cluster arises at the 8-clique level, which includes Australia, China, Indonesia, Japan, Malaysia, Singapore, Thailand, and the United States. We also identify three clusters at the 7-clique level, two of which are overlapping, while one stands separated.

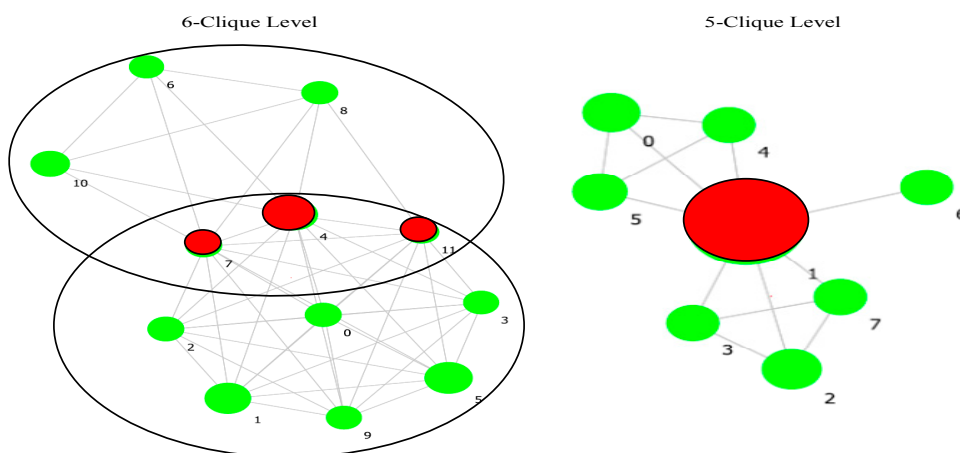
18. **Gatekeeper economies.** Combining the clusters resulting from the 7 and 8 clique levels produces an interesting initial result. As evident in Figure 4, European economies appear clustered together, along with Tunisia and Algeria. The inclusion of Tunisia and Algeria in this cluster is on account of trade relations and remittances, while, China, Japan, Korea, and the United States act as *gatekeeper countries* linking key Middle Eastern economies and Pakistan to Asia. Also, on account of being members of adjacent clusters Korea, India, and Brunei are also clustered together despite having no connecting edges. In many respects, these are non-trivial results as they explicate clearly both the importance of relationship dynamics within developing Asian economies, as well as the role of their gatekeepers in linking them to oil exporters. Moreover, the analysis presents a unique result for the gatekeepers pertaining to Hong Kong SAR (see group K in Table 1 of main paper). Traditionally, Hong Kong SAR is viewed as a financial hub which is responsible for intermediating Asian savings. The results of our analysis contextualize further and add granularity by explicating the idea that the dynamic amongst the Asian economies (which are subject by varying degrees to capital flow restrictions) and the United States may potentially be the driving factor behind the role of Hong Kong (i.e., the gatekeepers' real economic context drives the role of the equity financing hub).

Figure 4. Country Level View of First Clusters



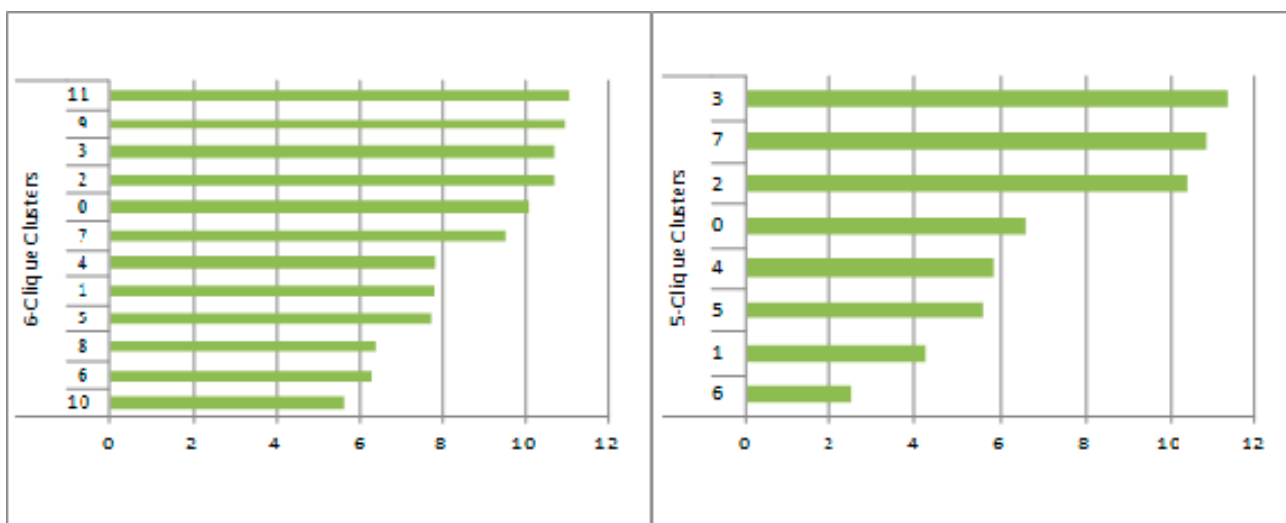
19. **Gatekeeper clusters.** There is also a clear internal organizational structure between clusters themselves (see Figure 5). Looking at the maximal overlap between clusters which takes place at the 6-clique level followed by the 5-clique level, we respectively identify 12 and 8 overlapping clusters containing 72 and 133 countries. The number of countries which are members in each cluster varies. For example at the 5-clique level, we see that cluster 1 is a giant cluster containing 117 countries. Moreover, we also see that the clusters are not only clustered into different yet overlapping groups. At first glance, the overlap between clusters appears to involve particular clusters (red circles). This suggests that the clusters situated in overlap region are *gatekeeper clusters*.

Figure 5. Structure of Clusters



20. **Gatekeeper economies in gatekeeper clusters.** We can also expect that gatekeeper clusters contain as members a higher than average level of gatekeeper countries. To test this hypothesis, we have developed a metric to gauge the relative involvement of gatekeeper countries in any particular cluster. This is done by measuring the weighted contributions of cluster members to each cluster’s overlap with other clusters relative to the average overlap between clusters over the entire graph, after normalizing to account for variation in cluster size. In effect we are rank ordering the clusters in terms of the contribution of their member countries to the density of adjacencies over the entire graph. This intuitively implies that we are rebuilding the graph structure from the cluster level by prioritizing those clusters whose members act as gatekeepers. According to this metric, we are able to confirm the status of cluster #11 under the 6-clique level as a top gatekeeper cluster in the graph, while cluster #7 and #4 rank higher than nearly half the other clusters (see Figure 6).

Figure 6. Gate-Keeper Score at the Cluster Level  
(Rank ordered by increasing involvement of gatekeeper economies)



21. **Characteristics of gatekeepers.** What are the characteristics of gatekeeper clusters? A gatekeeper cluster is a grouping of countries through which shock transmission can be mapped out. One potential implication of this is that the membership of the clusters which act as gatekeeper clusters contain specific countries or groups of countries which display particular characteristics that allow them to facilitate the gatekeeping role for the entire cluster. To confirm this, we focus on the country membership of cluster #s 4, 7, and 11 under the 6-clique regime.

22. **Centrality and gatekeepers.** It is clear that the majority of the country membership, in two of these three clusters, consists of very large and important economies (see Figure 7). In effect, the significant centrality of these countries, and their combined links, allow them easy connectivity to the remainder of the system. This becomes an even more intuitively acceptable statement, when we consider that the United States, The Netherlands, China, and Germany at the intersection of these three gatekeeper clusters. An immediate implication of these results is that core economies act (via different core regions) as gatekeepers for multiple other important economies which in turn provide a gatekeeping function throughout the entire graph. Based on this intuition we rebuild the graph representing global trade and financial flows based on the gatekeeping score of each cluster (see Figure 8).

Figure 7. Gatekeepers: An Illustration

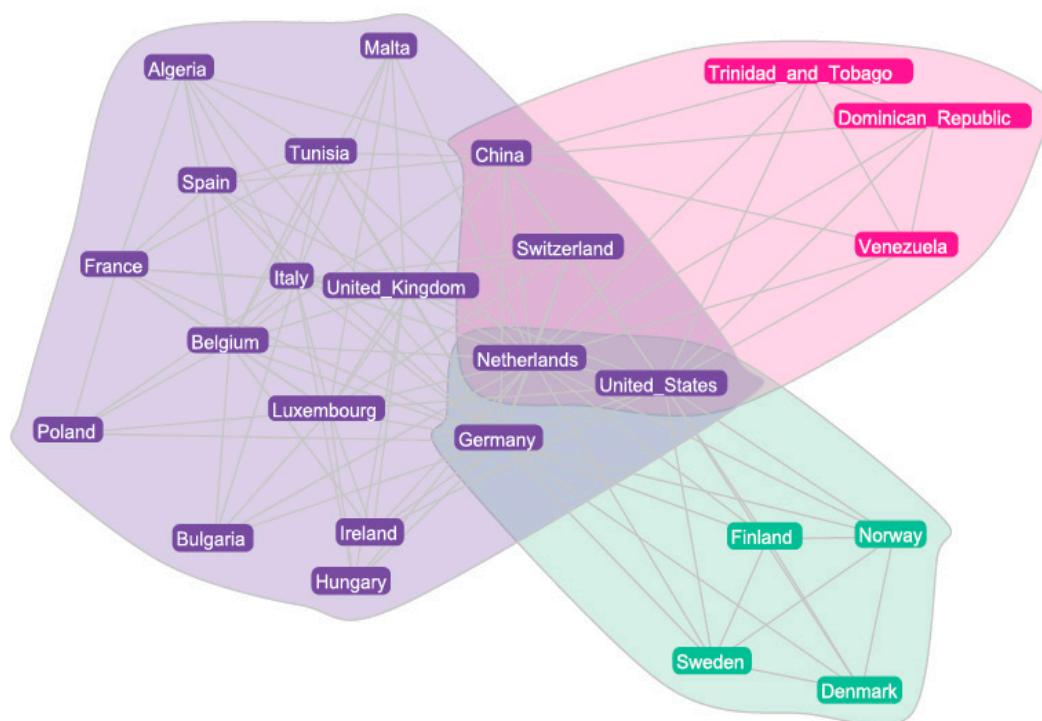
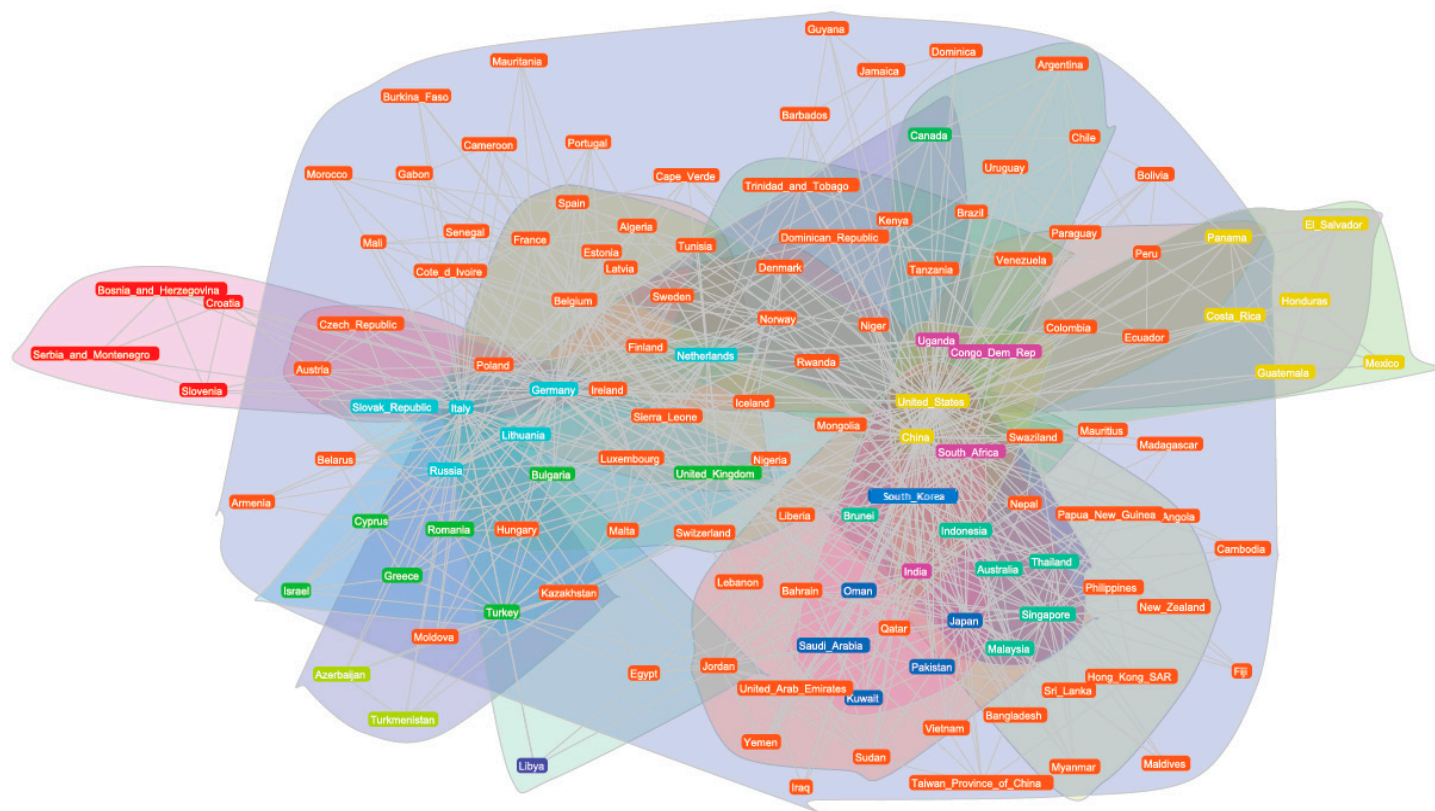




Figure 8. Final Architecture



23. **Shock propagation.** These findings shed insight on shock propagation within and across clusters. An important result of this exercise is reaching the understanding that while cluster #1 under the 5-clique level is a very large and seemingly important cluster, the gatekeeping function of the majority of its important gatekeeper countries is already accounted for in other clusters. However, it is also important to note that while this particular giant cluster does not rank highly, it does allow us to identify two important pieces of information. First, it inherently identifies the weakly gatekeeping countries which may link strongly peripheral countries to the rest of the network. Second, it also helps us identify how peripheral countries may be linked to one another thus linking smaller but more important clusters indirectly. Without this final piece of the puzzle we would remain without a clear understanding of which parts of the periphery rely on the core of the graph directly and which other parts also reside in cluster chains.

24. **An illustration.** An illustration of the gatekeeper role and potential for shock propagation is provided in Table 2. Countries playing a gatekeeper role are identified in groups along with the countries for which they play a gatekeeping role. Keeping in mind that i) a gatekeeper links countries together which may not appear naturally clustered; and ii) the transmission of shocks may take place between clusters through gatekeepers, some key elements of the results are as follows:

- Countries which are gatekeepers are coherently linked to other gatekeepers thereby creating an overlap cascade from the core of the system to the periphery. This implies that a shock transmitted from any one point must go through multiple “gates” to spread throughout the system. However, this also implies a vast potential for negative feedback effects within and between clusters.
- Potential transmission channels are strongest from Germany and Italy to Europe, CESEE, CIS, and parts of the Middle East.
- The United States is a key conduit for spillovers elsewhere.
- In addition to any first round direct effects of European stress in Italy or Germany on the U.S.—if not stemmed—additional feedback effects are likely to be transmitted from other European countries to both core economies such as the U.S. as well as peripheral regions.

## F. Putting it All Together—Cluster-Based Surveillance

25. **Analyzing shock propagation and vulnerabilities.** Cluster analysis provides a potentially useful tool in identifying country vulnerabilities, such as those related to the Euro zone. Applying the same methodology elaborated above, cluster membership and gatekeeper roles are illustrated in Figures 9 and 10. The main take-away from the analysis is that Italy is not only a “gatekeeper” for core Europe, becoming a conduit of significant shocks to Belgium, France, Germany, and the Netherlands, but it acts as a “gatekeeper” for five other areas: (i) the CESEE region; (ii) CIS economies; (iii) emerging Middle Eastern economies such as Tunisia and Jordan; and (iv) the United States. In turn, as core European economies are closely interconnected, a shock that emanates from Italy would also have secondary reverberation effects between the various core European countries, as well as the CESEE economies which are also connected to the core European economies. The analysis also suggests a few other interesting results:

- Unlike core Europe, and the CESEE economies, the CIS economies may not be as susceptible to secondary reverberation effects.
- However, certain African economies (Burkina Faso, Cameroon, Gabon, and Senegal) are susceptible to two distinct channels of reverberation aside of the direct impact from Italy—one is their interconnectedness with France, and the other is their interconnectedness amongst each other.
- The U.S. (rather than China) is the larger source of shock transmission from Italy to both Latin America and to Asia. The implication is that U.S. policies to counteract a shock from Italy are likely to have a greater positive impact on global stability at the margin, than isolated actions from China alone. However, concerted action by both will bring the greatest gains, as China is a “gatekeeper” to emerging Asia.
- The U.K. appears as a shock absorber from Europe. Owing to its unique role as a global intermediary of U.S. dollar assets, it acts as a conduit for shocks to the U.S. However, the

real effects are manifested in the economies which issued or whose financial sectors utilized them as funding vehicles (see Figure 10).

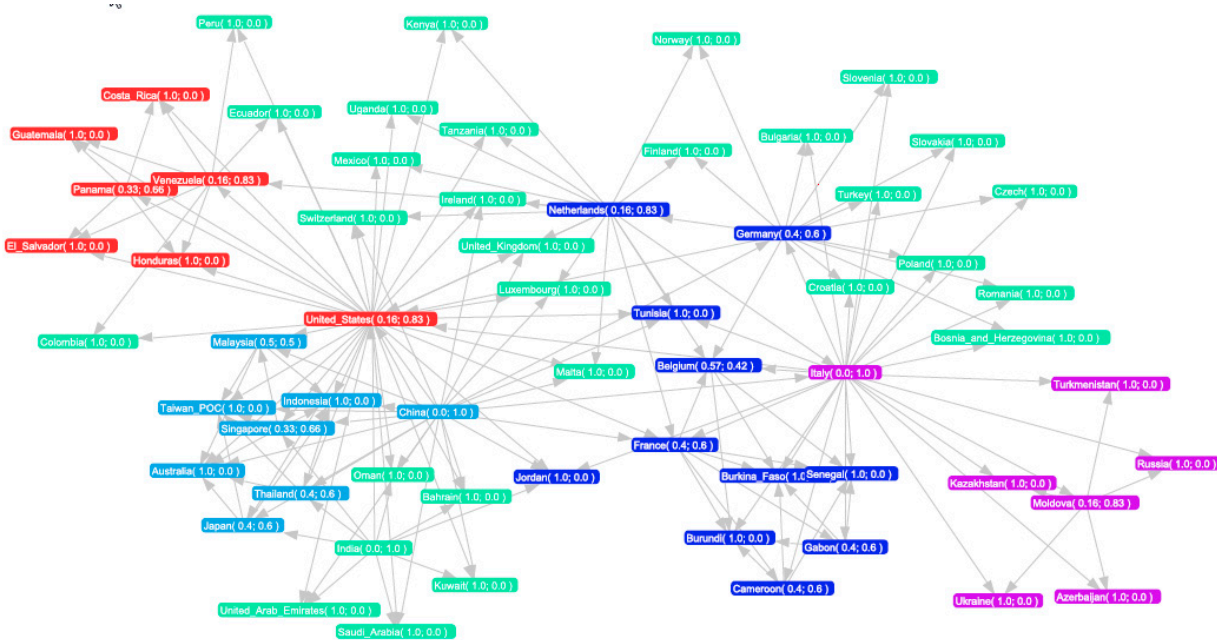
- China does not receive shocks from others. Compared to the rest of the core/gatekeepers, China's density lies more within Asia. Stickiness in trade relationships therefore is likely to mute the impact of certain shocks on China. However, if the Chinese economy were to come under severe stress, it would produce material effects on the countries in its clusters including the United States.

26. **Caveat.** This analysis is aimed at mechanically mapping out the potential transmission routes through which a shock would propagate between clusters and how the corresponding feedback loops might play out within each cluster in the first instance. This should not be interpreted as a quantitative gauge of the relative intensity of shocks between countries, given the need to subsequently assess policy space and action. But as a first step to understanding the impact of a shock on the system, the analysis is potentially insightful.

