INTERNATIONAL MONETARY FUND

ENHANCING SURVEILLANCE:

INTERCONNECTEDNESS AND CLUSTERS

March 15, 2012

KEY ISSUES

Focus. The global crisis of 2008–09 and its ongoing aftershocks have focused attention on the possible risks associated with global interconnectedness. Absent a satisfactory theory and empirics on the relationships among interconnectedness, stability, and policies, however, following through on the calls in the Triennial Surveillance Review for incorporating interconnectedness into the Fund's policy and risk analysis is challenging. This paper characterizes the architecture of cross-border trade and financial interconnectedness and points to how it might inform the Fund's work.

Architecture. The architecture that emerges from a network analysis of global interconnectedness has three elements: (i) a global *core*, comprising the major systemic economies; (ii) *clusters* or groups within which economies are more connected to one another than those outside (e.g., Asian supply chain); and (iii) *gatekeepers* or economies that link clusters to one another or the core to clusters (e.g., Austria to Central and Eastern Europe, Sweden to the Baltics). In this economic mapping, a country may belong to several different clusters, whose members need not be in its geographic proximity. Depending on its economic features, a country could potentially play a role in mitigating or amplifying and propagating shocks, including as a gatekeeper.

Know your cluster. Beyond mapping the interconnected architecture, understanding the economic characteristics of a cluster is important. Cross-border links evolve over time and, in that evolution, a country's role in its cluster(s) can be unique or similar to others, with different implications. In cross-border finance, for instance, the nature of the funding model matters (e.g., during the crisis, clusters dependent on global wholesale funding were more susceptible to shock transmission). In trade, being a part of a vertically integrated supply chain cluster could have implications for co-movements of exchange rates, even if outputs are not entirely synchronized. Some of these considerations that arise in the cluster context are illustrated via case studies.

Way forward. An approach motivated by examining cross-border interconnections could provide a broader context within which developments and policies are assessed. This paper is only a first step at identifying economic and policy clusters, and the architecture would need to be augmented by exploring structural and behavioral relationships to draw firm inferences and policy implications. These relationships and implications would need to be taken up in the context of surveillance, perhaps via pilot studies. They could bring further multilateral perspectives to bilateral surveillance (by nuancing the understanding of shock propagation, policy space, and stability), enhance the discussion of systemic stability (by examining the potential role of gatekeepers in propagating shocks), and foster dialogue and cooperation at the cluster level.

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CONTENTS

I. MOTIVATION

1. **Interconnectedness matters**. Rising cross-border trade and finance have underpinned strong and sustained growth in many parts of the world and delivered well-known economic benefits, such as access to new markets, cheaper funding, and more efficient allocation of capital. But the global crisis has brought home with devastating force the potential risks of interconnectedness, including that shocks in one part of the system—sometimes seemingly small in proportion to the whole—can be transmitted widely and quickly. With fragility and limited policy buffers expected to persist in the advanced economy core of the global financial system, the potential for systemic volatility remains high. Against this background, the Fund's recent Triennial Surveillance Review (IMF, 2011c) called for enhancing our understanding of interconnectedness and incorporating this understanding into the analysis of risks and policies.

2. **Limited understanding**. Notwithstanding its importance, our collective understanding of interconnectedness and its implications—whether shock amplification and propagation or policy effectiveness—is limited. We lack a satisfactory and comprehensive theory, backed by detailed empirics, on the relationships among interconnectedness, stability, and policies. Therefore, even though there is broad recognition of the complexity of interconnectedness—e.g., the myriad of trade, financial, expectations/confidence, and policy channels—and of its impact on stability and policies, existing analyses of interconnectedness tend to oversimplify. Going beyond direct exposures, systematically exploring the range of indirect connections and propagation channels is difficult, in part because there are many dimensions of linkages. Large-scale structural models provide precision in analyzing shock propagation, but lack granularity on the role specific, key partners may play. Their usability can therefore be limited when attempting to discern which partners' developments and policies to pay particular attention to (beyond the "global core"). Comprehensive data are also often missing on cross-border financial exposures as well as on the exposures and business models of globally systemically important financial institutions (G-SIFIs).

3. **Needed—a framework**. A country is linked *directly* to its partners through several distinct channels—trade, banking and portfolio exposures, foreign direct investment, policies, etc. It is also linked *indirectly* through common partners or a chain of partners. Common *policies* (e.g., membership in a monetary union), common *platforms* and infrastructure on which transactions are conducted (e.g., payments systems), and common *characteristics* (e.g., being in the same asset class, with episodic contagion pressures) are some of the ways in which economies are linked to each other. Keeping track of these direct, indirect, and common linkages and unpacking the inter-relationships requires not only collecting and assimilating large volumes of data (which oftentimes are neither comprehensive nor universally available) but also building a framework to digest and effectively deploy the data. To date, an easy way to track these linkages has been lacking.