Table 2. Structural Features of Global Trade and Financial Flows Network: Gatekeepers

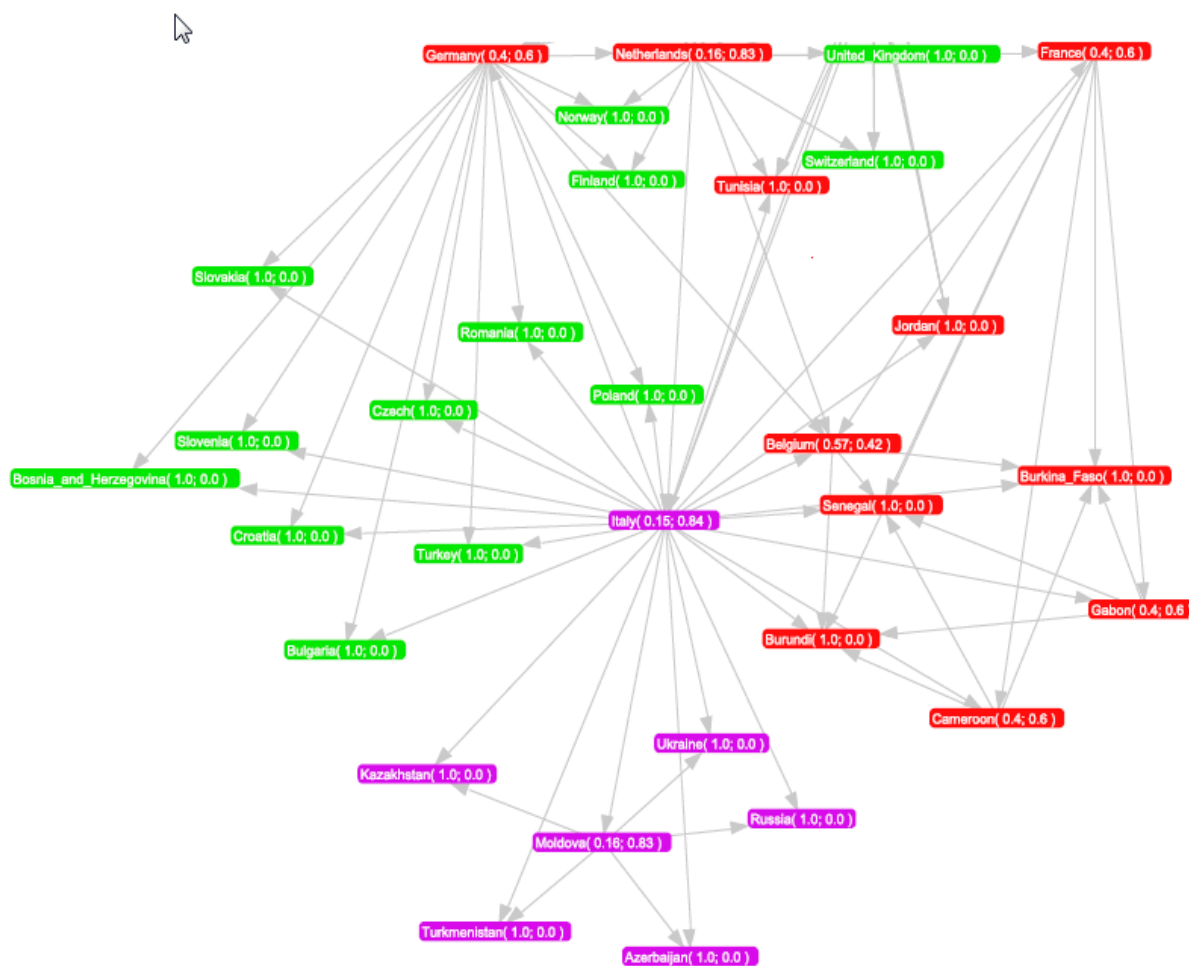
Group	Gatekeepers	Countries	Group	Gatekeepers	Countries	Group	Gatekeepers	Countries
A	U.S.	Argentina Brazil Canada Chile China Netherlands Venezuela Dominican Republic Trinidad and Tobago	I	U.S., Netherlands, Denmark & Sweden	Germany Finland Norway	Q	Italy, Turkey & Russia	Kazakhstan Azerbaijan Turkmenistan
B	U.S. & China	India South Africa Democratic Republic of Congo Uganda	J	U.S., China, Netherlands & Germany	Italy United Kingdom Algeria Belgium Bulgaria France Poland Spain Tunisia Hungary Ireland Luxembourg Malta Switzerland	R	South Africa	Botswana Malawi Zambia Zimbabwe
C	U.S. & Canada	Denmark Sweden Niger	K	U.S., China, Korea, Japan, Singapore, Malaysia, Thailand, Indonesia & Australia	Hong Kong SAR New Zealand	S	U.S., China, Argentina, Brazil & Venezuela	Dominica Guyana Paraguay Uruguay Bolivia
D	U.S., China, India & South Africa	Korea Swaziland	L	U.S., China, Japan, Korea, Kuwait, Oman, Pakistan, Saudi Arabia & Singapore	Jordan Bahrain Lebanon Qatar Sudan United Arab Emirates Yemen	T	U.S., China, Netherlands, Switzerland, United Kingdom, Brazil & Mexico	Cayman Islands Jersey Guernsey Bermuda The Bahamas Jamaica Barbados Maldives
E	U.S., China & Venezuela	Panama Colombia Ecuador Peru	M	U.S., Netherlands, Denmark, Sweden & Finland	Estonia Latvia	U	Belgium, Italy, U.S., China, France, India, Germany, Netherlands, Singapore, Hong Kong SAR, Korea, South Africa, Spain	Angola Madagascar Niger Burkina_Faso Mauritania Cape Verde Cameroon
F	U.S., China, Venezuela & Panama	Costa Rica El Salvador Guatemala Honduras Mexico	N	Germany & Italy	Austria Slovenia Jordan Turkey Egypt Libya			Kenya Mali Nigeria Mauritius Gabon Tanzania Rwanda Senegal Cote d'Ivoire Sierra Leone Liberia Guinea Bissau Lesotho Namibia Ethiopia
G	U.S., China & Korea	Japan Kuwait Oman Pakistan Saudi Arabia	O	Germany, Italy & Austria	Czech Republic Slovakia Poland Bosnia and Herzegovina Croatia Serbia and Montenegro			
H	U.S., China & Japan	Singapore Australia Indonesia Malaysia Thailand	P	Germany, Italy, United Kingdom & Turkey	Bulgaria Cyprus Greece Israel Romania			

Figure 9. Gatekeepers and Shock Propagation Channels



- Gatekeeper: U.S.
- Gatekeeper: Italy, Germany, Netherlands, US, and China
- Gatekeeper: China
- Gatekeeper: Italy
- Gatekeeper: Belgium, France, and Italy

Figure 10. European Shock Propagation Channels 1/ 2/



1/ A shock is mechanically applied where the value of all links are uniformly reduced (15 percentage points) to proxy for a global GDP shock. The resulting system is analyzed in the figure.

2/ The two numbers specified for each country are the share of the envisioned shock transmitted to it (i.e., incoming from others) on the left, and the share of its effects on others on the right.

**ANNEX 1**

**Understanding Clique Percolation Method (CPM)**

CPM introduces a parameter  $k$  which defines the size threshold for clustering. However, unlike the more restrictive partitioning clustering methods, CPM allows for an endogenous identification of an appropriate range for the parameter  $k$  which fits a critical regime in which the algorithm neither returns one giant cluster containing every vertex, nor breaks up the vertices into non-connected subsets.

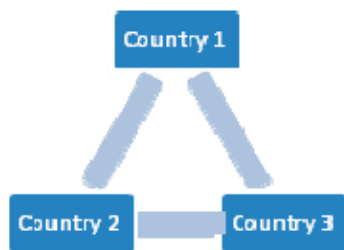
The aim of using CPM is to identify all the adjacent maximum complete sub-graphs within the trade and financial flows graph. We will subsequently refer to these as Maximal Country Clusters (MCC). MCCs are in effect an endogenously driven dissection of the structure of the graph into smaller cohesive yet overlapping communities.

MCCs can be found by appropriately imposing a threshold  $k$  for the size of clusters (in terms of how many countries may belong). There exists an appropriate value or range for  $k$  which allows for strong adjacency between cohesive groups of vertices, thus allowing us to identify all overlapping clusters which consist of **maximally adjacent  $k$ -cliques ( $k$ -clique percolation clusters)**.

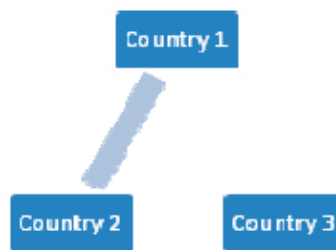
A  **$k$ -clique** is a fully connected or complete sub-graph, containing  $k$  vertices (countries). A network or graph is complete if there is a path connecting every pair of nodes, that is to say the set of vertices (in this case countries) cannot be divided into non-connected components. The concept of completeness in a graph implies that there is no potential for additional edges between vertices. For example, for a graph consisting of three vertices (i.e.,  $k=3$ ) each vertex would necessarily have two edges connecting it with the others (see Figure A1).

Figure A1. Graph Completeness and  $k$ -clique Example

Complete Graph with 3 Vertices forming 1 Component  
( $k$ -clique)



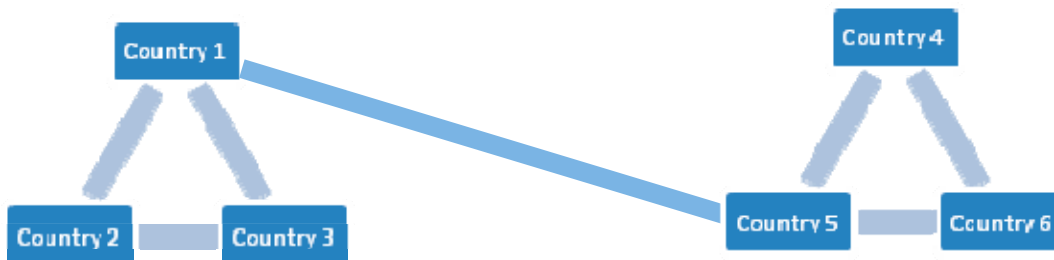
Disjoint Graph with 2 Components



A  **$k$ -clique chain** is the union of all  $k$ -cliques which can be reached from one another—hence are adjacent. Formally,  **$k$ -clique adjacency** is defined as two individually complete cliques of order  $k$ , which are connected by  $k-1$  vertices (i.e., 2 if we keep with the example above). As shown in

Figure A2 below, countries 1 and 5 have an edge between them, thus they render their corresponding k-cliques adjacent and facilitate a *k-clique* cluster.

Figure A2. Adjacent k-cliques (k=3)



A **maximal k-clique cluster** can be defined as a k-clique which contains only vertices which themselves do not belong as a subset of a larger k-clique. For example, none of the countries in Figure A2 can be identified as part of a k-clique where  $k=2$ , nor can they be identified in the case where  $k=4$ , hence they are a maximal 3-clique cluster.

In order to identify maximal k-clique clusters, it becomes necessary to undertake a process called **k-clique template rolling**. This involves beginning at an arbitrarily determined vertex, identifying its immediately corresponding k-clique, and subsequently rolling from that k-clique to other adjacent k-cliques. For example, Figure A3 shows a graph of four countries in which countries (1, 2, 3) and (1, 2, 4) respectively form two adjacent k-cliques of order  $k=3$ . We place a template (orange triangle) on the first k-clique (left panel) and roll it through to another (without changing the shape of the template or eliminating two of the original clique members).

Figure A3. k-clique Template Rolling



Based on this very simple example we can now define the **k-clique percolation clusters** (as associated with the CPM) as all those cohesive sub-graphs which can be fully explored by rolling a k-clique template through them.

More importantly, we find that a few important implications immediately arise as a result of utilizing CPM to identify Maximal Country Clusters. First, in spite of there being no edge connecting countries 3 and 4, they are part of a MCC. Second, on account of the adjacency, an overlap between the two 3-clique countries emerges in the form of countries 1 and 2 acting as **gatekeepers**



between 3 and 4. However, it is not hard to immediately appreciate the potentially powerful implications of such results with respect to (at minimum) mapping out shock transmission channels between countries, and (with some additional effort) generating and testing hypothesis related to shock propagation, amplification, or mitigation.

### Which $k$ to use in $k$ -clique

The uneven density and weights of edges throughout the trade and financial network as discussed earlier, implies that one choice of  $k$  may ignore important cluster overlaps. Nevertheless, CPM aims to identify all the  $k$ -clique percolation clusters, while maximizing their overlap. As such, identifying an appropriate range of  $k$  will be needed to fulfill this aim.

Given that we can express  $k$  as a function of threshold parameters related to the connectivity of the graph (i.e., the number and weight of the edges explicitly forming the graph), a heuristic yet efficient approach exists to identifying the appropriate values for  $k$  as explained below.

As done earlier, consider the structure  $G = (V, E)$  where  $G$  is a connected and weighted graph consisting of a vertex (country) set  $V = \{d_1, d_2, \dots, d_v\}$ , and an edge set  $E \subset V \times V$  (representing the weight of aggregated flows between countries) such that each edge  $\{i, j\}$  corresponds to a set of two adjacent vertices  $d_i, d_j$  in  $V$ , and a weight  $w_{ij}$ .

Let  $N$  be the average number of neighbors over all  $V$  in  $G$ . Let  $t$  be a threshold parameter for elements of  $G$  which allows only a subset of  $G$  where  $w_{ij} \geq t$  to be considered in a new structure  $G'$  used for cluster identification. Also, let  $p$  denote the probability for an edge to connect any two vertices in the graph. Finally, let  $p_c$  denote a critical value threshold for  $p$  at which a giant  $k$ -clique percolation cluster emerges encompassing all vertices in the graph. This is called the percolation threshold for random networks; at this threshold, a transition regime occurs which produces a single giant cluster. Setting the condition that  $p < p_c$  implies that no single cluster should be much larger than all others.

We can posit that at the percolation threshold  $p_c$  the remaining number of adjacent  $k$ -cliques into which we can expect to roll the  $k$ -clique template to be 1. Since we have not breached the percolation threshold but are at its limit, anything above 1 would necessarily allow us to reach the entire remainder of the graph vertices. As such, we estimate that  $(k-1)(V-k)p_c^{k-1} = 1$  (i.e., the product of the number of template vertices that can be selected in the next template relocation, the number of potential destinations for the relocation of the template, and the fraction of remaining acceptable destinations is equal to 1).

This can be rewritten to solve for the percolation threshold as a function of  $k$  and  $V$  as follows:

$$p_c(k) = [(k-1) \cdot (V-k)]^{-\frac{1}{k-1}}$$

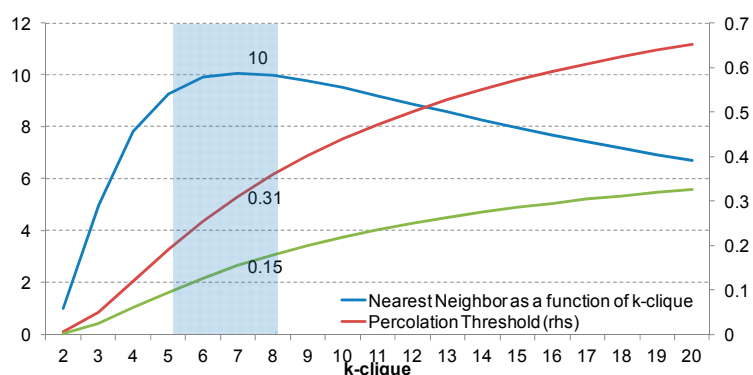
Having identified the percolation threshold, which approximates the critical connectivity of our graph at each  $k$ , we can now use it to identify the appropriate value range in which  $k$  maximizes the number of neighbors for the average clustered vertex. This can be done by expressing  $N$  as a function of the percolation threshold at a given  $k$  and a scaling factor which can be interpreted as the upper bound for the number of adjacencies between cliques at a given value of  $k$  as follows:

$$N(k) = p_c(k) \cdot \frac{V-1}{k-1}$$

Finally, using the percolation threshold at the value of  $k$  which maximizes  $N$ , we estimate the weight threshold parameter  $t$ . Uncovering this parameter will allow us to uncover a lower bound for edge weights to consider in the cluster analysis. The rationale here is that edges with weights below this threshold are either structurally trivial or may result in obscuring the discovery of maximal adjacency clusters. We reach this weight threshold by taking the product of the midpoint between all edge weights and the percolation threshold at  $k$  as follows:

$$t_c(k) = 0.5 \cdot p_c(k) \cdot (w_{\max} - w_{\min})$$

As shown in the text figure, we estimate the best fit  $k$  range for the trade and financial flows network as falling between 5 and 8. Within that range, the percolation threshold is around 31 percent, while the expected number of neighbors for each vertex is around 10 and the estimated weight pruning threshold is 15 percent. Hence, we eliminate from our analysis any bilateral relations where  $w_{ij} < 15$ .



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## IV. EXTERNAL LINKAGES AND POLICY CONSTRAINTS IN SAUDI ARABIA<sup>1</sup>

*Saudi Arabia's interconnections with the global economy, and the constraints that these linkages impose on domestic policy choices, continue to evolve. Specifically, fiscal policy is constrained by developments in the global oil market while monetary policy is guided by the U.S. dollar peg. Over the past couple of decades, two important developments have occurred. First, growing oil needs from EMEs has become increasingly important for oil market dynamics. Second, financial sector development in Saudi Arabia has strengthened the monetary transmission mechanism. The former implies greater influence of EMEs economic fluctuations on Saudi oil export revenues, while the latter suggests greater influence of U.S. monetary policy on the Saudi non-oil sector. Hence, situations in which global oil prices move counter-cyclically with the U.S. business cycle have become increasingly likely and could generate tension between policy objectives.*

### A. Introduction

1. **Backdrop.** On September 18, 2007, the U.S. Federal Reserve lowered its policy rate from 5.25 percent, the highest rate since March 2001, to 4.75 percent, citing tightening credit conditions and an ongoing housing market correction. By the end of October 2008, the federal funds target rate had been reduced to just one percent. During the same time period, crude oil prices surged from over \$65 per barrel in mid-2007 to over \$130 per barrel by the summer of 2008, partly driven by increased demand from EMEs. The situation in Saudi Arabia was quite different from that in the U.S. The rise in oil prices between 2004 and 2007 had raised oil revenues to the government which had been reflected in increased spending, leading to higher economic growth, but also rising inflationary pressure. Nonetheless, in order to prevent speculative capital inflows and maintain the exchange rate peg to the U.S. dollar the Saudi Arabian Monetary Agency (SAMA) cut its policy rate from 5 percent in October of 2007 to 2 percent by mid-2008. Annual credit growth increased from 6 percent in early 2007 to over 30 percent in July 2008, while higher world commodity prices coupled with a depreciating dollar further contributed to inflationary pressure, resulting in double digit inflation by mid-2008. This episode clearly illustrates how global interconnectedness affected policy trade-offs and had a significant impact on the Saudi Arabian economy.

2. **Purpose and motivation.** This note examines the evolution of interconnectedness and its impact on policy constraints in Saudi Arabia. Given the country's dependence on oil, growing linkages with developing Asia, and the peg to the U.S. dollar, the note focuses on three external factors: (i) global oil prices, (ii) U.S. business cycle, and (iii) developing Asia's business cycle. The motivation for examining Saudi Arabia is not only because it is an interesting case in its own right, but also because it illustrates many features that are common across resource rich economies. In particular, Saudi Arabia exhibits a low degree of economic diversification with the oil sector accounting for over half of GDP and oil exports accounting for over 80 percent of export receipts.

<sup>1</sup> Prepared by Niklas Westelius (MCD).

Furthermore, as oil revenues primarily accrue to the government, the public sector plays a central and dominant role in the non-oil economy. Finally, with the exchange rate pegged to the U.S. dollar and with a relatively open financial account, interest rate policy closely follows that of the U.S. Federal Reserve. All these characteristics can be found in many other resource rich countries albeit at varying degrees.

3. **Results.** The correlation of the Saudi business cycle with the U.S. has shifted over the past three decades with supply driven oil shocks causing a divergence in business cycle dynamics in the 1980s, while demand driven oil shocks in the 2000s—reflecting high growth in developing Asia—resulted in a convergence. It is further argued that the pass-through from global oil prices to fiscal spending has fallen over the past three decades, possibly accounting for the observed reduction in output volatility. Finally, based on empirical evidence, it is shown that credit dynamics are becoming increasingly more relevant for non-oil economic activity and that the importance of U.S. interest rate policy has likely risen in the 2000s.

4. **Implications.** Given the commitment to the fixed exchange rate and the on-going financial deepening, synchronization of the domestic and U.S. business cycles is likely to become increasingly relevant for the stabilizing impact of monetary policy. At the same time, the degree of structural interconnectedness with developing Asia has increased over time through growing trade flows and Asia's rising influence in the global oil market. Tensions between policy objectives are therefore more likely to arise when global oil prices and the Asian business cycle move counter-cyclically with the U.S. business cycle. Going forward, these tensions highlight the importance for Saudi Arabia of strong fiscal management as well as further refining macro prudential instruments to influence monetary conditions independent of interest rate policy.

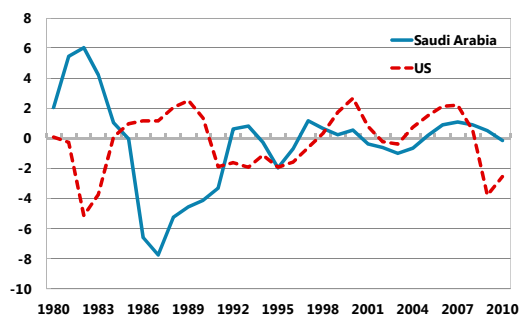
## B. Business Cycles and Global Oil Prices

5. **A glance at business cycle synchronization.** Figures 1 and 2 compare annually de-trended U.S. and developing Asia's real GDP with real non-oil GDP of Saudi Arabia.<sup>2</sup> The data cover the three decades from 1980 to 2010. Figure 3 compares fluctuations in Saudi non-oil GDP with the average global oil price. Four observations immediately stand out. First, there is a clear negative relationship between U.S. and Saudi Arabian economic fluctuations in the 1980s. This negative correlation is later reversed and a positive relationship emerges in the mid-1990s. Second, economic fluctuations in developing Asia do not appear to be well correlated with Saudi non-oil GDP in the first half of the sample, but become positively correlated at the end of the 1990s and throughout the 2000s. Third, oil prices tend to be positively correlated with Saudi non-oil GDP throughout the whole sample period. Finally, volatility in Saudi non-oil GDP falls significantly in the 2000s. This also appears to be true in comparison to the U.S. and developing Asia.

<sup>2</sup> Developing Asia includes Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Fiji, India, Indonesia, Kiribati, Lao PDR, Malaysia, Maldives, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Samoa, Solomon Islands, Sri Lanka, Thailand, Timor-Leste, Tonga, Vanuatu, and Vietnam.

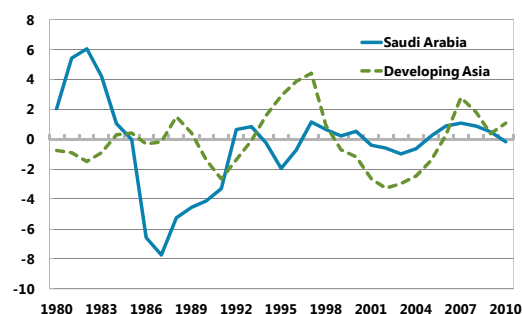
6. **A simple correlation analysis.** The conditional relationship between the three external factors and the Saudi non-oil economy can be examined via a simple regression with Saudi Arabia's non-oil GDP as the dependent variable and U.S. and developing Asia's real GDP together with the average oil price as independent variables. All variables are de-trended using the HP-filter. The assumption of exogeneity of the explanatory variables is fairly non-controversial as economic fluctuations in the U.S. and developing Asia and movements in the global oil price are unlikely to be affected by Saudi non-oil GDP. Given the observed reversal in business cycle correlations, the regression analysis is conducted on the full sample as well as for two subsamples i.e., 1980–1995 and 1996–2010. The results (shown in Table 1) are in broad agreement with the observations from figures 1–3. When the full sample is used, U.S. real GDP is negatively and statistically significant related to Saudi non-oil GDP. When splitting the sample, the negative relationship only holds for the 1981–1995 period while it turns positive in the 1996–2010 period. As expected, developing Asia's real GDP is not statistically significant when using the full sample, but positive and statistically significant for the 1996–2010 period. Finally, the oil price has a positive impact on non-oil GDP in the first period, but is neither economically nor statistically significant in the second period. The latter may reflect both that oil prices were primarily driven by global demand—captured through the Asian and U.S. business cycle dynamics—and that the pass-through from oil revenues to fiscal spending has declined (section III).

Figure 1. Cyclical GDP of United States and Saudi Arabia



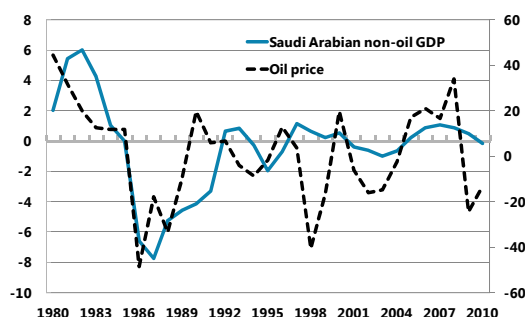
Sources: National authorities and author's calculations

Figure 2. Cyclical GDP of developing Asia and Saudi Arabia



Sources: National authorities and author's calculations

Figure 3. Oil price and Saudi Arabia non-oil GDP



Sources: National authorities and author's calculations

Table 1. Relevance of external factors for the Saudi non-oil economy

Independent Variables*	Sample Period		
	1980-2010	1980-1995	1996-2010
U.S GDP	-0.66*	-1.02*	0.20*
Std. error	(0.24)	(0.48)	(0.10)
Developing Asia GDP	-0.05	0.43	0.21*
Std. error	(0.21)	(0.48)	(0.06)
Oil Price	0.18*	0.25*	-0.01
Std. error	(0.04)	(0.07)	(0.02)
R-squared (adj)	0.49	0.69	0.40

\* All variables were detrended using the HP filter  
Sources: National authorities and author's calculations

7. **Demand and supply driven oil shocks.** What could explain the divergence between U.S. and Saudi business cycles in 1980s and subsequent correlation reversal in the late 1990s and 2000s? To a large extent the answer is related to whether the oil price cycle was supply or demand driven. For Saudi Arabia, as a net oil exporter, it is largely irrelevant (at least in the initial stage) whether a rise in the global oil price is due to a positive demand shock or a negative supply shock. Both will cause oil export revenues to rise. However, for a net oil importer such as the U.S. the economic impact of a supply driven or demand driven oil shock is quite different. For instance, a rise in the oil price due to a supply shock increases the cost of production, leads to output contraction and raises prices. Thus, one possible explanation for the observed reversal of business cycle correlations is that oil price shocks were primarily supply driven in the 1980s and early 1990s, while demand driven in the late 1990s and 2000s. Box 1 explores this explanation in more detail.

### C. Fiscal Policy and Oil Revenue Volatility

8. **Fiscal policy.** With government spending amounting to over 80 percent of non-oil GDP and the public sector taking a central role in the economy, fiscal policy constitutes the main driving force behind non-oil growth. The principal task for fiscal policy has been to balance development goals (i.e., invest in social and economic infrastructure and promote economic diversification) with macroeconomic stability in an environment of volatile oil revenues. To do so the government has engaged in counter-cyclical fiscal policy with respect to the oil price cycle. That is, when oil prices are low the government either draws down on international reserves or issues debt to finance its expenditure, and when oil prices are high part of the surplus is used to retire existing debt and build up reserves. Hence, by conducting counter-cyclical policy, the government attempts to smooth fiscal spending over time.

9. **Outcome.** How successful has the Saudi government been in its attempt to smooth spending in the face of volatile oil revenues? Table 2 summarizes the volatility in the growth rates of oil revenues and fiscal spending and the corresponding correlation coefficient for each of the past three decades. Several broad observations can be made. First, there is a clear positive relationship between oil revenue and spending growth over the past three decades. Second, oil revenue volatility was high in the 1980s, declined in 1990s, and rose again in the 2000s. Spending volatility, on the other hand, has fallen consistently over the past three decades. Finally, the correlation between revenue and spending was high in the 1980s and 1990s, but fell significantly in the 2000s. Hence, it appears that the fiscal authorities have been gradually more successful in smoothing spending despite continued oil revenue volatility. One major difference between the 1980s and 2000s was that oil revenues were declining for a significant portion of the 1980s while the opposite was true in 2000s. There might thus be an asymmetrical response to increases versus decreases in oil revenues. This could potentially explain why non-oil GDP in the 2000s was less volatile than in previous decades.



### Box 1. Demand and Supply Driven Shocks and Business Cycle Correlations

**The 1980s and early 1990s.** Three major oil supply disruptions occurred between 1978 and 1991: (i) the Iranian Revolution (1978–1979), Iraq’s invasion of Iran (1980–1981), and the first Gulf war (1990). The effect of these shocks on the Saudi Arabian economy was significant. The rise in the oil price in 1978–1981 caused oil export revenues in Saudi Arabia to increase by over 90 percent from approximately \$58 billion in 1978 to \$111 billion in 1981. This sizable windfall was partly spent as fiscal spending rose by 41 percent over the same time period and partly saved as international reserves. As a result, non-oil growth increased from 6 percent in 1979 to 10 percent in 1981.

Contrary to Saudi Arabia, the impact on the U.S. economy was far from favorable. Although many factors contributed to the U.S. recessions of 1979–1980 and 1981–1982, the rise in the price of oil is generally viewed as a significant contributor. The economic downturn in the U.S. and Europe in the early 1980s led to a sharp decline in oil consumption. To support the high oil price, OPEC assigned production quotas to each member. However, the bulk of the burden fell on Saudi Arabia which operated as the swing producer and was committed to the official price system. As a result, Saudi oil production fell sharply from 10 mbd in 1980 to about 3 mbd in 1985. Hence, at a time when the U.S. economy was recovering, the favorable conditions in Saudi Arabia began to deteriorate. Oil export revenues fell from \$111 billion in 1981 to \$11 billion in 1986 and spending fell from \$84 billion to \$37 billion over the same time period. The effect on growth was substantial as non-oil GDP contracted by 1.2 percent in 1984 and by 5.7 percent in 1986. However, with abandonment of its role as the swing producer in OPEC, Saudi Arabia’s oil revenues slowly began to recover, and the non-oil economy began to expand by the end of the decade.

By the end of the 1980s the U.S. economy was at its business cycle peak, but a financial crisis coupled with tighter monetary policy started to weigh on the economy and the economy fell into a recession in 1990. The oil price shock following Iraq’s invasion of Kuwait in August 1990 came therefore at an unfortunate point in time for the U.S. economy and likely worsened the downturn. Meanwhile, the oil price spike—coupled with an increase in Saudi Arabian oil production to compensate for the disruption in global supply—increased oil revenues in Saudi Arabia and further helped the domestic economy in its post-1986 recovery as non-oil growth rose above 5 percent in 1992.

**The late 1990s and 2000s.** Although several events occurred in the late 1990s and 2000s that had a significant impact on the global oil prices (e.g., the Asian crisis, the OPEC meeting in 1999, the recession in 2001 and the second Gulf War in 2003), the most striking characteristic in oil price dynamics has been the consistent upward trend since 1998.

Hamilton (2009) and other observers have attributed this upward trend to the strong growth performance of developing Asia and its impact on global oil demand. Indeed, the sharp increase in crude oil consumption in China, the main consumer within the block of developing Asian economies, is particularly impressive. Since mid 1990s crude consumption in China has increased from 3 mbd to above 8 mbd in 2010. The country’s share of global consumption increased from 4 percent to 10 percent over the same time period. Meanwhile the share of global crude oil consumption of developing Asia as a whole increased from 11 percent in 1995 to over 19 percent in 2010.

The rising demand for oil by developing Asia was particularly apparent in the period 2004–2008 as the price of oil climbed from an average of \$40 per barrel to over \$130 per barrel. During this time period developing Asia accounted for over 43 percent of the global increase in crude oil consumption while North America and Europe combined for 21 percent. Another contributing factor to the sharp rise in oil prices during this time period was the stability in global oil production. While the global economy grew by over 19 percent from 2004 to 2008, total oil production only rose by 1.8 percent (from 80.6 mbd to 82.0 mbd).

As oil price dynamics in the 2000s began to primarily reflect demand forces, the oil price cycle became increasingly procyclical. This, in turn, implied that the Saudi non-oil GDP began to co-move positively with both the U.S. and developing Asia’s GDP. The sharp increase in oil revenues in the latter part of 2000s translated into stable annual non-oil growth rates of 4 and 5 percent, the highest since the early 1980s.

Another argument for the increased relative importance of demand dynamics in the 1990s and 2000s is that Saudi Arabia has internalized the impact of negative supply shocks on revenue volatility by investing in, and using, spare capacity to smooth oil price dynamics (e.g., the Gulf Wars and the Libyan crisis).

**Table 2. Volatility and correlation of oil revenue, spending and non-oil growth**

	Oil revenue growth volatility (std)	Spending growth volatility (std)	Correlation between oil revenue and spending growth	Non-oil growth volatility (std)
1980s	44.4	19.8	0.9	4.6
1990s	21.1	16.2	0.7	1.6
2000s	38.5	6.4	0.2	0.7

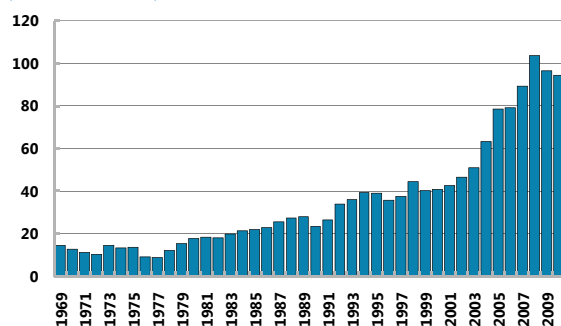
Sources: National authorities and author's calculations

## D. Financial Deepening and Monetary Policy

10. **Bank dominance.** As in most emerging economies, the financial system in Saudi Arabia is dominated by commercial banks. As a consequence, monetary policy primarily influences economic activity through two channels; the exchange rate and bank lending. However, with the U.S. dollar peg and the open financial account, SAMA's ability to affect the economy through the exchange rate and the short-term interest rate is limited. Al-Jasser and Banafe (1999) lay out the channels of the monetary transmission mechanism in Saudi Arabia. They argue that the interest and credit channels are likely to be weak due to the presence of government controlled Specialized Credit Institutions (SCIs), lack of financial leverage, and imperfect pass-through of the policy rate to the lending rate due to imperfect competition.

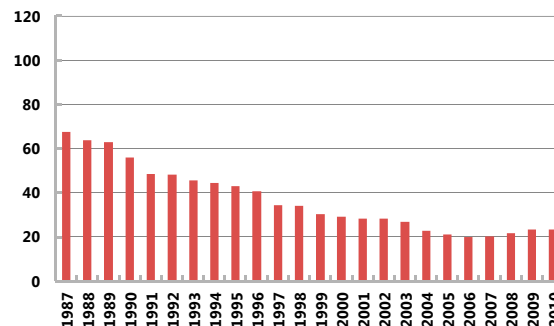
11. **Financial development.** Since 1999, however, the banking system in Saudi Arabia has grown significantly in size while the relative importance of SCIs has declined (see Figures 4 and 5). Furthermore, SAMA has taken steps to liberalize the banking system and allow for increased competition (SAMA, 2003). An increased presence of foreign banks has also emerged, following Saudi Arabia's accession to the WTO (Ramady, 2010). Thus, as the financial system has deepened and the frictions identified by Al-Jasser and Banafe (1999) have loosened up, it is reasonable to assume that the effectiveness of monetary policy has increased over time.

**Figure 4. Credit by commercial banks**  
(Share of non-oil GDP)



Source: Saudi Arabian Monetary Agency

**Figure 5. Credit by Specialized Credit Institutions (SCIs)**  
(Share of non-oil GDP)

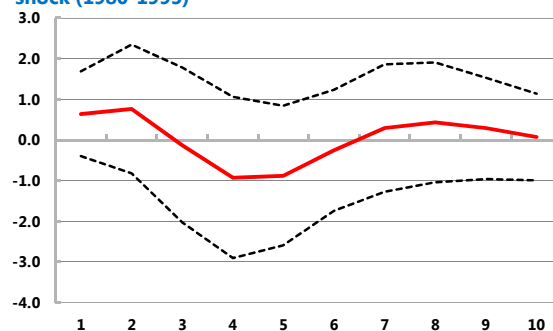


Source: Saudi Arabian Monetary Agency

12. **Credit and non-oil GDP.** The first step in assessing the evolving relevance of monetary policy is to examine whether credit has become increasingly more important to business cycle dynamics.

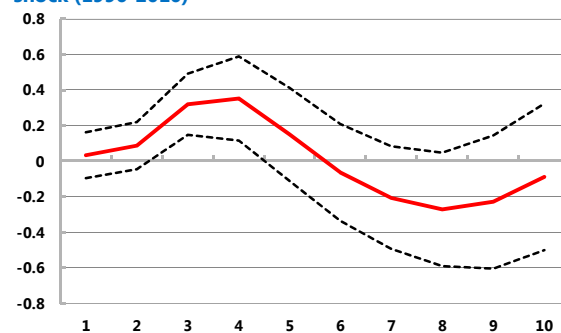
- Granger causality test.** The test addresses the following question: Can real credit help forecast fluctuations in non-oil GDP (and vice versa) and has its ability to do so changed over time? Based on annual de-trended data of real credit and non-oil GDP from 1980 to 2010 the answer is no. That is, real credit does not *Granger cause* non-oil GDP and vice versa. However, when splitting the sample, results change significantly. In particular, for the sample period 1996–2010, the null of no Granger causality is rejected, supporting the notion that real credit has become more important to the non-oil economy over time.
- Impulse responses.** To further investigate the relationship between bank credit and non-oil economic activity over time, a simple bi-variate vector autoregressive model (VAR) was constructed. The model was estimated with two lags as suggested by the AIC lag order selection criteria. The identification scheme assumes that non-oil GDP reacts contemporaneously with a shock to credit, but not the reverse. The results do not change markedly if the reverse ordering is used. Again, the model is first estimated for the full sample and then for the subsamples 1980–1995 and 1996–2010. For the full sample, the response of non-oil GDP to a one standard deviation shock to real credit is positive in the first two years, but insignificant. The dynamics change substantially when the sample is split. Non-oil GDP still responds positively initially to real credit shocks in both sub-periods. However, although the magnitude of the response is smaller, the positive effect is more prolonged and statistically significant in the 1996–2010 period (see Figures 6 and 7).
- Variance decomposition.** The results from the corresponding variance decomposition shows that that real credit explains more of the forecast error variance of non-oil GDP in the 1996–2010 period (58 percent after 5 years) compared to the 1980–1995 period (40 percent after 5 years). Again, this seems to indicate an increased relevance of credit for the non-oil economy.

**Figure 6. Response of non-oil GDP to a one std real credit shock (1980-1995)**



Sources: Author's calculations

**Figure 7. Response of non-oil GDP to a one std real credit shock (1996-2010)**



Sources: Author's calculations

13. **Interest rates and real credit.** The results from the VAR using annual data indicate evidence in favor of increased relevance of real credit for non-oil activity. But how has the imported interest rate policy affected real credit over time?

- Vector autoregressive model:** To answer this question a monthly VAR was specified with credit and the CPI as endogenous variables and the 3-month LIBOR, oil price and an international food price index as exogenous variables. The VAR is estimated by log-differencing the variables (except for the LIBOR). The main objective is to test whether the LIBOR significantly impacts credit and inflation. Table 3 displays the results from the VAR with respect to the exogenous variables. The full sample is 1997:1 to 2008:9. The end date was picked to exclude the global financial crisis as it represents a structural break in U.S. monetary policy as well as a sharp disruption in the overall economic environment. Furthermore, the model was estimated for two sub samples (1997:1–2003:12 and 2003:9–2008:9) to evaluate the evolution of the interest rate channel over time.
- Results:** When using the full sample the LIBOR is negatively correlated with credit growth and positively related to inflation, but the net effect of a rise in the LIBOR would be a decline in real credit growth. However, none of the exogenous variables are statistically significant. When the sample is split, statistical significance emerges in both sub-samples. In the first period a statistically significant relationship between LIBOR and credit growth is not established. However, for the later period LIBOR has a negative and statistically significant impact on credit growth. Interestingly, the reverse is true for LIBOR and CPI inflation. In the first period LIBOR has a negative and statistically significant effect on inflation, while the relationship breaks down in the second period. Note that an increase in LIBOR on real credit growth is positive in the first period, but negative in the second. The period 2003:9–2008:9 also shows some significance in terms of other exogenous variables. As expected, the oil price has a positive impact on credit growth and international food prices have a positive impact on inflation. Perhaps more surprisingly is that the nominal effective exchange rate is positively and significantly correlated with credit growth.

**Table 3. The impact of LIBOR on credit and inflation**

Exogenous Variables	1997:1-2008:9		1997:1-2003:8		2003:9-2008:9	
	Credit	CPI	Credit	CPI	Credit	CPI
3-Month LIBOR	-1.13 (1.14)	0.08 (0.17)	-0.20 (1.37)	-0.56* (0.19)	-4.01* (1.87)	0.54 (0.32)
Oil price	0.02 (0.02)	0.01 (0.01)	-0.03 (0.02)	0.00 (0.00)	0.14* (0.03)	-0.01* (0.01)
International food price	0.00 (0.07)	0.00 (0.00)	0.01 (0.09)	-0.02 (0.02)	-0.06 (0.09)	0.04* (0.02)
NEER	0.01 (0.14)	-0.01 (0.02)	-0.28 (0.16)	0.01 (0.02)	0.45* (0.22)	-0.04 (0.04)
R-squared (adj)	0.13	0.35	0.19	0.29	0.27	0.41
Number of observations	137		78		61	

Note: The optimal length criteria was chosen by considering five different lag order selection criteria.

## E. Conclusion

14. **Summary of results.** This paper examined the evolution of Saudi Arabia's interconnectedness with the global economy and the constraints that these linkages impose on domestic policy. Two important developments over the past couple of decades were emphasized. First, growing oil needs from EMEs has become increasingly important for oil market dynamics. Second, financial sector development in Saudi Arabia has strengthened the monetary transmission mechanism. The former implies greater influence of EMEs economic fluctuations on Saudi oil export revenues, while the latter suggests greater influence of U.S. monetary policy on the Saudi non-oil sector. It was also argued that fiscal policy has been increasingly more successful to smooth spending despite continued volatility in oil revenues, possibly accounting for the lower output volatility in 2000s.

15. **Going forward.** As external links continue to evolve it is imperative to understand the implications for domestic policy. Given Saudi Arabia's growing interconnectedness with developing Asia (e.g., China and India) and the continued commitment to the U.S. dollar peg, tension between policy objectives is likely to arise when global oil prices move counter-cyclically with the U.S. business cycle. For instance, the collapse of Libya's oil exports in 2011 boosted oil revenues and fiscal spending in Saudi Arabia. At the same time, the debt crisis in Europe raised concerns of a global economic downturn. The combination of expansionary fiscal policy and accommodative monetary policy in the U.S. may again cause inflationary pressure to rise. These developments underline the importance for Saudi Arabia to effectively use fiscal policy as a stabilizing tool and to further refine macro prudential instruments to influence monetary conditions independent of interest rate policy.

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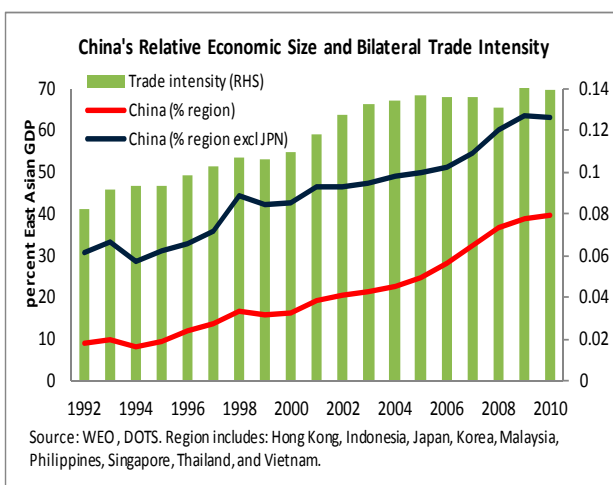
## V. ASIAN SUPPLY CHAIN: A CASE STUDY<sup>1</sup>

This note seeks to examine the implications of increased trade linkages on policy setting in the Asian supply chain economies. With a vertically integrated production structure, particularly for machinery and electronics, the Asian supply chain appears closely linked to both the global electronics and to China's business cycle. China is at the 'core' of the cluster and a 'gatekeeper'. It therefore may have an important role as a propagator, and dampener, of shocks, and a bearing on the policies employed by the other cluster members. Taking a cluster-view thus can shed light on policy issues.

### A. Background

1. **The cluster.** The Asian cluster comprises, for the purposes of this note, economies identified on the basis of strong trade and (to a lesser extent) financial ties in the region. These include: China, Hong Kong SAR, Indonesia, Korea, Japan, Malaysia, Philippines, Singapore, Thailand, and Vietnam.

2. **Structure of the cluster.** Given its economic size and growing trade intensities with the cluster, China has been playing an increasingly "central" role in the cluster (see text figure).<sup>2</sup> China also connects the Asian cluster to other overlapping clusters due to its centrality to global trade (see text figure). The cluster analysis points to China as a 'gatekeeper'. As such, it could play an important role in transmitting shocks across the cluster or insulating the cluster from global shocks, provided it has sufficient policy buffers to act as a "circuit-breaker." As financial centers with numerous linkages to other countries outside the Asian supply chain, Hong Kong SAR and Singapore play important roles in linking the Asian trade cluster to global financial centers and intermediating financial flows from a wider set of countries to the rest of the region. Hong Kong SAR and Singapore may also act as conduits through which financial shocks can spill over into trade shocks across the cluster.



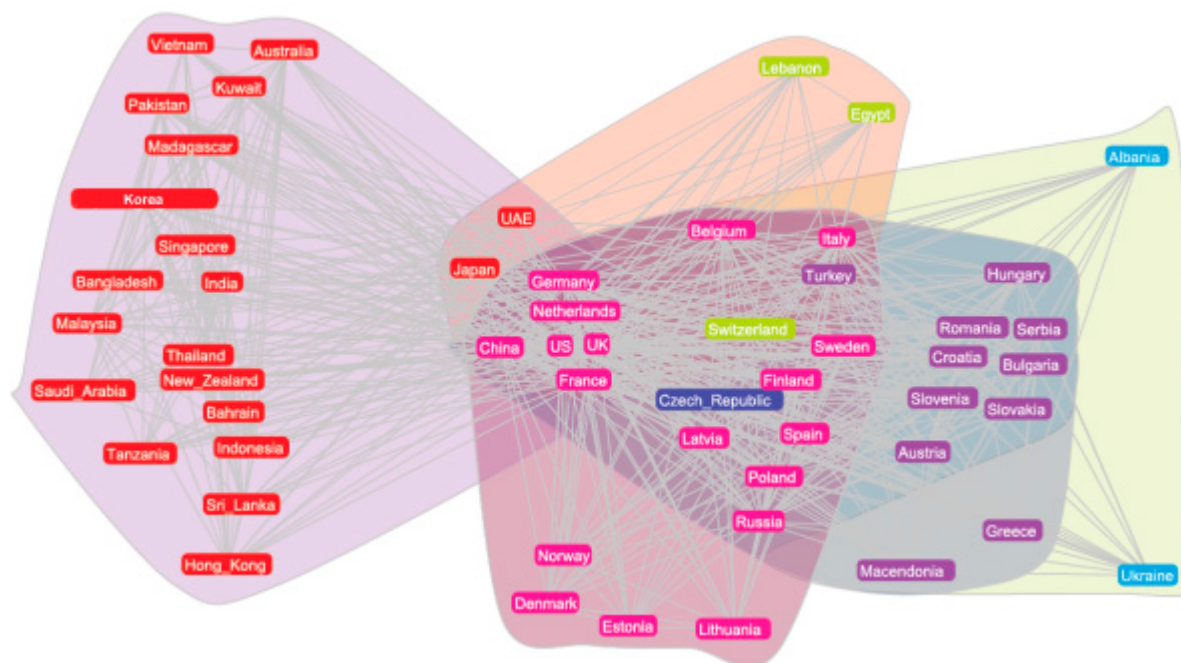
3. **Preliminary findings.** The Asian cluster is underpinned by a vertical production structure that links the output and export structures of the economies in the region, but not necessarily their monetary policy frameworks or exchange rate regimes. The latter, in theory, should provide an additional policy lever not available in the other clusters, such as in the Baltics or Central and Eastern

<sup>1</sup> Prepared by Nagwa Riad and Swarnali Ahmed (SPR) and Samar Maziad (MCM).

<sup>2</sup> Following Frenkel and Rose (1996), bilateral trade intensity is defined as  $wt_{ij} = (X_{ijt} + M_{ijt}) / (X_{it} + X_{jt} + M_{it} + M_{jt})$ , where:  $X_{ijt}$  denotes total nominal exports from country  $i$  to country  $j$  during period  $t$ ;  $X_{it}$  denotes total global exports from country  $i$ ; and  $M$  denotes imports. Higher values of  $wt_{ij}$  indicate greater trade intensity between countries  $i$  (East Asia) and  $j$  (China).

Europe. But, in practice, countries could be internalizing—to varying degrees—the policies and actions taken not only in China, but also other countries in the cluster. This could affect the policy space and options of any single country and conditions its responses. It also underlines the scope for cooperation and for the Fund to potentially bring a cluster-based lens to its surveillance work.

Figure 1. Asian Trade Cluster



4. **Analytical approach.** This note combines network-based cluster analysis with correlation analysis and a narrative approach to shed light on the potential policy implications of belonging to the cluster. The next section documents the evolution of trade and financial linkages, i.e., the fundamentals, underpinning the cluster. Section III examines the impact of these fundamentals on business cycle synchronization. Section IV looks into the effect of belonging to the cluster on policy choices by focusing on the experience of a sub-set of economies in the period following China’s exchange rate reforms up to the crisis (mid-2005 to 2008).

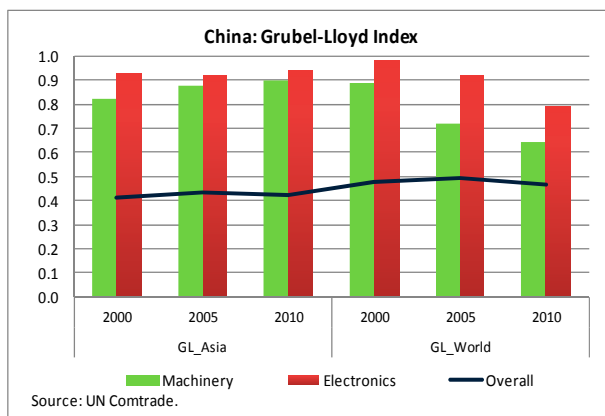
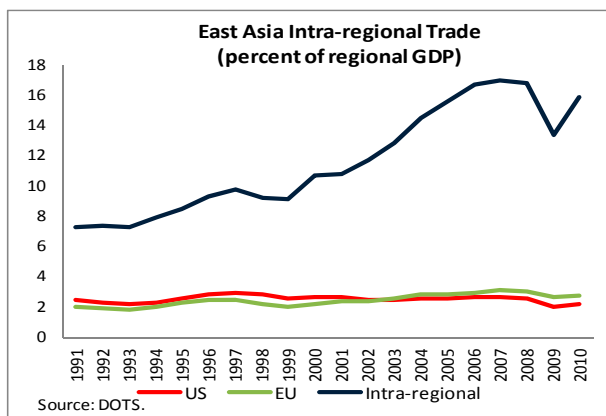
## B. Trade and Financial Linkages

### Trade Linkages

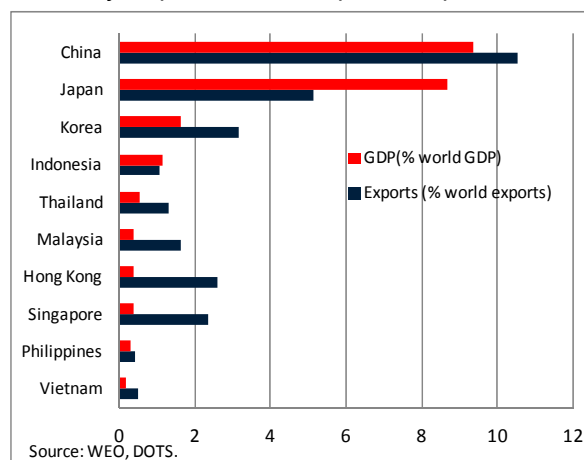
5. **Growing intra-regional and intra-industry trade.** Intra-regional trade (measured by imports) among cluster economies has grown at a much faster pace compared to that with the United States and European Union, to reach a peak of 17 percent of GDP in 2008 (see Figure 2). Trade between China and other cluster economies is also mostly of the intra-industry type, especially in the electronics and machinery sectors, as illustrated by the Grubel-Lloyd index (which takes the value of zero if no products in the same category are both exported and imported and one if all trade is intra-industry). The extent of intra-industry trade has also increased over time, against a

declining trend in China’s trade with the world. Almost half of China’s imports of capital and intermediate goods are from cluster countries, and 40 percent of its exports are destined to them.

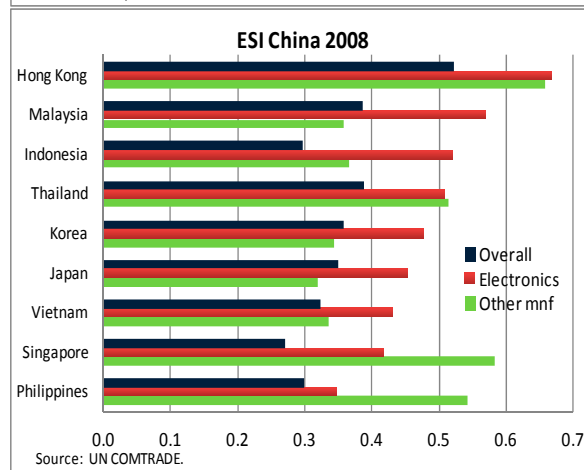
Figure 2. Asia: Growing Intra-Regional and Intra-Industry Trade



6. **Export dependence.** Countries in the cluster are heavily dependent on exports. Exports as a share of GDP exceed 100 percent in Singapore, Hong Kong SAR, and Malaysia, although they account for less than 3 percent each of total world exports. In contrast, whereas exports account for only 27 percent of GDP, Chinese exports account for close to 11 percent of global exports (text figure). China is therefore an important outlet for exports of cluster economies. Moreover, and with the exception of Vietnam and Hong Kong SAR, most cluster countries had fairly small trade balances (either deficit or surplus) with China up until the crisis in 2008. Given this overall export dependence, economies in the cluster could be sensitive to exchange rate changes vis-à-vis China.



7. **Convergence in export structures.** The export similarity index (ESI) (calculated at the 6-digit product level) is a common indicator to gauge export competitiveness, defined following Finger and Kreinin (1979), and takes the value of 1 for identical export structures and zero otherwise (See Riad et al, 2012 for details). Export structures in cluster countries are fairly similar to China’s, and similarity is much higher for individual subsectors such as electronics and other manufactures (text figure). At the same time, given vertical production





structures, a high ESI value could also reflect complementarity (see Riad et al., 2012 for details). Electronics trade is particularly important for the region, accounting for about 25 percent of China's total imports and exports in 2010; of electronics imports, almost half come from cluster partners. Imports and exports of electronics between China and the region have grown remarkably; in contrast, the G7 (excluding Japan) remains important for China on export side, but significantly less so on the import side. With emerging Asia competing with China in electronics and manufactures and to preserve market share, they may be less willing to allow too much flexibility in their currencies, especially vis-à-vis China.

## Financial Linkages

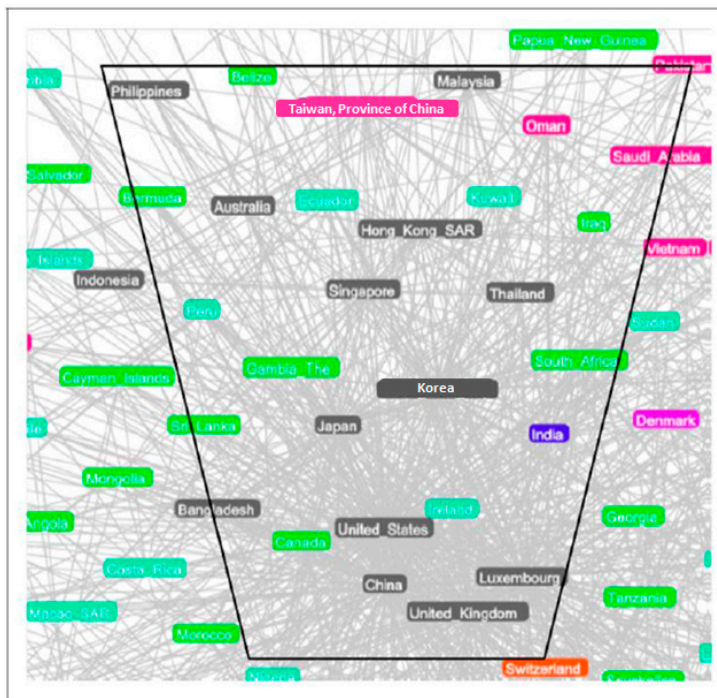
8. **Growing financial links.** While Hong Kong SAR is an important channel of financial flows in and out of China, Singapore is a hub of the Asian Dollar Market (ADM) intermediating financial flows from a wider set of countries not only in Asia (such as Malaysia and India), but also from the main oil producers such as Kuwait and Saudi Arabia to the rest of the region (see also Table 4 in Chapter VI). In addition to the role of Hong Kong SAR and Singapore as equity and fixed income hubs facilitating Asian trade, an important aspect of financial linkages throughout East Asia is through FDI (Table 1), and likely also asset and equity holdings by government-owned corporations or sovereign wealth funds (SWF). While very limited information is available, asset and equity holdings by government-owned corporations suggest an additional layer of (non-trivial) financial linkages in the region. For the three SWFs in Singapore (Temasek), China (China Investment Corporation), and Korea (Korea Investment Corporation), investments in Asia were about 45 percent, 30 percent, and over 15 percent (of total reported portfolio by value) as of end-2010.

Table 1. Foreign Direct Investment

East Asia: FDI Patterns, 2010 (USD millions)						
Reporting	Inward			Outward		
		Amount	% Total		Amount	% Total
<b>China</b>	Hong Kong SAR	710,852	45%			
	Japan	106,303	7%	NA	NA	
	Singapore	62,543	4%			
	<b>Sub-total region</b>	<b>879,698</b>	<b>56%</b>			
<b>Malaysia</b>	Singapore	16,348	16%	Singapore	16,654	17%
	Japan	12,168	12%	Indonesia	12,560	13%
	<b>Sub-total region</b>	<b>28,516</b>	<b>28%</b>	<b>Sub-total region</b>	<b>29,214</b>	<b>30%</b>
<b>Thailand</b>	Japan	44,479	32%	Singapore	2,692	11%
	Singapore	17,994	13%	China	1,761	7%
				Malaysia	1,628	7%
	<b>Sub-total region</b>	<b>62,473</b>	<b>45%</b>	<b>Sub-total region</b>	<b>6,081</b>	<b>25%</b>
<b>Philippines</b>	Japan	5,291	25%	Singapore	1,889	54%
	Singapore	2,420	11%	Hong Kong SAR	22	1%
	Hong Kong SAR	1,398	7%			
	<b>Sub-total region</b>	<b>9,109</b>	<b>43%</b>	<b>Sub-total region</b>	<b>1,911</b>	<b>55%</b>
<b>Hong Kong SAR</b>	China	375,147	38%	China	330,770	41%
<b>Japan</b>	Singapore	13,912	6%	China	66,527	8%
<b>Singapore</b>	Japan	39,761	9%	NA	NA	

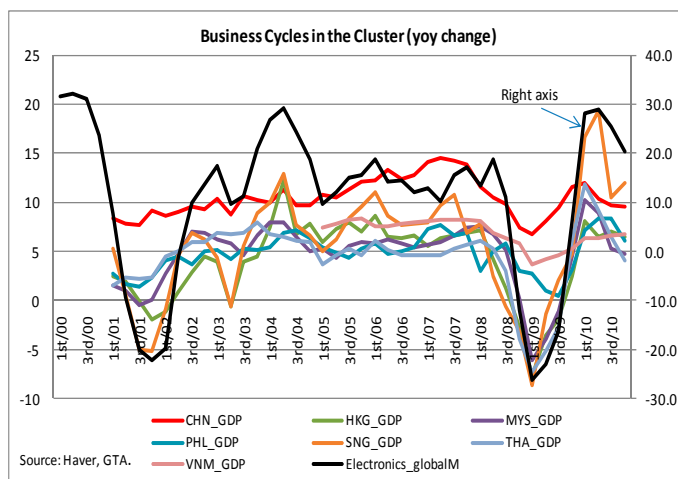
Source: CDIS.

9. **Financial gatekeepers.** Hong Kong SAR and Singapore also play an important role in linking the Asian cluster to global financial centers such as the United Kingdom, Luxembourg and Switzerland (text figure). Whereas UK banks have by far the largest presence in Asia, recent Fund analysis suggests that Asian countries may be particularly impacted by deleveraging by Euro zone banks which provide a large proportion of total trade credit in Asia (French and Spanish banks account for about 40 percent; Aiyar, 2011). Credit extension may also be hard hit, given that Euro zone banks are very active in this area, including in syndicated trade credit. At the same time, given the important role of Singapore in intermediating funds in and out of the region, a reduction in ADM interbank activity could significantly impact the provision of trade financing to the region. Trade credit is therefore an important link between financial and trade clusters in Asia and a channel through which financial shocks can spill over to a trade cluster.



### C. Stylized Facts: Correlations

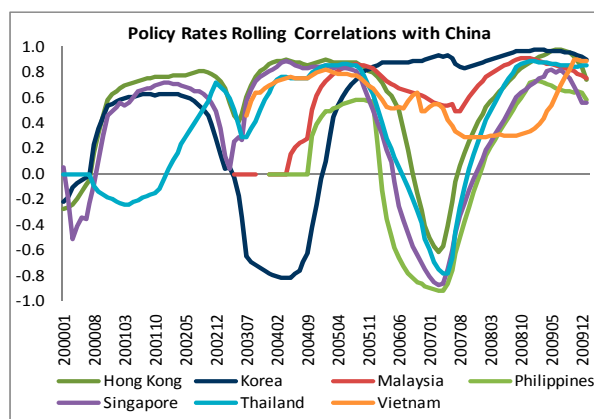
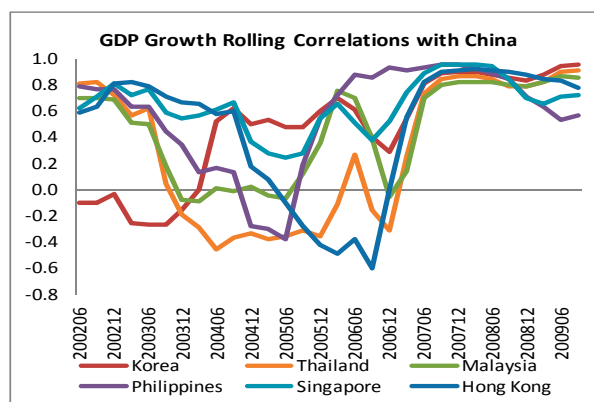
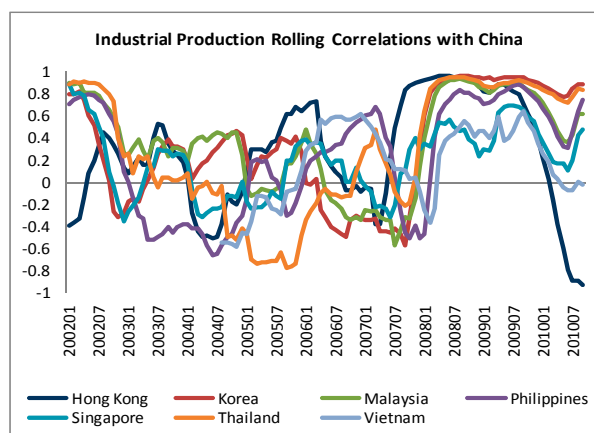
10. **Output synchronicity.** Given vertically integrated production structures, particularly for machinery and electronics, the Asian cluster is closely linked to the global electronics business cycle, with the result that business cycles in the cluster are largely synchronized with China's. GDP changes are quite synchronized across the cluster, although the depth of the contraction during the recent crisis varies across countries (text figure). This is broadly consistent with the literature that suggests higher business cycle correlation across countries whose bilateral sectors use each other as intermediate inputs, with vertical production linkages providing the main channel through which trade generates business cycle synchronicity (Di Giovanni and Levchenko, 2009; Ng, 2010).



11. **Correlation analysis.** To further analyze co-movements, unconditional correlation matrices were calculated across countries in the clusters for industrial production, interest rates, and exchange rates (see Appendix Table A1). Admittedly, in the present context of simultaneity, one needs to be careful in interpreting the results. Nonetheless, several points are worth noting. First, output variables are somewhat synchronized, as suggested by high correlations in industrial production. Correlations in industrial production are higher in the period since mid-2005, especially with respect to China and particularly for emerging Asia. Second, policy rates are also reasonably synchronized across the cluster, although the correlation with China is less obvious compared to industrial production. Finally, exchange rate correlations are relatively higher across emerging Asian countries in the cluster, albeit on the lower side for China. These are generally consistent with empirical research suggesting that while the impact of global factors on business cycle correlations in the Asian region has intensified over the past decade, a more sizable contribution in fact is attributed to regional factors (He and Liao, 2011).

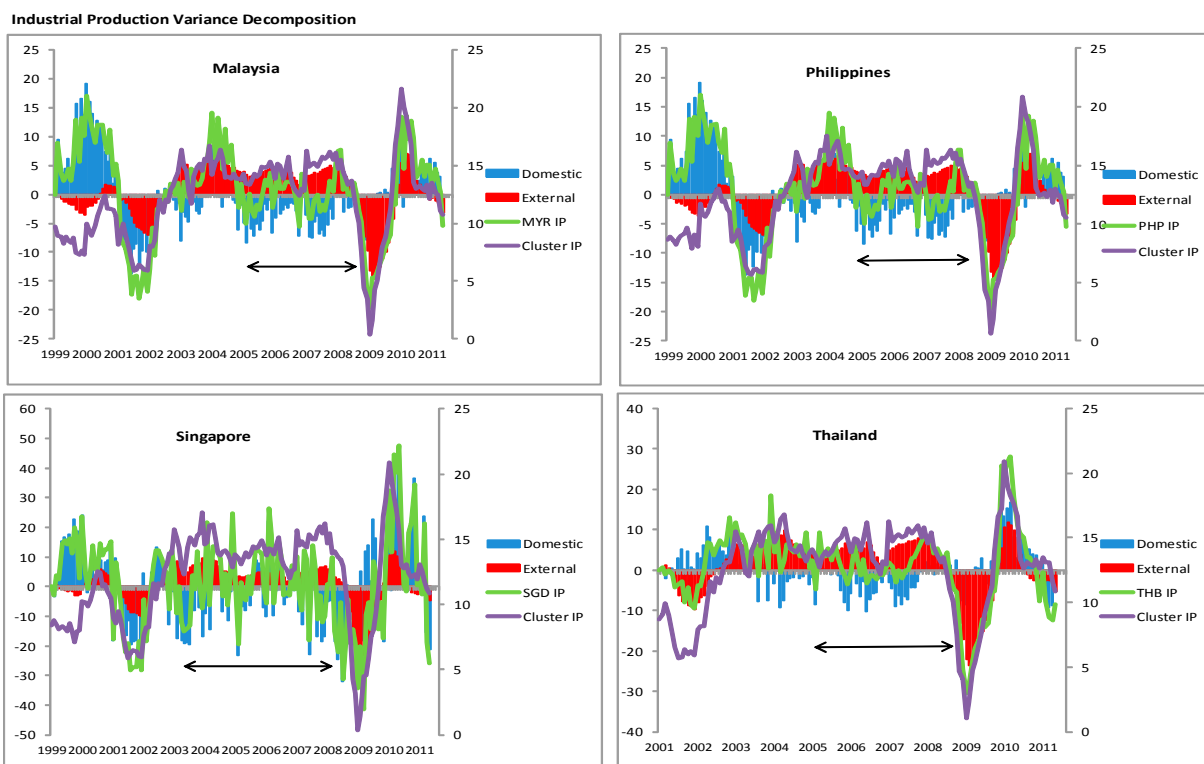
12. **Rolling correlations.** Rolling correlations with China on a subset of economies from 2002 to 2010 also point to a sharp increase in co-movement in GDP growth and industrial production during periods of financial stress (see text figures). The following points are noteworthy:

- Industrial production and GDP growth correlations points to some divergence during ‘peace’ time 2004-2007/8, before rising and peaking during the global crisis.
- However, *policy rate correlations appear more persistent over the entire period, even at times of lower output correlation.* For instance, it is possible to identify a drop in correlation of GDP growth and industrial production from 2002 to 2006, while policy rate correlations remains relatively high. This would point to possible tradeoffs/stresses in policy making germane to members in the cluster.



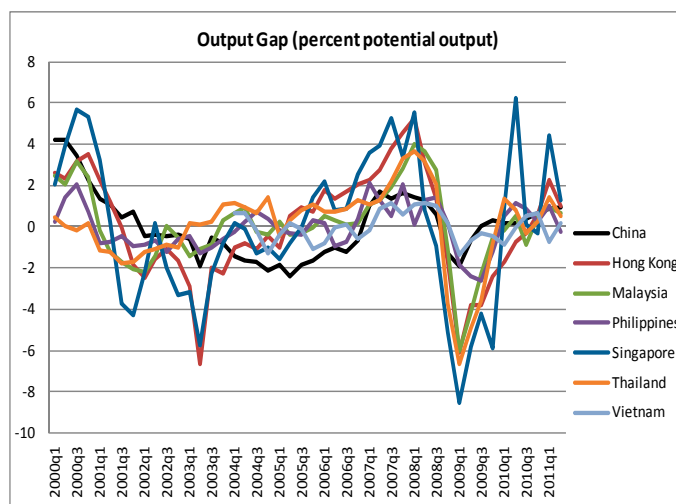
He and Liao (2011) also find that despite a rising contribution of regional factors in business cycle correlation in Asia, the impact on individual countries has varied, with Malaysia and Thailand being most impacted by regional factors.

13. **Historical decomposition.** The variation in industrial production cycles is further decomposed into domestic and external/cluster specific factors (see figures below). Cycles are to a large extent synchronized between 2000 and 2004, and during the crisis. Between 2004 and 2008, however, there appears to be a divergence between country-specific and cluster-wide cycles. The analysis broadly confirms correlation-based findings and the fact that for emerging Asian countries such as Malaysia, Thailand and the Philippines, the importance of cluster-wide factors in explaining the variance in industrial production has increased since 2002.



Source: Haver and author calculation.

14. **Relative cyclical positions and policy mix.** To assess whether this divergence was policy-driven (i.e., due to independent policy actions in the cluster countries relative to the gatekeeper) or due to idiosyncratic shocks, we first consider the relative cyclical positions of countries in the cluster and then assess whether the policy mix was appropriate in response to those shocks (see text figure). Despite relatively synchronized industrial production cycles, output gaps across the cluster were somewhat less synchronized with China between 2004 and 2008, suggesting the scope for divergent policy mix across countries. For instance, output gaps turned positive starting 2004 for Malaysia, Singapore and Thailand, suggesting a need for policy tightening, against negative output gaps in China until mid-2006 where policies could remain relatively accommodative. From 2007 onwards, however, output gaps became more correlated, declining rapidly through early 2009 and recovering thereafter. The next section elaborates on the implications for the policy space in a subset of emerging Asian countries.

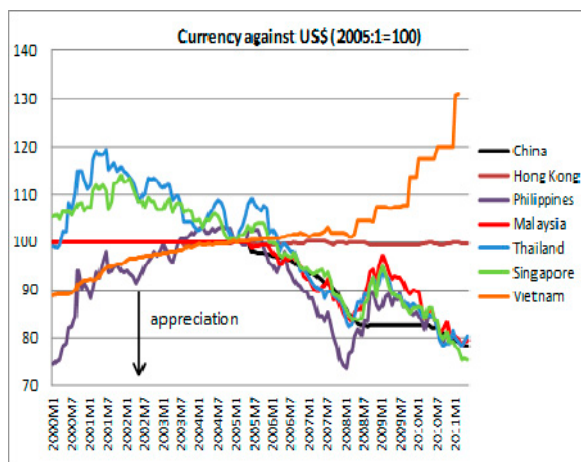


## D. Interlinkages and Policies

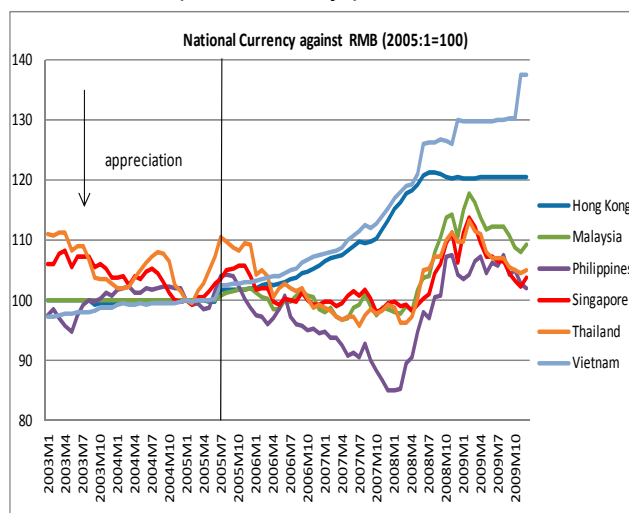
15. **China's growing centrality—premise.** Given vertically integrated trade structures and rising financial linkages with the region's largest economy, a key consideration may be that of preserving their place in the production structure relative to China that in part could result in maintaining relative currency stability vis-à-vis each other. This may particularly be the case for countries that are further down in the supply chain where processing trade plays an important part in overall export performance, such as Malaysia, Thailand, the Philippines, or Vietnam. In such cases, the availability of the exchange rate instrument as a policy tool in managing macroeconomic conditions, especially capital inflows, could become limited.<sup>3</sup> The analysis below focuses on a subset of Asian countries including Hong Kong SAR, Malaysia, Philippines, Singapore, and Thailand.

<sup>3</sup> Preliminary empirical analysis has lent support to the presence of a statistically significant foreign exchange effect of China in the Asian region, especially following its exchange rate reforms in mid-2005 (Fratzscher and Mahl, 2011).

16. **Policies in the gatekeeper.** Between 2003 and 2008, China grew at more than 10 percent per year, led by strong investment and export growth. Against the backdrop of large reserve buildup (reflecting large current account surpluses and strong capital inflows), pressures on the Chinese peg to the U.S. dollar intensified by 2005. In July 2005, the authorities announced reforms to the exchange rate regime to allow greater flexibility, with three key elements: an immediate 2.1 percent revaluation of the currency against the U.S. dollar; a daily fluctuation within +/- 0.3 percent band, with the closing rate being the reference rate for the following day; and its link to an undisclosed basket of currencies. Despite sustained capital inflows, the exchange rate appreciated cumulatively by 20¾ percent against the U.S. dollar by end-2008 (see text figure). It should be noted that China’s investment-driven growth continually added to the economy’s productive capacity, and thus inflationary pressures remained relatively contained. This may have provided the space for the Chinese authorities to pursue such gradual appreciation as monetary policy continued to rely heavily on administrative measures.



17. **Policy space in the cluster.** Following China’s exchange rate reforms in mid-2005 and in the period before the crisis, nominal exchange rates of the economies in the rest of the cluster appear to have been stable relative to the renminbi (see text figure). As Box 1 elaborates, policy responses to the surge in capital inflows starting 2003 and to China’s limited exchange flexibility to a large extent reflected initial conditions, or policy buffers. For instance, in *Malaysia*, fiscal consolidation accommodated a slower pace of currency appreciation in response to the surge in capital inflows. In contrast, in the *Philippines*, fiscal dominance effectively constrained the ability of monetary policy to mitigate the impact of the surge in capital inflows, and the authorities opted for greater nominal exchange rate appreciation to contain inflationary pressures (in fact, the currency appreciated the most against both the dollar and the renminbi). In *Thailand*, despite relatively prudent macroeconomic policies and a series of more targeted administrative measures to curb speculative inflows, currency appreciation outpaced other regional currencies both against the dollar and the renminbi and capital controls were imposed in end-2006, some of which were lifted only in mid-2008. Prudential measures therefore become an additional policy instrument in a situation where the traditional policy space is effectively “constrained” by policies undertaken in other countries in the cluster.



18. **The scope for greater coordination.** Several studies have attempted to discern the role of China's exchange rate policy on Asian countries and find evidence that policy makers paid attention to regional currency developments as China gradually strengthened the flexibility of its exchange rate regime.<sup>10</sup> These findings corroborate anecdotal evidence provided in Fund surveillance reports. The scope therefore appears to have existed to coordinate the policy dialogue at the level of the cluster.

19. **Gatekeepers and the role of buffers.** The analysis highlights the role of China in influencing developments and policies in the cluster. It also highlights its potential role as a "circuit breaker" in the face of a global demand shock, as was evident during the crisis. Because of its significant policy buffers, China's countercyclical response to the collapse in demand from advanced economies during the crisis mitigated the impact both on the Chinese economy and on economies in the cluster (note the sharp increase in rolling correlation at that time). With China being at the core of several overlapping clusters, it has the potential to link countries in the East Asian cluster to other clusters that may have been less impacted by the slowdown in advanced economies, such as surplus countries in the Middle East and other fast-growing emerging markets in Latin America.

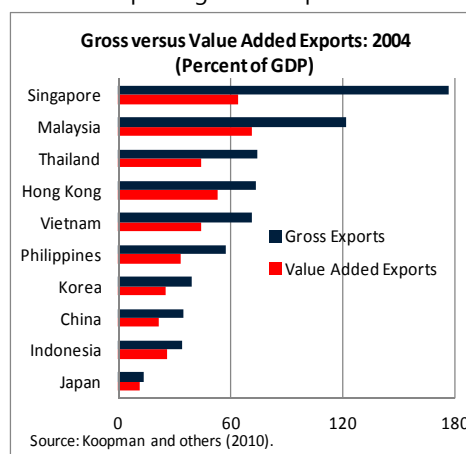
20. **Cluster-based surveillance.** The above analysis suggests the scope for surveillance to potentially focus on policy cooperation on a cluster level. A cluster-based approach to surveillance can help provide a context for policy responses across countries, by recognizing the nature and intensity of the links not only to the gatekeeper/core but also to others in the cluster. In addition to being able to make a judgment about the relative stability of belonging to certain clusters, it also helps to hone in on the buffers available to different countries so that 'gatekeepers' can act as 'circuit breakers'.

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<sup>10</sup> Ito (2010), for instance, shows that the renminbi had acquired a strong influence on Asian currencies between July 2005 and August 2008 and that it was fast gaining the status of an 'anchor' currency. Fratzscher and Mahl (2011) also find evidence of a statistically significant regional foreign exchange factor in emerging Asia's exchange rate dynamics.

**Box 1: Policies in a Cluster—A Narrative Approach Drawing from Staff Reports**

Renminbi appreciation is likely to be associated with a positive effect on firms exporting to China, and a negative effect on firms providing inputs for China’s processing exports and on firms importing Chinese products with large imported content (Eichengreen and Tong, 2011). In a vertically integrated trade cluster, the position of the country along the supply chain (i.e., upstream or downstream) and the extent of its reliance on imported inputs in its exports would influence the extent to which exchange rate movements vis-à-vis the renminbi would have real effects. Based on an analysis of value-added trade (as opposed to gross exports) to determine the extent to which a country relies on imported inputs in the production of its exports, Singapore, Malaysia and Thailand in the supply chain would be expected to be more impacted by exchange rate volatility both with respect to China, but also other countries in the cluster with whom they compete in third markets.



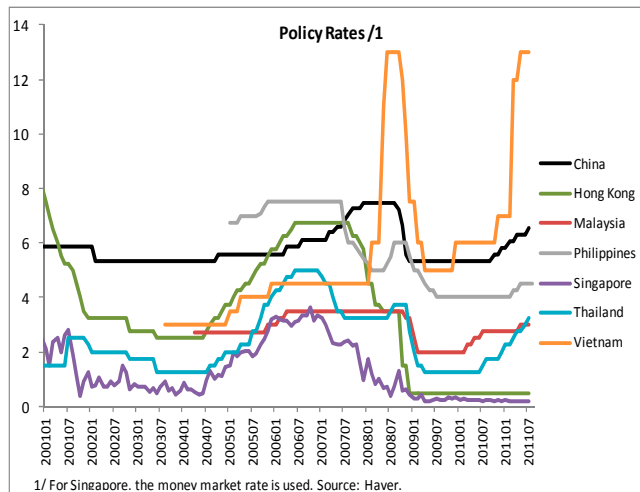
**Malaysia:** Between 2004 and 2007, Malaysia grew at an average of 6 percent per year amid an environment of broadly contained inflation. Fiscal policy focused on consolidation, bringing down the central government deficit from 4.1 percent of GDP in 2003 to 3.2 percent in 2007, and generally striking a balance between contributing to fiscal sustainability and supporting growth. Domestic credit was managed prudently, consistently with the peg until mid-2005 and with the managed float regime thereafter. Malaysia is also a very open economy and displays one the highest correlations with China in terms of industrial production and policy rates, especially after mid-2005. Like China, Malaysia’s exchange rate was pegged to the U.S. dollar, which it abandoned on July 22, 2005—one day after China. The exchange rate remained managed as limited movements closely followed the pace of renminbi appreciation until mid-2008. Policy buffers were deemed adequate, allowing Malaysia sufficient space to respond to a surge in capital inflows through limited exchange rate flexibility.

**Thailand:** During 2003-2008, growth rebounded strongly, amid generally contained inflation, albeit tempered by almost regular episodes of political unrest. Fiscal policy had generally been prudent, with the general government registering modest surpluses during this period, notwithstanding the broader objective of restoring investment to pre-crisis levels through public “megaprojects”. Thailand also exhibited one of the highest correlations with China in terms of industrial production. Unlike China, however, Thailand adopted an inflation targeting regime, and hence policies in 2006 faced, on the one hand, the need to raise interest rates to combat supply-side inflationary pressures (as the output gap turned positive) and, on the other hand, the need to curb the surge in speculative capital inflows (see figure below). These trade-offs resulted in the adoption of controls.

Despite a series of earlier, more targeted administrative measures to curb these flows, the rapid pace of appreciation and the fact that it was outperforming all other regional currencies confirmed to the authorities that pressure arose from short-term speculation rather than a long-run trend appreciation. The [2006 Article IV staff report](#) cited several reasons for this (largely speculative) influx, including Thailand’s relatively flexible exchange rate regime and open markets which facilitates position-taking, and attractive interest rate differentials, particularly when compared to funding currencies, including yen carry trade. As macroeconomic stability and competitiveness became serious concerns, the authorities imposed a number of capital controls in end-2006, some of which were only lifted in mid-2008.



**Philippines:** Unlike most countries in the cluster, the Philippines suffered from long-standing problems in the fiscal, power, and banking sectors. Fiscal deficits were relatively high, external financing requirements large, and debt levels remained elevated since the crisis. In response to the oil price shock and supply-side induced inflationary pressures in 2005, policy rates were raised, although the cumulative hike was much lower than those implemented in Thailand or Indonesia. During 2005-2007, greater (nominal) exchange rate appreciation allowed for robust growth with inflation within the target range, and helped manage exchange rate pressures in the



face of huge capital inflows. The peso appreciated by a cumulative 25 percent against the U.S. dollar and by 20 percent in real effective terms (more than other regional currencies). Fiscal dominance thus effectively constrained the ability of the inflation targeting regime in mitigating the effect of the surge in capital inflows, as the authorities opted for greater exchange rate appreciation to contain inflationary pressures.

**Singapore.** Faced with growing competitive pressures in traditional sectors from low cost regional economies such as China, in 2003 Singapore adopted a broad medium-term government sponsored agenda to 'remake Singapore.' The agenda focused on tapping new engines of growth and reorienting the economy towards higher-value and knowledge-based industries and services.

Since April 2004, monetary policy shifted to a tightening stance, by targeting a modest and gradual appreciation path. Following changes to the China's and Malaysia's currency regimes in July 2005, capital inflows increased as the Singapore dollar's use to proxy trade the renminbi and ringgit grew. The currency continued to trade in the upper half of the band throughout end-2007, and in April 2008, MAS re-centered the exchange rate policy band to help moderate inflation against a backdrop of continuing external and domestic cost pressures. Staff had recognized in 2005 that the impact on Singapore of the July regime changes was somewhat ambiguous. Increased flexibility in the renminbi implied appreciation against the Singaporean dollar and therefore an improved competitive position. However, many of the products and services exported to China and Malaysia are intermediate goods; much would depend on the impact of the appreciation on the demand for the final goods produced by the importers using such inputs. Cross exchange rates could therefore not be allowed to deviate much.

In the event, the currency closely tracked movements in the renminbi between end-2005 and mid-2008; the Singaporean dollar was virtually unchanged against the renminbi while appreciating significantly versus the U.S. dollar. In this case, the authorities opted to keep the exchange rate firmly focused on inflation, relying instead on structural reforms and fiscal policy to improve competitiveness.

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**Appendix Table A1: Unconditional Correlation Matrices**

Note: Data is monthly and covers the period 1998:1–2011:8.

Unconditional Correlation Industrial Production 1996:1-2011:08										
	China	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Thailand	Vietnam
China	1									
Hong Kong	<b>0.426</b> (5.89)	1								
Indonesia	<b>0.332</b> (4.47)	<b>0.185</b> (2.45)	1							
Japan	<b>0.602</b> (9.57)	<b>0.509</b> (7.68)	<b>0.328</b> (4.58)	1						
Korea	<b>0.327</b> (4.39)	<b>0.234</b> (3.12)	<b>0.404</b> (5.82)	<b>0.633</b> (10.77)	1					
Malaysia	<b>0.364</b> (4.94)	<b>0.365</b> (5.10)	<b>0.501</b> (7.60)	<b>0.695</b> (12.66)	<b>0.695</b> (12.67)	1				
Philippines	<b>0.192</b> (2.38)	<b>0.385</b> (5.02)	<b>0.283</b> (3.59)	<b>0.703</b> (12.02)	<b>0.472</b> (6.52)	<b>0.544</b> (7.89)	1			
Singapore	<b>0.347</b> (4.69)	<b>0.418</b> (5.97)	<b>0.141</b> (1.87)	<b>0.589</b> (9.58)	<b>0.549</b> (8.65)	<b>0.511</b> (7.80)	<b>0.395</b> (5.23)	1		
Thailand	<b>0.729</b> (11.89)	<b>0.228</b> (2.57)	<b>0.221</b> (2.54)	<b>0.846</b> (17.77)	<b>0.787</b> (14.28)	<b>0.768</b> (13.34)	<b>0.641</b> (9.29)	<b>0.520</b> (6.79)	1	
Vietnam	<b>0.373</b> (3.46)	<b>0.281</b> (2.48)	<b>0.253</b> (2.25)	<b>0.385</b> (3.59)	<b>0.383</b> (3.57)	<b>0.514</b> (5.16)	<b>0.447</b> (4.29)	<b>0.354</b> (3.26)	<b>0.376</b> (3.49)	1

Source: Haver.

Unconditional Correlation Policy Rates 1996:1-2011:08										
	China	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Thailand	Vietnam
China	1									
Hong Kong	<b>0.156</b> (2.15)	1								
Indonesia	<b>-0.230</b> (-3.22)	0.019 (0.26)	1							
Japan	<b>0.712</b> (12.03)	<b>0.469</b> (6.29)	<b>0.165</b> (1.99)	1						
Korea	<b>0.832</b> (17.32)	<b>0.565</b> (7.89)	0.058 (0.67)	<b>0.733</b> (12.41)	1					
Malaysia	<b>0.711</b> (8.69)	<b>0.597</b> (6.41)	<b>0.367</b> (3.39)	<b>0.582</b> (6.16)	<b>0.911</b> (19.01)	1				
Philippines	-0.044 (-0.35)	<b>0.471</b> (4.30)	<b>0.539</b> (5.16)	0.103 (0.84)	<b>0.297</b> (2.51)	<b>0.496</b> (4.61)	1			
Singapore	-0.036 (-0.48)	<b>0.642</b> (11.39)	0.040 (0.55)	0.094 (1.12)	<b>0.266</b> (3.18)	<b>0.350</b> (3.21)	<b>0.662</b> (7.13)	1		
Thailand	<b>0.341</b> (3.98)	<b>0.469</b> (5.84)	<b>0.663</b> (9.74)	<b>0.537</b> (1.65)	<b>0.755</b> (6.99)	<b>0.752</b> (9.89)	<b>0.551</b> (9.19)	<b>0.551</b> (7.27)	1	
Vietnam	<b>0.453</b> (4.59)	-0.076 (-0.68)	<b>0.323</b> (3.09)	0.177 (1.63)	<b>0.557</b> (6.08)	<b>0.517</b> (5.19)	<b>0.316</b> (2.68)	-0.152 (-1.39)	<b>0.481</b> (4.97)	1

Source: Haver.

Unconditional Correlation Exchange Rates 1996:1-2011:08										
	China	Hong Kong	Indonesia	Japan	Korea	Malaysia	Philippines	Singapore	Thailand	Vietnam
CHN_DER	1									
HKG_DER	<b>0.157</b> (2.15)	1								
IDN_DER	0.038 (0.52)	-0.105 (-1.43)	1							
JPN_DER	<b>0.273</b> (3.84)	0.084 (1.14)	<b>0.419</b> (6.25)	1						
KOR_DER	<b>-0.157</b> (-2.15)	<b>-0.231</b> (-3.22)	<b>0.665</b> (12.06)	<b>0.311</b> (4.44)	1					
MYS_DER	<b>0.246</b> (3.45)	<b>-0.199</b> (-2.76)	<b>0.757</b> (15.74)	<b>0.329</b> (4.73)	<b>0.706</b> (13.53)	1				
PHL_DER	<b>0.393</b> (5.79)	-0.106 (-1.45)	<b>0.727</b> (14.37)	<b>0.315</b> (4.49)	<b>0.677</b> (12.48)	<b>0.851</b> (21.96)	1			
SGP_DER	<b>0.440</b> (6.64)	-0.133 (-1.82)	<b>0.633</b> (11.09)	<b>0.430</b> (6.47)	<b>0.627</b> (10.91)	<b>0.830</b> (20.17)	<b>0.815</b> (19.05)	1		
THA_DER	<b>0.220</b> (3.06)	-0.078 (-1.06)	<b>0.673</b> (12.34)	<b>0.422</b> (6.31)	<b>0.712</b> (13.77)	<b>0.847</b> (21.66)	<b>0.833</b> (20.43)	<b>0.762</b> (15.94)	1	
VNM_DER	<b>0.189</b> (2.61)	0.044 (0.59)	<b>0.356</b> (5.15)	0.018 (0.24)	<b>0.321</b> (4.59)	<b>0.397</b> (5.86)	<b>0.422</b> (6.29)	<b>0.360</b> (5.22)	<b>0.253</b> (3.54)	1

Source: IMF IFS.

## VI. FINANCIAL INTERCONNECTIONS AND CROSS-BORDER POLICY DEPENDENCE<sup>1</sup>

*This note assesses the nature of cross-country financial stability and policy linkages that arise due to the cross-border operations of financial institutions. Since membership in financially integrated clusters increases contagion risk, countries stand to gain from coordination and information sharing in the areas of macro-prudential policy and the regulation, supervision, and resolution of distressed financial firms. On the other hand, clusters that are generated by financial firms' attempts at engaging in regulatory arbitrage may require a policy treatment that eliminates such opportunities. IMF surveillance stands to gain substantially by monitoring the developments of, and in, such clusters, but its ability to do so is currently hampered by lack of access to adequate information on financial institutions' exposures to countries, markets, and sectors.*

### A. Background

1. **Financial interlinkages.** Drawing on a series of examples, this note examines the implications of cross-country financial interlinkages established and sustained by financial firms' cross-border operations. The objective is to understand how existing policy frameworks drive the formation of such financial interlinkages which, once established, can constrain the effectiveness of domestic macro-financial policy instruments due, in part, to the increase in policy externalities.
2. **Spillovers and clusters.** When banks go abroad to exploit diversification gains in credit markets or to serve existing (non-financial) corporate clients who are doing so, they establish cross-country clusters consisting of their home country and host jurisdictions. Where these operations become systemically important for the host, they result in spillovers of home country policies to the host and in constraints on the effectiveness of the latter's domestic economic and financial policies. Where these operations become a significant proportion of the banks' businesses or revenues, host country policies can exert an externality on the home. Examples of such clusters include the Nordic-Baltic countries, Austria and selected Central and Eastern European countries (CEE), and potentially, South East Asian countries with Singapore.
3. **Arbitrage.** Policy initiatives may themselves encourage cross-country financial integration. If such initiatives are not accompanied by a correspondingly adequate harmonization of prudential regulation and of cross-border cooperation in supervision and resolution of financial firms, this can create regulatory arbitrage opportunities that banks may exploit by moving operations and offices across countries. In addition—and equally importantly—such decisions of financial firms are also driven by opportunities for tax arbitrage that are notoriously difficult to iron out, given the often wide range of factors underpinning differences in countries' tax regimes.

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<sup>1</sup> Prepared by an MCM team led by Jay Surti, comprising Jeanne Gobat, Ivan Guerra, Patrick Imam, Pamela Madrid, and Rodolfo Maino.

4. **Cooperation.** The policy lessons derived from this study are that in order to extract the maximum benefits of living in a financial cluster, country authorities may need to share financial supervisory information, coordinate on prudential standards, and cooperate in the process of supervision and resolution of firms and markets. If the appropriate degree of coordination—which recognizes the economic and policy externalities that arise in a cluster—is not achievable, countries may implement defensive policies against increased macro-financial contagion risk that effectively limit their participation in the cluster. Where some clustering appears to reflect financial firms’ attempts to exploit regulatory arbitrage opportunities, it often results in a skewed distribution of benefits and costs, wherein the said-firms gain during upswings and the taxpayer pays during the downturns. Reduction in clustering generated by closure of regulatory arbitrage opportunities may, in such circumstances, represent a net gain to all countries.

5. **Implications for the Fund.** Fund surveillance and policy advice stands to gain from studying more comprehensively and continuously the development of, and in, clusters of financially interconnected countries. In order to do this well, however, access to further information on the funding and asset exposures of globally systemically important financial institutions (G-SIFIs) to countries, markets and economic sectors will be critically important.

## B. Cross-Border Banking Linkages I: Credit Intermediation

### Architecture of Financial Linkages in the Cluster

6. **Home-host linkages.** The cluster is composed of one or more home countries of the banks or financial groups (BHCs) and a number of hosts for whom BHC operations are systemically important.

- Parent funding is an important source of capital for domestic credit intermediation in the host countries.
- In turn, host country exposures, either individually or as a group, are material to the liquidity and solvency of the BHC. The adverse impact of a downturn on the quality of these exposures can threaten the BHC or parent bank’s refinancing capacity in wholesale markets, and, in the worst case, directly threaten solvency.
- The Nordic-Baltic banking system is a particularly good example. Five large banks chartered in Sweden (Nordea, SEB, and Swedbank), Denmark (Danske), and Norway (DnB NOR) are active, and dominate deposit and credit markets, throughout the region (see Table 1).
- Parent funding constitutes an important source of financing of the banks’ credit intermediation in host countries. For example, in the case of Swedbank, deposits and lending by the parent bank, on a gross basis, to the Baltic affiliates increased its share of non-equity liabilities from 17½ percent at end-2005 to 46 percent by end-2008. To give some perspective regarding the relative importance of (growth in) local savings and parent funding in propelling the corresponding credit boom, it is noteworthy that parent funding

rose from 28 percent of local deposits to over 107 percent over this 3 year period. In turn, for most of these banks, each of the host markets is vital, in terms of the impact on group liquidity or solvency, of financial problems arising in that jurisdiction (see Table 2).

Table 1. Share of Foreign Nordic BHCs in Domestic Banking Assets

	2010	2009	2008	2007	2006	2005
<b>Host country</b>	(percentage points)					
<b>Nordics 1/</b>						
Denmark	7.3	6.2	4.4	6.9	2.7	2.9
Finland	65.3	61.8	62.3	56.2	55.8	50.3
Norway	26.4	25.5	29.6	28.4	22.9	22.9
Sweden	2.3	2.4	2.4	2.3	2.6	5.0
<b>Baltics 1/</b>	70.7	72.1	74.7	72.4	76.3	55.3

Sources: Bloomberg LP; central banks; institutions' annual and risk reports; and staff calculations.

1/ Excludes SEB holdings for 2005 and 2006

Table 2. Materiality of Host Country Businesses for Nordic BHCs

<b>Institution</b>	2010	2009	2008	2007	2006	2005
	(in percent of BHC tier I capital)					
<b>Nordea</b>						
Denmark	1146.8	1032.5	766.2	845.9	819.7	895.7
Finland	1359.1	1129.7	1395.7	1034.8	999.1	1081.6
Norway	302.4	328.1	353.2	389.8	342.2	339.8
Baltics	42.1	41.6	57.7	41.7	26.6	17.5
<b>DnB NOR</b>						
Denmark 1/	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Finland 1/	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sweden	69.2	68.6	82.5	56.0	121.4	136.5
Baltics	43.2	51.9	83.2	68.5	86.5	n.a.
<b>Danske</b>						
Finland 2/	126.9	133.8	195.2	194.7	152.0	n.a.
Norway	128.5	127.8	160.0	162.0	109.0	126.5
Sweden	153.9	142.0	196.6	191.7	143.4	165.1
Baltics 2/	19.1	22.7	34.4	31.9	19.2	n.a.
<b>SEB</b>						
Denmark	223.9	214.4	255.9	385.3	n.a.	n.a.
Finland	30.1	29.9	33.8	28.6	n.a.	n.a.
Norway	115.9	117.5	185.3	199.9	n.a.	n.a.
Baltics	137.7	155.9	247.4	242.5	220.6	181.4
<b>Swedbank</b>						
Denmark	24.8	21.7	24.7	85.0	44.4	56.9
Finland	31.8	17.8	15.5	14.8	8.5	11.3
Norway	61.9	60.8	60.1	49.3	49.2	38.4
Baltics	218.2	275.2	317.3	361.3	283.6	238.0

Sources: Bloomberg LP; central banks; institutions' annual and risk reports; and staff calculations.

1/ DnB NOR's lending to Danish and Finnish corporate clients is carried out through the parent bank.

2/ Danske's Baltic operations are carried out through its Finnish subsidiary. 2005 numbers are unavailable as it precedes Danske's takeover of Sampo bank

- Austria, alongside those CEE countries wherein its systemically important banks Erste and Raiffeisen are active, prominently, the Czech Republic, Hungary, Poland, Romania, and Slovakia constitutes another example of this type of cluster (see Table 3). In all but one host country, i.e., Poland, the Austrian banks' affiliates are systemically important, and the affiliates are themselves, without exception material to the parent banks themselves.

Table 3. Austria-CEE Cluster as of end-2010

Institution	Czech Rep	Hungary	Poland	Romania	Slovakia
(in percentage points)					
Erste Bank					
Credit exposure-to-group tier I capital	351.0	106.8	15.9	209.7	124.5
Credit exposure-to-host banking assets	30.6	13.3	0.6	39.4	26.2
Raiffeisen					
Credit exposure-to-group tier I capital	101.4	115.6	91.7	92.6	124.8
Credit exposure-to-host banking assets	6.6	10.8	2.5	13.1	19.7

Sources: European Banking Authority, central banks, and staff calculations.

- Singaporean banks are important generators and conduits of regional capital flows into South-, South-East-, and East-Asia as measured by the proportion of bank-sourced external capital by these countries (see Table 4).

Table 4. Singapore-South East Asia Cluster as of end-2010

Singaporean banks' holdings in ....	India	Indonesia	Malaysia	Philippines	S. Korea	Vietnam
(in percent of total positions of foreign reporting banks holdings)						
	28.9	48.4	48.9	18.9	20.3	19.0

Sources: Bank for International Settlements; and staff calculations.

Note: The numbers in Table 4 are drawn from data on the geographic distribution of holdings reported confidentially by Singaporean banks to the Bank for International Settlements (BIS) in combination with information available in Table 6a of the BIS's locational banking statistics.

7. **Centralized business models reinforce direct financial connections.** Centralization of credit, funding, treasury, and risk management across borders reinforces clustering via direct financial interlinkages.

- Whereas retail credit risk management and underwriting may rely on local expertise, corporate credit business is often managed out of a single affiliate or the parent bank. In the Nordic-Baltic cluster, credit to Finnish corporate counterparties is managed centrally by the parent bank of the DnB NOR group and to Danish corporate counterparties by the parent bank (DnB NOR) or an overseas affiliate (Nordea Finland).

- Austrian banks have exploited cost differentials to fund and extend local retail and corporate credit via their affiliates in some CEE countries in Swiss franc (CHF). Credit extension—by the Austrian parent bank to the CEE affiliates and, in turn, by the latter to local borrowers—in CHF or on a CHF-indexed basis extinguishes market risk and may meet regulatory risk requirements. But, the attendant credit risk can become problematic for borrowers and banks in the event of appreciation of the funding currency, as it has apparently done recently in the case of this cluster owing to CHF appreciation vis-à-vis the Forint.
- In the case of both the Nordic and Austrian BHCs, a significant proportion of funding at the group level is raised from global wholesale capital markets, in foreign currencies, and subsequently distributed to regional operations. In addition, enterprise risk management is centralized, combining capital buffers at the affiliate level with treasury operations hedging affiliate and parent market and liquidity risks at the group level.

### How does this Affect the Domestic Policy Space of Countries within the Cluster?

8. **Monetary policy.** From the host country perspective, direct parent funding translates into constraints on the effectiveness of monetary policy in containing credit and asset booms.
  - Nordic and Austrian banks borrow in wholesale capital markets, at funding costs driven by global market conditions—which, in turn, are driven largely by macroeconomic developments and policy in global financial centers—rather than host country policy. In the context of open capital accounts, this can clog the credit channel of monetary policy.
  - Consequently, countries may have no recourse other than to address rapid increases in capital inflows, rendered possible by parent bank funding under easy global credit conditions, by other instruments. These could include partial capital controls (e.g., India); tax treatment of capital inflows that is sensitive to the instrument, maturity, and currency in which the flow occurs (e.g., Brazil); and subsidiarization of domestic banking with strict limits on intra-group exposures (e.g., Mexico and Spain); among others.
9. **Need for cooperation.** Containing systemic financial risk solely via domestic prudential regulatory policy and supervision of local affiliates of the BHCs could become difficult.
  - Organizing a satisfactory prudential framework along national boundaries for BHCs that have crossed borders and, in doing so, built-up substantial intra-group funding exposures may be both difficult and inefficient.
  - A good example of this in the Nordic-EEA context is the challenge in lowering household leverage in the residential mortgage market by using domestic policy tools alone. The Norwegian authorities have been attempting to do so by lowering borrower loan-to-value and loan-to-income ceilings and are contemplating raising the risk weight on residential mortgages. However, given the *passport regime* under which Norwegian (and EEA) licensed banks operate, changes to these policy tools may have limited impact in the absence of



- corresponding measures being undertaken by other Nordic countries. This is because the supply and cost of funds lent to Norwegian households could continue at the same levels, via Norwegian branches of foreign banks to which domestic Norwegian regulations would not apply.
- As the [2011 Article IV consultation](#) suggests, a preferred approach, that is cognizant of financial clustering in the Nordic region and the policy constraints applicable under EEA rules, would entail coordinated policy action by the Nordic countries wherein either (i) they agree to raise risk weights on Norwegian residential mortgage exposures; or (ii) they agree on uniformly higher risk weights on their banks' residential mortgage exposures independent of location of the borrower.

10. **Positive policy spillovers.** Strengthening the countercyclical component of macro-prudential policy in one country may increase the efficiency of countercyclical policies elsewhere in the cluster.

- Weaknesses in countercyclical macroeconomic management can yield a combination of high levels of corporate, household and public sector indebtedness alongside asset bubbles. This often leaves limited room for maneuver in terms of the scope for using targeted fiscal, monetary, and financial policy instruments to limit losses in incomes and wealth during downturns.
- Overheating in the Baltic housing markets and the associated high levels of household mortgage indebtedness in the period leading up to the global financial crisis was, in hindsight, not addressed to the required extent by domestic macro-prudential tools. This was reflected, for example, in the case of Latvia, by indicators of procyclicality in fiscal and monetary policy following EU accession in 2005.
- At the same time, monetary and financial stability policies in the Nordic countries did not adequately address the risks posed by the combination of rising levels of wholesale funding and of intra-group credit exposures that were funding the Baltic boom.
- In a cluster context, such weaknesses in individual countries' policy frameworks can exercise negative externalities on others. A confluence of exogenous shocks starting in Q3 of 2008—the liquidity tightening in bank funding markets following the Lehman bust and the recession in Germany—turned the tide in the Nordic-Baltic region. Overheating in the Baltic countries and limited scope for deployment of countercyclical policies in the downturn that followed in the aftermath of the German recession contributed significantly to the serious threat to the liquidity and solvency of SEB and Swedbank, the Swedish firms most exposed to a recession. In turn, the squeeze in wholesale funding markets post-Lehman and the high exposure of Nordic BHCs thereto exacerbated the bust in the Baltics.
- Given the funding exposure of other Baltic states to these banks, the liquidity swap lines extended by the Riksbank had to cover all the Baltic central banks in H1 2009 despite the

fact that Estonia, for example, clearly had better macro-financial fundamentals than Latvia. Moreover, Swedish authorities were also forced to adopt other defensive policies such as the general creditor guarantees, eventually subscribed to by SEB and Swedbank in 2009, that substantially increased contingent fiscal liabilities.

- The Nordic-Baltic example neatly illustrates the scope for positive and negative spillovers from countries' policy actions within a cluster. Available policy space in Sweden—low debt burden and fiscal surplus positions in the years preceding the crisis—was utilized to both prevent creditor runs on its systemically important banks as well as maintain liquidity and credit lines to the banks' affiliate operations in the Baltic countries that were crucial to limiting the depth and duration of the downturn there.
- A country wishing to safeguard domestic financial stability in a situation where other cluster members' policy frameworks do not adequately address the externalities they generate may be forced to ramp up liquidity and capital buffers for domestic banking operations and ring-fence them within their jurisdiction. Notably, these defensive measures serve to reduce the country's vulnerability to contagion by limiting its degree of inclusion within the cluster.
- The example of the Nordic-Baltic countries should by no means suggest that such defensive strategies need only be adopted by the home country. The experience of U.K., Dutch, and Isle of Man creditors and authorities in dealing with the consequences of weak regulation of Icelandic parent banks/groups suggests that host authorities would also benefit from either harmonization to a higher standard of prudential regulations or adequate and consistent implementation of harmonized standards across the cluster.

11. **Information sharing and coordinated supervision.** Absence of supervisory information sharing or of coordinated supervisory action may increase vulnerability to exogenous shocks and risk of financial contagion for individual countries or the entire cluster.

- Good supervision entails, as a key ingredient, taking appropriate action, on the basis of accurate, timely, and comprehensive information, to stem excessive risk taking by regulated institutions. It also requires endowing supervisors with an adequate budget and sufficient enforcement powers and legal protection.
- Executing good supervision within a cluster could become problematic, particularly in a setting of high intra-group exposures, in the absence of supervisory information sharing and the provision of adequate scope for coordinated supervisory action.
- Poor resourcing or empowerment of supervision, or its capture by national banking champions, can exert a significant negative externality on other countries within the cluster particularly in a setting wherein information sharing is less than optimal.
- The pre-crisis Nordic supervisory MoU embedded in an institution-specific component and paved the way for supervisory information sharing and joint inspections as in the cases of

Nordea and Sampo. While in the wider EU context, joint inspections were not mandated, this did not necessarily impede bilateral cooperation arrangements along these lines in specific cases as the one that existed between Belgium and the Netherlands for Fortis wherein both authorities had a long-standing relationship involving supervisory information sharing and joint inspections. As illustrated by the Fortis example, the existence of such an arrangement did not preclude a national approach to resolution.

- The inability of national supervisory action in enforcing prudential standards to affect the behavior of business units operating outside the national boundary represents a problem for domestic financial stability. The inability to trigger risk mitigating action in group affiliates residing elsewhere in the cluster may necessitate undertaking measures to ring-fence local operations, thereby again limiting participation in the cluster.

12. **Crisis management.** Coordinated management of BHC failure or of systemic financial distress can, at times, serve to reduce the economic costs of a financial crisis.

- The cross-border nature of BHC business operations complicates the resolution process particularly in cases where the scale of intra-group exposures are high either because of centralized liquidity management, as in Dexia and Lehman, or due to the importance of parent funding for affiliates, as in the case of the Baltic operations of the Swedish banks. In such cases, national resolution frameworks and responsibilities for crisis management can conflict with the efficient and equitable resolution of a cross-border banking group.
- Home countries may encourage the adoption of subsidiary structures to limit parent bank liability—and hence, contingent fiscal costs—in the event of distress. In a similar vein, home country legislation enabling subordination of deposits in overseas branches of their banks as part of bank restructuring and resolution operations could result in a transfer of fiscal costs to the host jurisdiction.
- While not always feasible in the heat of the moment, concerted efforts to coordinate on joint restructuring solutions—despite the absence of explicit and ex-ante burden sharing agreements—can be successful and welfare improving for all concerned members of the cluster. Recent and past experience indicates that equitable distribution of resolution costs, in proportion to the share of the enterprise held by each jurisdiction, and clear communication of the strategy adopted, can allow the distressed institution to obtain finance and, hence the time to sell off certain operations and retrench others.

### C. Cross-Border Banking Linkages II: Arbitrage

13. **Clusters and arbitrage.** Countries may also find themselves inadvertently entering clusters with others when banks active in their market enter other jurisdictions to exploit opportunities for tax and regulatory arbitrage.

- Policy initiatives to dissolve barriers to the movement of financial capital and promote seamless access for, and penetration by, financial firms of one country into another's market can lead, as in the case of the EU, to highly integrated financial systems. Banks may utilize different jurisdictions to raise market funding, manage risk, engage in credit intermediation, and extend brokerage services, among others.
- The cases of the Nordic-Baltic and Austria-CEE clusters highlight that in some cases, these choices reflect an objective to exploit economies of scale and scope. In other cases, however, it reflects banks' desire to exploit opportunities for arbitrage provided by differences in the tax treatment of alternative revenue sources relevant to the bank or by the ease of cross-border financial penetration without corresponding convergence of prudential standards or of supervisory coordination.

### **The Case of Deutsche Pfandbrief Bank (Depfa) and Hypo Real Estate (HRE)**

- The corporate restructuring of the German public covered bonds issuer Deutsche Pfandbriefbank, AG, the parent bank of Depfa group, in 2001, resulted in a new parent bank, Depfa Bank plc, which was incorporated in Ireland. This action was motivated by the potential for substantial tax savings and high asset-liability maturity mismatches (ALMMs) permitted in Ireland but strongly regulated in Germany after 1999. It was enabled by the bank's ability to change its group structure and the member state of its incorporation so that responsibility for consolidated supervision moved from Germany to Ireland. The combination of a thin spread business with assumption of high liquidity and interest rate risk made Depfa group especially vulnerable to increases in global risk aversion and liquidity squeezes of the type seen in 2007–08.
- Depfa bank's primary funding came from jumbo covered bonds. While the ALMM entailed by this funding strategy would have been manageable, at the group level, it used the regulatory space available to it under Irish regulations to swap down the overall funding duration substantially. Anecdotal market commentary suggests that whereas Northern Rock, which followed a similar strategy to fund mortgages in the United Kingdom, lost market access in 2007 due in part to the impact of the domestic recession, the solid asset quality of Depfa bank's cover pool of German public sector loans allowed Depfa group to continue to attract funding using this strategy well into 2008.
- The German covered bonds business continued to be a large part of Depfa group's business operations and Depfa bank itself remained a mid-sized issuer of (public) Pfandbrief. Liquidity or solvency problems at the Depfa group level might, therefore, have disrupted confidence in the Pfandbrief market and this would have impacted the refinancing needs of the public sector.
- These concerns were brought into sharper relief after the Depfa group's takeover by the German mortgage lender HRE in 2007. Unlike Depfa group, HRE had a portfolio of legacy bad loans and the strategic thinking underlying the takeover was likely to have been the improvement in average asset quality forthcoming from the acquisition of Depfa bank's cover pools. However,

since HRE was a larger institution in terms of asset size, the end-product was an institution with a riskier funding profile and poor asset quality.

- Depfa group's ALMM proved costly to HRE, and by extension, the German authorities, being a major source of HRE's vulnerability to funding squeezes throughout 2008 resulting ultimately in a takeover by SoFFin, as part of a rescue package amounting to over €100 billion, a substantial proportion of which was funded by the state.

### **Policy Spillovers Highlighted by the Depfa-HRE Case**

- The ability of banks to engage in corporate restructuring and relocation of their home country without corresponding changes in the nature of their business operations can be problematic in the absence of sufficient harmonization in prudential standards. If the institution's primary intent is to exploit regulatory arbitrage, this is likely to lead to excessive risk taking, and may ultimately be very costly to the countries concerned.
- In this particular case, the pre-crisis legal gateway for supervisory information sharing was either not sufficiently precise or not appropriately utilized for the German authorities to access necessary prudential financial information on Depfa on an ongoing basis from the Irish authorities.
- As a result, maintenance of a sound prudential policy by German authorities as reflected in the constraints on a domestically licensed Pfandbrief bank was no panacea for the accumulation of excessive risk by group affiliates located outside Germany. Since the German supervisor (BaFin) did not automatically obtain information on this risk accumulation on a regular basis, it was not alerted in advance to the need for defensive action.<sup>12</sup> Moreover, it is unclear how effective the German authorities would have been, at the group level, in undertaking defensive action prior to HRE's takeover since they had to pass on the baton of Depfa group's prudential oversight to the Irish supervisor in 2001.
- The example brings to light a more general problem of alignment of regulatory incentives in such clusters wherein the home agency may possess less incentive for allocation of scarce prudential resources than the host agency because the institution's primary activity takes place in the latter's jurisdiction. In the worst case scenario, the institution may be systemically important to the host market or banking system but not so for the home country. An example of such a confluence of incentives is presented by the case of Bank DnB Nord, the Danish subsidiary of DnB NOR which does not have substantial business operations in Denmark, is not systemically important at the group level, but whose Baltic branches are systemically important in that region.

<sup>12</sup> Subsequent to HRE's takeover, BaFin assumed the role of consolidated supervisor and this alerted the German authorities to the existence of substantial duration mismatches arising from Depfa's business model. BaFin requested its Irish counterpart for permission to review Depfa's books in March 2008 and on the basis of this review, issued an order to HRE to close out Depfa's unhedged positions.

- The problem of arbitrage in the presence of regulatory misalignments can also be seen in the use by large global BHCs of off-shore financial centers (OFCs) for booking transactions and hedging of risks. From the OFCs' perspective, the tax breaks and regulatory advantages they may supply are necessary to get this business on-shore and, given the size of their economies, an effective strategy for increasing domestic standards of living. To the extent that this yields an increase in global (unhedged) risk for the BHCs or parent firms—and this takes place in an environment wherein supervisory information sharing is absent—it can represent a serious stability and fiscal risk for home authorities.
- To the extent that clustering primarily or purely reflects financial firms' response to incentives to exploit regulatory arbitrage opportunities, country authorities may legitimately question the salience of their continuation. This is particularly so if the benefits accrue—during a boom—to the financial enterprises, whereas the costs—falling due during a downswing—are widely distributed among the tax payers, including potentially in other jurisdictions. In such an event, appropriate policies may well be those that eliminate the arbitrage opportunities and which, in doing so, also eliminate the clusters they give rise to.

#### D. Challenges in Identifying Clusters

14. **Information gaps.** Identification of clusters and ongoing assessments of developments therein is important for enhancing the quality of Fund surveillance and advice, albeit mapping the financial interlinkages essential to doing so is constrained by information gaps. This analysis had to confront significant gaps in information on global and regional financial interlinkages that is necessary to guide consistent and comprehensive cluster identification and characterization. The information gaps fall into the following broad categories:

- **Unavailability of information in the public domain.** The geographic distribution of a country's banking sector holdings in other countries is not publicly available through the Bank for International Settlements (BIS) banking statistics. Similarly, information on the geographic distribution of portfolio assets held by fund managers domiciled in a given country are not publicly available and typically need to be compiled from private sources such as EPFR and Lipper.
- **Unavailability of comprehensive cross-country information.** Consistent identification of nations as originators or as conduits of capital flows to other countries through their banks and non-bank institutions is difficult even when using confidential or proprietary information. Confidential BIS data does not carry information on the geographic distribution of risk exposures for a majority of countries including for large emerging markets such as Brazil and Mexico. Nor is corresponding information supplied by EPFR on bonds and equities funds' holdings. To the extent that such countries are important originators or conduits of capital flows to regional economies, such clustering would be difficult to identify.
- **Gaps in information content.** First, since the BIS data provides net—and not gross—flows, the use of this type of information to prepare effective early warnings is blunted in part because gross banking flows can provide useful information. Second, it is difficult to tell from the data whether a country (e.g., Singapore) is an originator of bank lending, or if the

lending is only booked in that country for tax purposes. But, this is quite important in determining the materiality of policy decisions taken in the regional financial center for capital flows to the region, and hence, for policy responses there. Third, constructing metrics of the relative importance of potential regional financial centers for driving external capital into other countries is dependent on calculating on the same accounting and institutional basis, the total amount of external capital flows/stock held in that country. In general, beyond banks, it is difficult to reconcile the latter amount (e.g., available from the CPIS or IIP databases) with the former.

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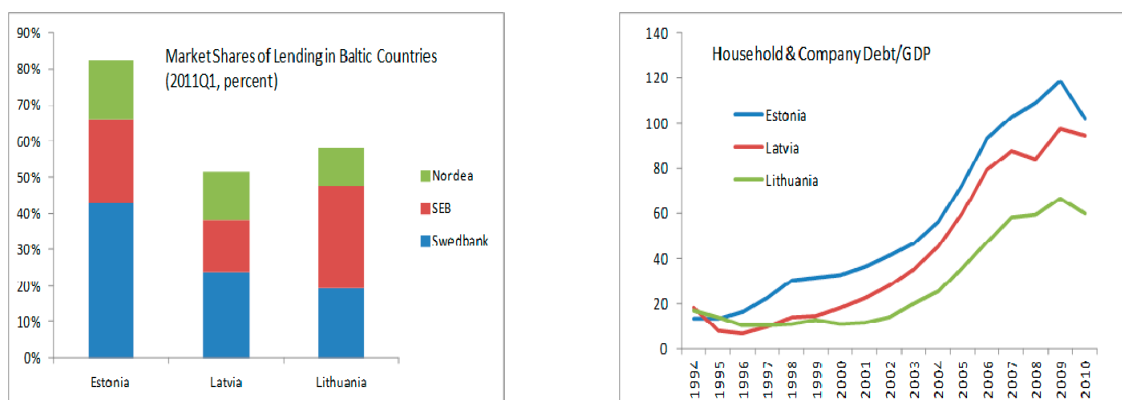
## VII. SWEDEN-BALTIC CONNECTIONS: A CASE STUDY<sup>1</sup>

*Building on the previous note, this note provides a brief overview of the Nordic-Baltic, or Sweden-Baltic, cluster. Strong financial connections from the Nordic economies (gatekeepers) to the Baltics implied a key role for the former in providing funds to the latter in the run up to the crisis. During the crisis, however, policy actions in the gatekeepers, including to strengthen banks, helped to limit deleveraging and negative output effects in the cluster.*

### A. Introduction

1. **The cluster.** The Nordic-Baltic cluster was singled out mainly due to financial linkages, though trade linkages are also strong. Although the countries in this cluster all belong to the European Union (Estonia, Latvia, and Lithuania joined the EU on May 1, 2004 along with the Czech Republic, Hungary, Poland, Slovakia, and Slovenia) and are connected to the core through that bigger cluster, the Nordic (Denmark, Finland, Iceland, Norway, and Sweden) and Baltic (Estonia, Latvia, and Lithuania) countries have particularly strong ties through banks. Starting in the early 2000's, the Baltic countries experienced a large boom, financed in large part by loans by Nordic (mainly Swedish) banks as they prepared for and went through the EU accession process. Part of the boom was due to convergence with the rest of the EU, but the upheavals during the global financial crisis hit the Baltic countries hard (Figure 1).

Figure 1. Nordic-Baltic Financial Linkages and the Boom



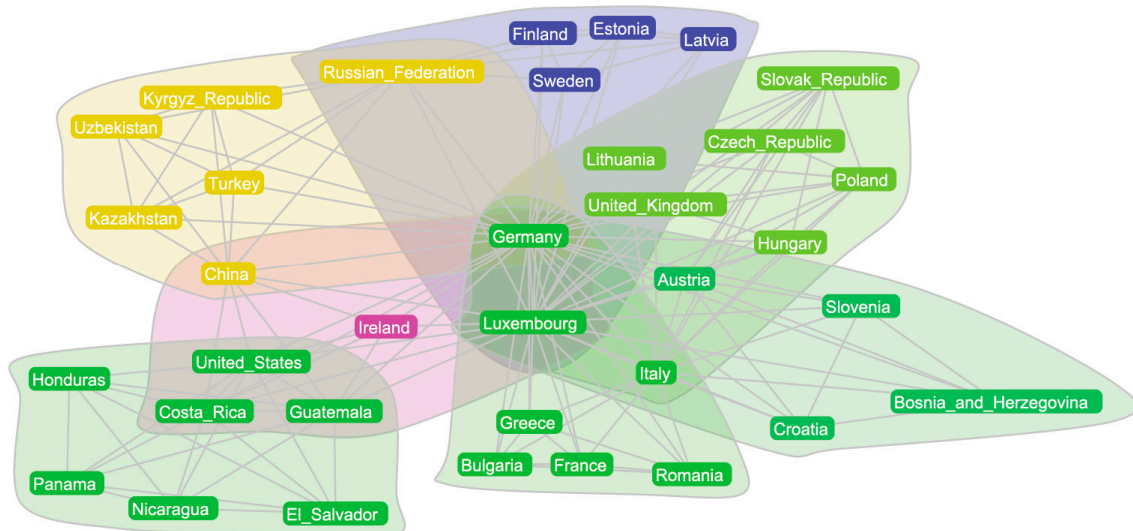
2. **The crisis.** The Nordic and Baltic countries were hit early in the global financial crisis but had differentiated responses. As small, open EU members, Estonia, Latvia, and Lithuania are not insulated from global shocks and are relatively constrained in their ability to respond to them. The Nordic countries were also hit, but as larger, developed countries, were not as affected. Owing to their strong historical ties, the Nordic countries show up as financial gatekeepers for the Baltic countries.

<sup>1</sup> Prepared by Irena Asmundson and Chris Marsh, with Swarnali Ahmed and Sergejs Saksonovs (SPR).

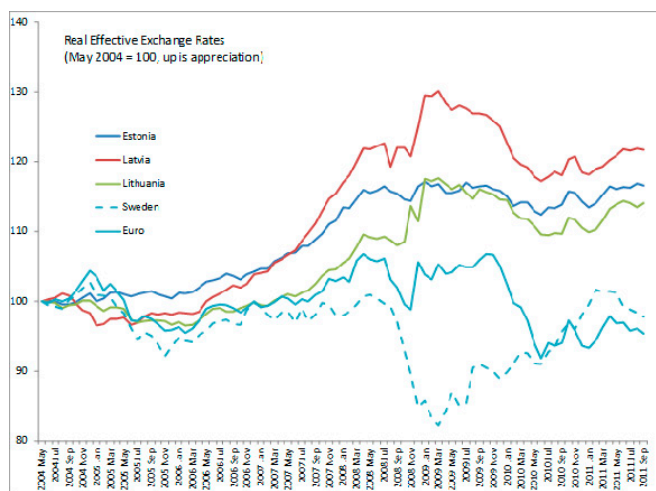


This is true to a lesser extent for Lithuania, which on the basis of the cluster analysis appears to be more closely tied to the Central and Eastern European cluster (Figure 2).

Figure 2. The Nordic-Baltic Cluster



3. **Policy space.** As small, open economies, policymakers in the Baltic countries had little room to maneuver. EU membership obligates the Baltic countries to maintain open borders with the rest of the EU, including with respect to capital flows. The Baltic countries were also under some pressure to meet the convergence criteria—policymakers in all three had made joining the euro the anchor of economic policy. The convergence criteria on inflation, interest rates, debt, deficits and the exchange rate meant that any adjustments could come at the expense of growth. While there were some concerns expressed about the real exchange rate levels before the crisis, revaluing in nominal terms would have delayed by several years the adoption of the euro, and adjusting the real exchange rate through austerity is never popular (text figure). Estonia successfully joined the euro at the beginning of 2011, while Lithuania and Latvia hope to qualify in the near future.

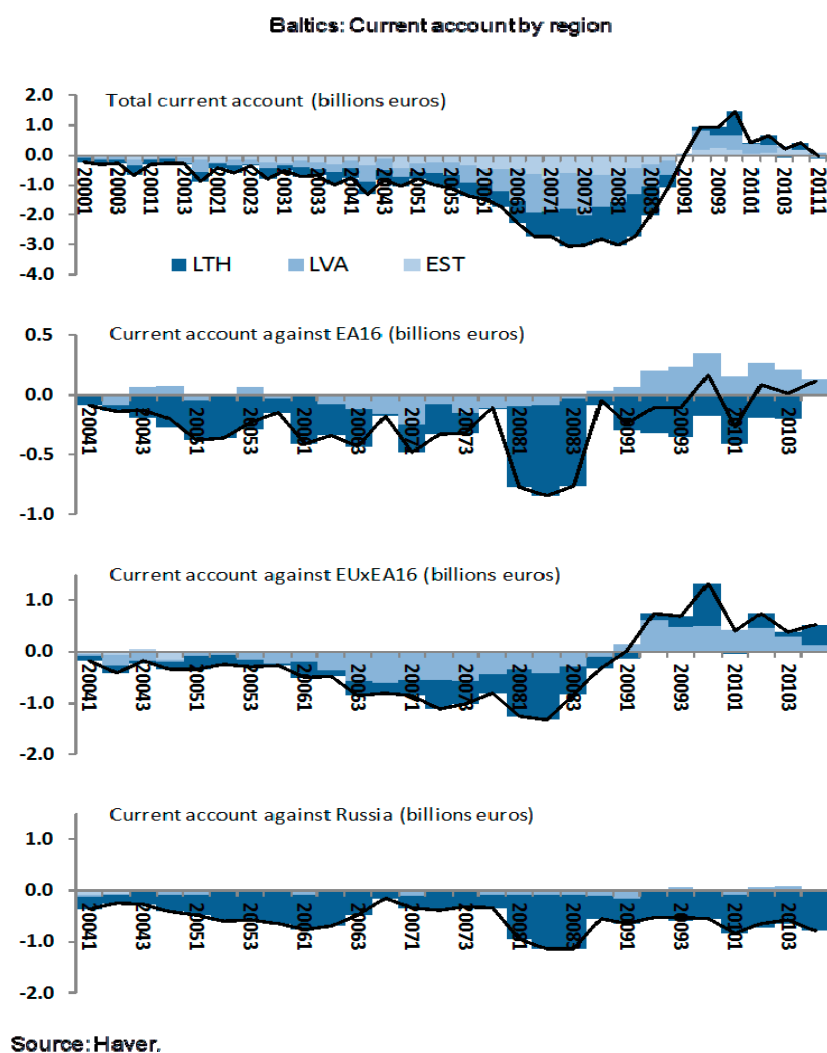


4. **Benchmarking policies.** At the same time, the Baltic countries were very conscious of the need to benchmark against each other. Policy statements by politicians in all three emphasized the need to keep taxes low, especially corporate rates. Competitiveness was a concern: with nominal exchange rates fixed, real adjustments had to come from wage cuts. As part of the euro accession

process, policymakers were also constrained by the desire to demonstrate credibility. For example, the authorities in Estonia had committed to “balance or better” in their budget.

5. **Severe adjustments.** The adjustments in the Baltic countries were particularly severe. Pre-crisis, all three Baltics were running large current account deficits, supported by the consumer loans from Nordic banks (Figure 3). When the crisis hit, the deficits became surpluses, although in Latvia’s case this was partially an accounting issue. (Latvia’s central bank recorded losses written off by parent banks as positive entries in the income account. Given the scale of the losses, these amounted to a few percent of GDP, although the current account adjustment was still massive after stripping these out.) As revenues dropped along with GDP, fiscal deficits had to be closed through painful combinations of expenditure cuts and new revenue sources. Deleveraging in the medium-term was recognized as necessary, and has been happening gradually.

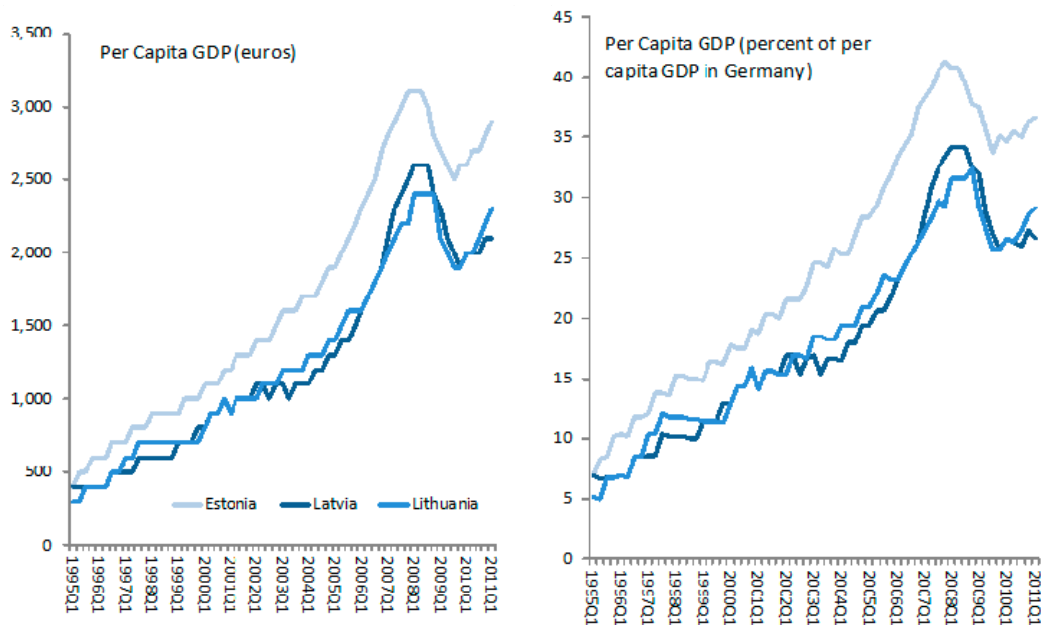
Figure 3. Baltics: Current Account Balances vis-à-vis Other Regions



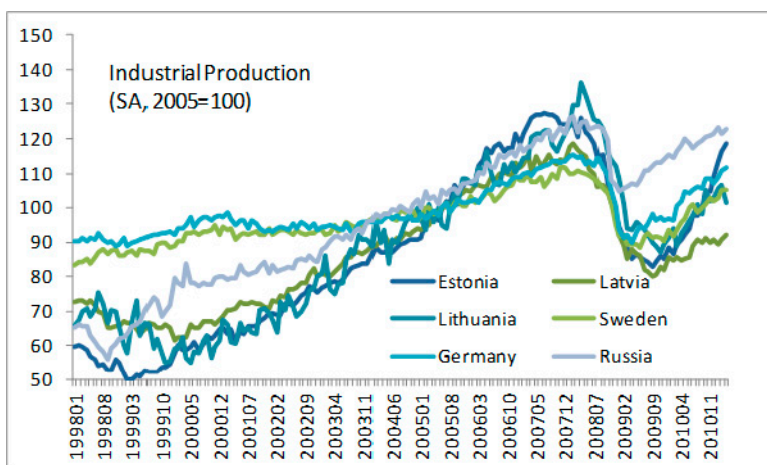
## B. Pre-Crisis

6. **Convergence?** Figure 4 shows nominal GDP levels, industrial production indices, and per capita GDP. All show relatively high levels of co-movement among the Baltics and co-movement with others, particularly during the financial crisis when the Baltic countries were hard hit.

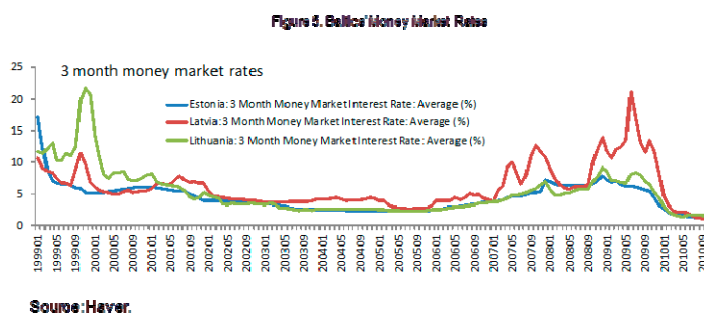
Figure 4. Baltics: GDP and Industrial Production



Source: Eurostat.



7. **Or over-heating?** After the Baltic countries joined the EU, it was expected that they would experience some convergence with the rest of the region, which would imply higher-than-average growth rates. This would be supported by lower real prices and relative competitiveness, leading to more investment and exports (Figure 5). At the same time, access to credit from the EU and income-smoothing implies that consumption would rise during the convergence. Therefore, the sustainability of the path was somewhat difficult to judge.



8. **Limits of some policy actions.** At the same time, Baltic policymakers did make some moves to rein in lending. Hilbers, Otker-Robe, and Pazarbasioglu (2007) identified many of the issues from the cross-border financial integration, but these did not have much of an impact as many of the mechanisms were not legally binding and did not specify what to do in distress situations. The wider issues were also recognized as being more properly discussed at the European level—a *clear indication that coordination within the cluster could only go so far*. But in calmer times, it was admittedly difficult to make the case for rule changes. Among the weaknesses identified were: uncertainty about deposit insurance, burden-sharing in the event of insolvency, and the particular constraints on small countries with restricted policy space from fixed exchange rates.

9. **Sweden as a gatekeeper.** With low wholesale funding rates and high growth in the Baltic countries, Swedish banks had large incentives to serve as a conduit. Globally, funding costs were low and liquidity was abundant, fueling a search for placement. The market in Sweden was generally saturated, but the Baltic countries provided a new source of growth. Given the convergence story, it was also easy to believe that the rising debt levels were sustainable. Swedish banks quickly built up large market shares in the Baltic countries, which persist to the present. Hilbers, Otker-Robe, and Pazarbasioglu (2007) mentioned a lack of clarity regarding the roles of Ministries of Finance when bank solvency is an issue—in case of distress in a cross-border entity, who should pay?

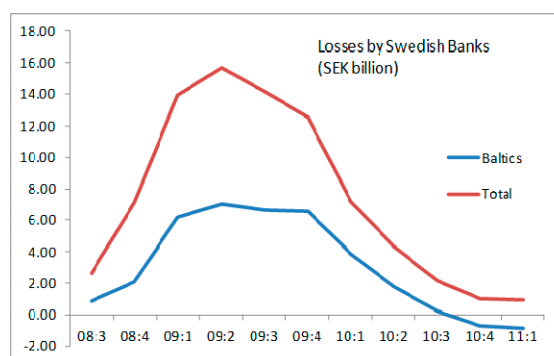
## C. Crisis

10. **Amplification.** In the immediate press of the crisis, the continued withdrawal of funding by Swedish banks amplified the global shock. As global liquidity dried up, the business model of transforming short-term wholesale funding into longer-term loans in the Baltic countries became unviable. When individual banks face shocks, the usual reaction is to pull back to limit damage. However, in a generalized shock such as the global crisis, the collective dynamics of this force is a destabilizing spiral. The sudden switch from capital inflows to outflows forced a crisis in Latvia, and severely impacted both Estonia and Lithuania. The financial sector movements also quickly affected the economy through drops in consumption and investment in sectors such as construction.

11. **Feedback.** The crisis in the Baltic countries had the potential to hurt Nordic banks. The share of overall lending to the Baltic countries was relatively low compared with lending to Nordic countries, but after the crisis Baltic loans contributed a large proportion of the losses. Sweden moved quickly to support banks, and to tighten supervision to prevent such a concentration of risk in the future (see 2011 Sweden FSAP update). Although losses in the Baltic countries have reversed, low growth rates and rebalancing of economic factors will likely weigh on future profits, which could affect tax revenues. On the other hand, the risks to the Swedish authorities from insolvency are likely lower.

12. **Dampening.** Quick and decisive action by the Swedish authorities allowed the Swedish banks to act as a shock absorber. Box 1 is from the 2011 Sweden FSAP update, and lists some of the policy measures enacted after the crisis hit. They provided liquidity in both krona and foreign currencies to replace the loss in liquidity from frozen wholesale funding markets, and also directly supported banks in trouble. This stabilized the markets by easing the pace of deleveraging, and prevented fire-sale dynamics from completely swamping the Baltic countries. The Swedish policies also allowed the Baltic policymakers to use their remaining policy space to containing the more purely macroeconomic effects of the crisis. If the Baltic countries had to adjust to pay for (larger) financial sector bailouts as well as the collapse of growth, the subsequent austerity would have been even more severe. The counterfactual analysis in the next section empirically illustrates the role of gatekeepers in the transmission of shocks.

13. **Gains from sharing.** In sum, greater clarity about possible weaknesses could have been achieved with better information sharing and consultation. Chapter VI laid out some of the advantages of coordination among regulatory and supervisory authorities in a cluster, but cooperation may be needed for macroeconomic issues as well. A discussion of both the macroeconomic assumptions underpinning financial stress testing and regulatory decisions, and the potential weaknesses of the financial system that may affect the economy, would have focused attention. This discussion could also have identified issues that could not have been dealt with at the cluster level, such as the very low cost of wholesale funding, or the obligations of home and host country authorities in the event of insolvency. Coordination on these issues is easier after actual contingencies have been faced, of course, because then the discretionary measures necessary during an emergency can be codified as rules. However, if such discretionary measures are recognized as inadequate in the future, this would also point to areas of cooperation needed at a higher level than the cluster.



**Box 1. Key Crisis Intervention Measures**

Measures	Status
<b>Measures to increase liquidity in Krona and foreign currencies (mostly introduced in September–December 2008)</b>	
The Riksbank expanded a collateral policy framework by fully accepting covered bonds and lowering the minimum credit rating requirements for long-term securities pledged as collateral.	Active.
The Riksbank set up new 3, 6, and 12-month loan facilities to facilitate banks' access to longer-term funds.	Replaced by 28-day loan facility with a penalty rate, April 2010.
The Riksbank established a new temporary credit facility using commercial paper as collateral to facilitate the supply of credit for non-financial companies.	Discontinued, September 2009.
The Riksbank granted emergency liquidity assistance to Kaupthing Bank Sverige AB and Carnegie Investment Bank AB (both SEK 5 billion). Later, the former bank was sold to Alandsbanken by its Icelandic owners, while the later was taken over by the state and later sold to private investors.	All repaid.
The Riksbank and U.S. Fed set up temporary reciprocal swap facilities (\$30 billion). A separate swap facility was also established with the ECB.	Active, but currently no use.
New dollar tem loan facilities (with the maturity of 28 and 84 days) were introduced.	Discontinued, November 2009.
The SNDO held extraordinary auctions of treasury bills to provide markets with securities generally accepted as collateral. The funds raised were invested (via repos) in covered bonds to support the covered (mortgage) bond markets.	Discontinued.
<b>Measures to support banks' capital and assure market confidence (all measures were introduced in October 2008)</b>	
The deposit guarantee was raised from SEK 250,000 to SEK 500,000, and the coverage was broadened to include all types of deposit.	To be raised to EUR 100,000 (about SEK 895,000) from 2011.
The parliament enacted the "Government Support to Credit Institutions Act," which gives the government unlimited fiscal powers to finance measures needed to ensure financial system stability. The support can be provided through guarantees, capital injections, or other means. Support would be provided based on contracts between the government and a bank.	Active.
- National Debt Office was given power to take over a troubled bank if there is a serious systemic risk and bank capital falls below 25 percent of the regulatory requirement.	Active.
- A debt guarantee scheme for the medium-term borrowing of banks and mortgage institutions was established. The total amount of guarantee was set at SEK 1.5 trillion (later reduced to SEK 750 billion). An institution applying to the guarantee would pay fees and be subject to restrictions on remuneration for senior management.	Active, but currently no use.
- A recapitalization scheme was established for solvent banks and other credit institutions. The government's capital injection takes the form of shares or hybrid capital (Tier 1 capital). Participating institutions are subject to restrictions on remuneration for senior management.	Active, but currently no use.
- A stabilization fund was set up, aimed at financing government measures to support the financial system. The sources of the funds are annual fees from banks and other credit institutions. The government contributed to SEK 15 billion for the establishment of this fund.	Active.
Source: IMF (2011).	

## D. Gatekeeper Role: A Counterfactual Analysis

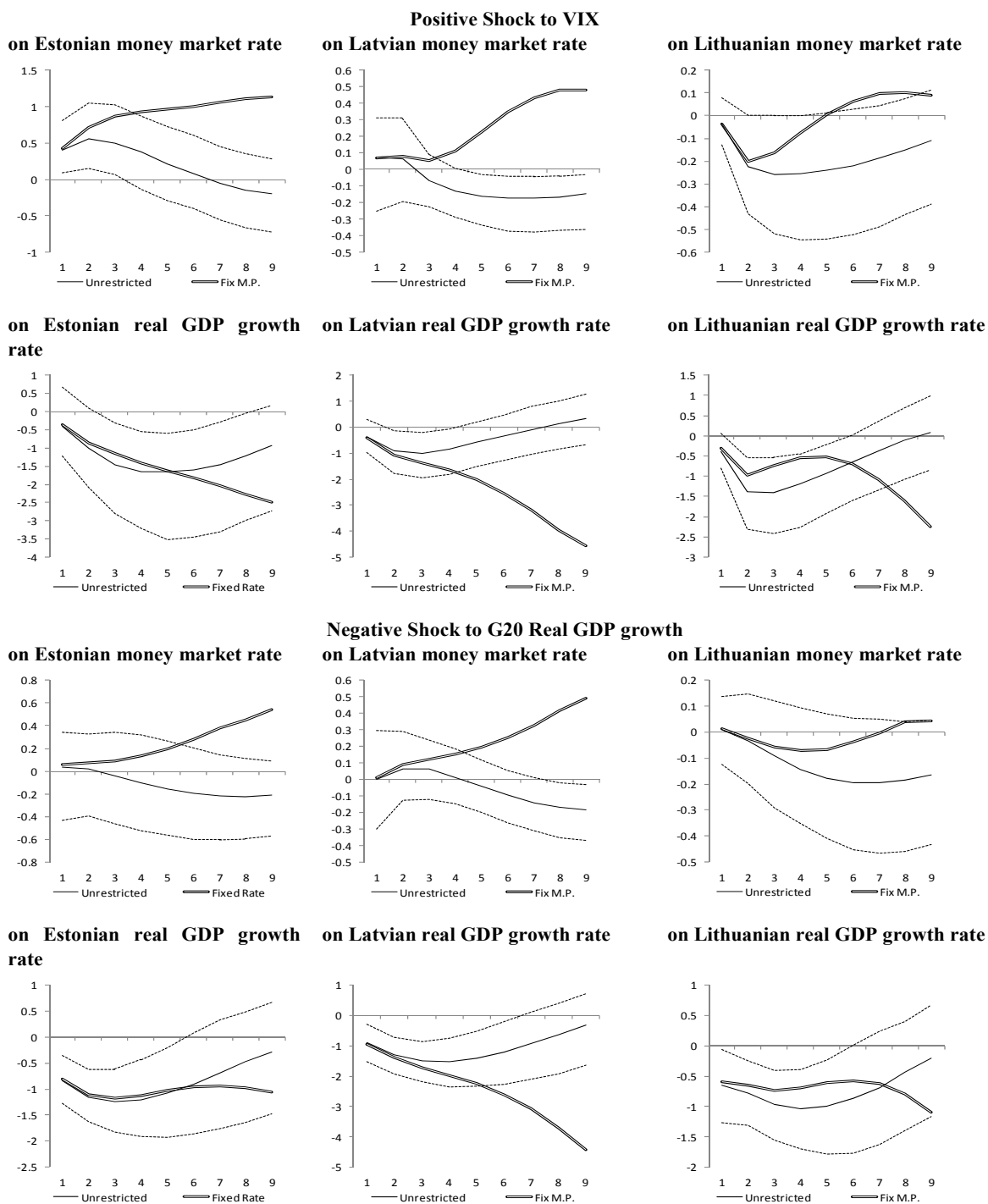
14. **Amplification or dampening?** In this section, we consider how the conduct of monetary policy in certain countries affects the transmission of global macroeconomic shocks. The analysis uses a VAR model with six variables: VIX and G20 GDP weighted real GDP growth, to proxy global shocks, money market rate and real GDP growth in the *gatekeeper* country and the ultimate *destination* country. The destination countries are Estonia, Latvia and Lithuania and the gatekeeper is Sweden. The estimation period is typically from the first quarter of 1995 to the third quarter of 2011, with some variation across countries due to different data availability.

15. **Identification.** Structural shocks are identified by Cholesky ordering, with the chain of contemporaneous effects as follows: VIX, G20 real GDP growth, gatekeeper money market rate, gatekeeper real GDP growth, destination money market rate and destination real GDP growth. In this identification scheme, it is assumed that the shock to the gatekeeper money market rate reflects gatekeeper's monetary policy. An important caveat is that, in times of financial stress, the link between monetary policy and money market rate may become more tenuous and progressively more accommodative monetary policy may not necessarily cause money market rates to decline.

16. **Comparisons.** The effect of gatekeeper's monetary policy on the transmission of global shocks to destination countries is measured by comparing two impulse responses: first, with the behavior of all model variables is unrestricted, and second, with gatekeeper's money market rate is restricted to a constant. This restriction is implemented by generating corresponding shocks to the gatekeeper's money market rate and constructing the conditional impulse response function as a sum of the impact of the original shock and additional monetary policy shocks that would be required to keep the money market rate constant.

17. **Results.** Figure 6 shows that Swedish monetary policy attenuates the spillovers from negative global shocks to money market rates and real GDP growth rates in the Baltic countries, as illustrated during the recent crisis. This conclusion is particularly strong for the money market rates in Estonia and Latvia, where the median expected path of the money market rate conditional on the gatekeeper's monetary policy remaining unchanged is outside the 90 percent confidence interval of the unrestricted impulse response after three to four quarters (confidence intervals are computed based on a bootstrap procedure with bias correction as proposed by Kilian, 1998). The reason is that a negative global shock lowers Swedish money market rates (presumably due to monetary policy being more accommodative). If monetary policy were instead unchanged, this would imply positive shocks to money market rates, which would also raise money market rates in destination countries. There are also differences in the effect of Swedish monetary policy on the impact of global shocks on real GDP in destination countries: the strongest difference is observed for Latvia and Lithuania (in response to a VIX shock), whereas in Estonian case the conditional median impulse response of real GDP growth is within the 90 percent confidence interval of the unconditional one.

Figure 6: Baltics: Effects of Volatility and G20 Growth Shocks on Money Market and Real GDP Growth Rates (1 standard deviation shock, percentage points)





18. **Policy measures.** Differences in conditional responses of destination countries could be explained not only by varying strengths of financial linkages, but also by different policies adopted in the destination countries. For example, if Estonia had chosen to exercise larger fiscal policies to counteract the impact of the 2008 financial crisis, the measured impact of accommodative Swedish monetary policy (and hence the difference between conditional and unconditional responses) could possibly be lower.

19. **Caveats.** The analysis above is subject to several caveats. These include controlling for uncertainty of conditional impulse response estimates, time variation and low number of observations for some countries. Nevertheless, the above analysis illustrates that policy in countries identified as the gatekeepers can have material impact on other countries in the cluster and consequently policy in other cluster countries should remain aware of this fact.

## E. Core and Cluster Connections

20. **Benefits and limits.** Even with perfect coordination between the gatekeeper and cluster members, conditions in the global core will affect the cluster. The easy access to wholesale funding was driven by conditions in the global core, and with a commitment to open capital flows, it would have been very difficult for the cluster (or even just the gatekeeper) to lean against the flows. In aggregate, conditions in all the clusters will also form the environment that the global core operates in—access to higher growth markets will pull in more funding. Individually, it may be possible to ignore the effect of one cluster on the core, but if the conditions in the peripheral clusters are correlated, for example through the business model they use, the robustness of the clusters matters.

21. **Gatekeepers' policy space matters.** The Nordic gatekeepers had the policy space to serve as a shock absorber for their cluster, much like Austria with the CEE economies. Both Austria and Sweden had gross government debt below 60 percent of GDP, had current account surpluses, and had comfortable fiscal accounts in 2008 (a small deficit for Austria, a small surplus for Sweden). As noted in the recent FSAP update, Sweden quickly moved to bolster their banks operating in the Baltics after the crisis, with coordinated support from both the Ministry of Finance and the Riksbank. This was very similar to the rapid response by Austria once the potential damage to CEE countries became clear. Both would not have been possible if the gatekeepers themselves were cut off from market access. This contrasts with the situation in Bulgaria and Romania, which have Greece as their gatekeeper – there the cluster members could not rely on their gatekeeper to be a shock absorber.

22. **Flexibility.** With uncertainty about sources of future shocks, flexibility by gatekeepers becomes more important. Different policy choices could easily have implied a different role for the gatekeepers. If Sweden (and Austria) had not chosen to backstop their banks, the deteriorating conditions globally could have forced the banks to deleverage more severely in the recipient countries. If in addition growth slowed sharply in the recipient countries, and banks deleveraged even more, this would have amplified the shock. If this had eventually endangered the health of the banks, and spread to the rest of Europe, the amplification would have worked both ways.

23. **Data.** Better data would help. There have been long lags between the initial suspicion of something wrong and the provision of data to track certain kinds of interconnections. The ongoing Data Gaps initiative is attempting to bridge some of the gaps, for example. One could argue that by the time data are requested and received, it may already be too late. As flows become larger, the role of the gatekeepers as potential shock absorbers could also grow. Against this background, larger policy space is likely to be essential.

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## VIII. INVESTIGATING CLUSTERS: INITIAL CONSIDERATIONS

*Understanding the functional characteristics of a cluster is as important as the appreciation of its topology. Cross border economic links evolve over time, and reflect a variety of considerations. Building on analysis in the preceding notes, this note provides a summary of the key considerations to be examined, or questions to be raised, in the context of Fund surveillance.*

### A. Background

1. **Know your cluster.** Understanding the functional characteristics of a cluster is as important as the appreciation of its topology. Cross border links, whether in trade or finance, evolve over time, and reflect a variety of considerations. In that evolution, a country's place and role in the cluster can be unique or can bear similarity to other members of the cluster—with different implications. The existing theoretical and empirical literature suggests that the impact of interconnectedness on macroeconomic outcomes is largely context-dependent (see Section II, Main Report). It does, however, raise a number of considerations that can inform surveillance discussions of cluster-relevant issues and policies. And these considerations will differ depending on whether the country is located in a trade or a financial cluster, or both.

### B. Trade Clusters

Some considerations that may arise in better understanding trade clusters include:

2. **Export sectors.** Knowing the trade sectors to which a country belongs provides information on the extent to which macroeconomic conditions (domestically and in the cluster) are impacted by global factors/cycles (e.g., terms of trade) (Figure 1). To the extent that others in the cluster have divergent macroeconomic policies and outcomes, there could be lessons for how countries might respond.
3. **Position.** A country's position as upstream or downstream in the supply chain matters. (This requires an analysis of value-added trade to determine the extent to which a country relies on imported inputs in the production of its exports.) Advanced countries tend to be upstream, that is, they are important sources of inputs to other countries' exports. Emerging markets (EMs) tend to be further downstream because of their heavier reliance on imported inputs. A supply shock in an upstream country (as was the case with the earthquake in Japan in 2011) could reverberate through the cluster to the extent there is heavy reliance on inputs from that country and if substitution across suppliers is difficult in the short term. But the impacts may also depend on the conditions and policies in the gatekeeper(s).
4. **Competition.** Countries that are similar in export structures are more likely to compete in third markets, and therefore may have lesser flexibility in using some policy instruments (e.g., nominal exchange rates). Depending on whether output gaps co-move, this could create policy

challenges and trade-offs (e.g., a country may find it harder to appreciate nominally for competitiveness reasons, even if output is above potential).

5. **Trade credit.** Trade credit constitutes one link between financial and trade clusters and a channel through which financial shocks can spill over. For example, Euro Area banks have provided a large proportion of total trade credit in Asia, and Asian trade as well as finance could be adversely impacted by deleveraging by Euro Area banks. However, some trading partners may be less susceptible, depending on the funding model (see next sub-bullet).

### C. Financial Clusters

Similarly, some of the considerations that may arise in understanding financial clusters include:

6. **Funding model.** The nature of the funding model underpinning cross-border lending in the cluster may matter. During the crisis, for instance, it has been suggested that the behavior of foreign banks that relied on retail deposits was very similar to that of domestic banks during the crisis.

7. **The parent.** The balance sheet strength of the parent may also matter, both in stressful times and in “normal” times. Prior to the crisis (“normal” times), abundant liquidity in advanced markets was channeled to EMs that contributed in some cases to rapid growth and high leverage. During the crisis, headquarters’ financial support was received by an EM subsidiary of a bank whose parent was weathering the crisis well, but not by a subsidiary whose parent was more severely affected. Smaller foreign-owned banks whose parents were more exposed to the global financial turmoil were cut off from the head office (including funding cutbacks in limits that the headquarters applied to their EM subsidiaries’ foreign exchange positions) and had to reduce their exposures to the corporate sector.

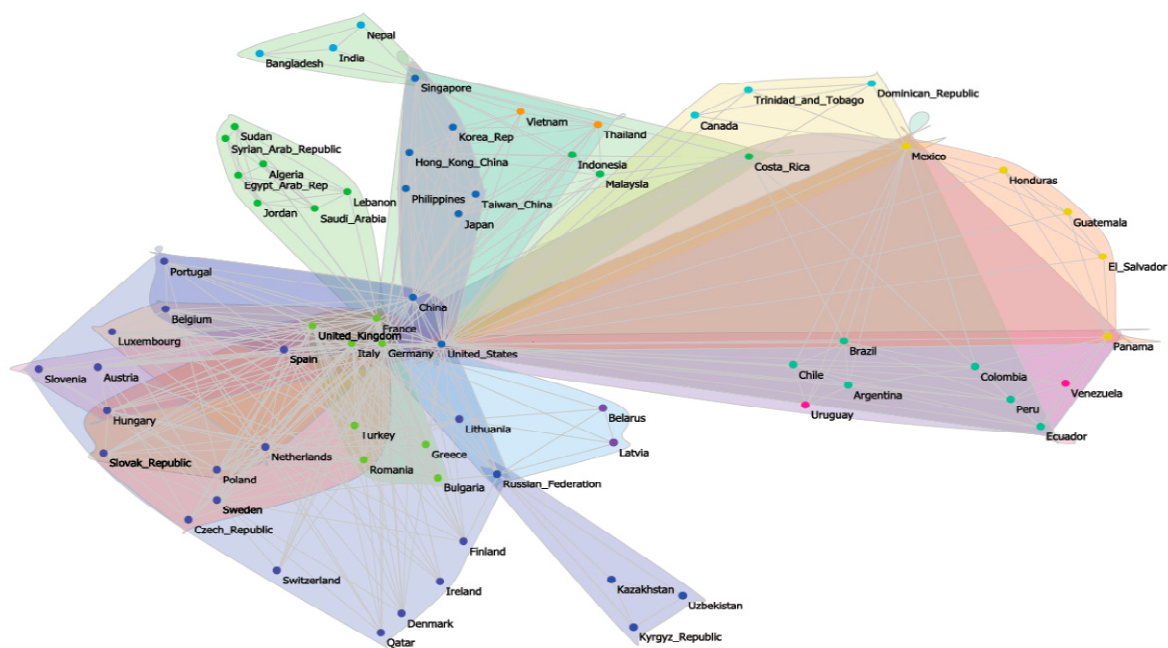
8. **Strategic importance.** Whether an economy has markets of strategic importance to others also matters. For example, a number of EU-headquartered banks consider CEE part of their core market, which creates a strong incentive to maintain a presence, even in the face of significant stress. On the other hand, a country that serves primarily as a booking center for financial transactions (e.g., some off-shore centers) are likely substitutable within or across clusters. Countries that host platforms/ infrastructure/markets vital to a cluster are, however, likely to be durable elements of that cluster, and could affect other cluster members and other clusters.

9. **Integration.** The degree of integration across clusters could affect transmission. In the crisis, difficulties in cross-border financing affected domestic liquidity conditions in EMs through several channels. First, funding costs in domestic currency increased in several economies as the dislocation of the cross-border funding market prompted financial institutions to fund their U.S. dollar borrowing through the FX swap market. Second, heightened counterparty risk affected borrowing in the interbank market. Finally, there was a shortening in the maturity structure of funding.

10. **Other channels.** Identifying the key channels enables a more targeted analysis of transmission across clusters. Domestic interbank money markets were relatively less affected in the crisis compared to those reported for the FX market. In most EMs, the effects on domestic bond markets were relatively limited. In other EMs where bond markets are comparatively deep, concerns that foreign investors would sell their government bond positions led to a sharp widening in bid-ask spreads that effectively stopped market activity.

**Figure 1. The Architecture of Cross-Border Trade**

A. Machinery Trade (UN Comtrade, 2009)



B. Oil Trade (UN Comtrade, 2009)