4. **This paper**. To make headway, this paper examines one way—not necessarily the only one—to characterize the global network of trade and financial interconnections and analyze some of its implications. It does so in two parts:

- ***Architecture***. First, it uses cluster (network) analysis to understand the architecture of cross-border trade and financial interconnectedness. Cluster analysis is a graph theoretic tool that unpacks the characteristics of a network by subdividing it into overlapping groups or clusters of connections. This analysis reveals an architecture comprising a global *core* (mainly, the systemic-5), *clusters* of economies within which connections are closer than outside (e.g., Nordic-Baltics), and *gatekeepers* or connectors that link clusters to one another and the core to clusters (e.g., China appears as a gatekeeper to the Asian supply chain). It is hypothesized that gatekeepers can play important roles in dampening or amplifying shocks. Sensitivity analyses point to their role as possible pressure points or "circuit breakers", where in the face of shocks interconnections within the system can either change or remain robust.
- ***Applications***. Second, going beyond a characterization of the interconnected architecture, the paper presents select case studies to shed initial light on how the functional or economic features of a cluster can shape the discussion of shock propagation and policies. Existing theory and empirics on interconnectedness and output synchronicity show that *context matters*: there is no general relationship between rising trade or financial interconnectedness and synchronicity of output (Background Paper, Chapter 1). It thus becomes necessary to delve into the specific context of clusters, and of a country's role in the cluster, to draw out the implications of interconnectedness. For instance, if countries are linked in a trade supply chain through strong intra-industry links and where industry-specific shocks dominate, their outputs are likely to co-move (with consequences for policy setting). However, if they trade closely but produce in different industries, then outputs need not co-move much. Similarly, financial connections can potentially facilitate risk diversification or concentration, with divergent consequences for outputs and policies.

5. **Implications**. By shedding light on direct and indirect trade and financial linkages, a cluster-based approach can point to ways in which interconnectedness is systematically integrated into the Fund's work. Situating an economy in its respective cluster(s) can facilitate a sharper assessment of shock propagation and risks. To the extent that the role of economies as dampeners or amplifiers of shocks is confirmed through further analyses of the underlying structural and behavioral relationships and of shock propagation, the role of these economies and of their policies in contributing to systemic stability is highlighted. Providing specificity on the partners to pay particular attention could be a basis for promoting a dialogue in the cluster context on the effectiveness of macroeconomic and macro-prudential (and capital flow management) policies.

6. **Caveats**. Nonetheless, some caveats must be borne in mind. The paper is a step toward understanding more precisely the structure of the interconnected economic and financial system. Much more work is required to better understand how countries are connected, how shocks—whether positive or negative—are transmitted across these connections, and the role that economies and policies can and have played in enhancing stability. To this end, a plurality of approaches could be taken. The hypotheses generated by the cluster analysis, such as with regard to the role of gatekeepers in mitigating shocks, are just that—hypotheses—until confirmed through thorough economic analysis and on the basis of which further inferences may be drawn. This would help to avoid the problem of type I and type II errors, wherein true hypotheses are incorrectly

rejected or false hypotheses are not rejected. Attention is paid here to broadly intuitive results, as the confirmation of well known patterns provides comfort about the methodology used. But the structure also yields some surprises as countries appear in certain groupings that one may normally not think of. It should also be noted that the usefulness of the cluster analysis, as from any tool that relies heavily on data, depends on the quality and quantity of data available. The more the data that are made available (in particular, on financial exposures), the sharper would be the findings.

7. **Structure**. The rest of the paper is organized as follows. Section II sketches a framework for analyzing trade and financial interconnections and its implications. Section III discusses a cluster-based architecture of cross-border interconnectedness, which has the potential for generating hypotheses regarding the role of economies as gatekeepers (or "circuit breakers" or "pressure points") in the system. Section IV elaborates select case studies on implications of this cluster-based architecture. Finally, section V draws possible implications for Fund surveillance and work.

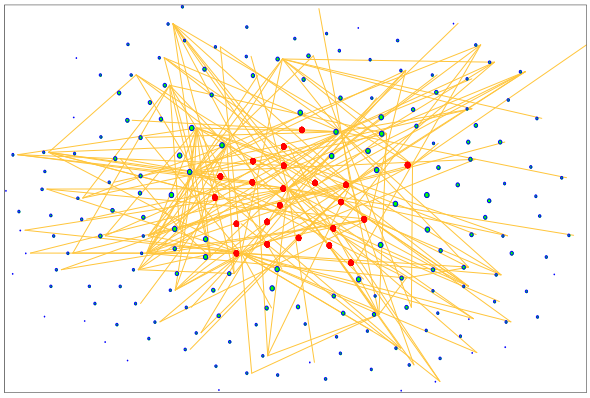
II. FRAMEWORK

8. **Two stages**. A two-stage approach is taken to incorporate interconnectedness into an analysis of stability and policies. In the first stage, the architecture of cross-border trade and financial linkages is mapped using cluster analysis. This stage seeks to discern the structure embedded in global trade and finance in order that more pointed questions and hypotheses may be raised regarding shock transmission and policy effectiveness. As such, it is "behavior or risk neutral", that is, it makes no presumption about the underlying economic behavior that gives rise to observed interconnections. The second stage brings to bear the economic characteristics of the linkages to some of the questions and hypotheses raised in the first stage.

Stage I: Mapping the Network Architecture

9. **Dense structure**. Viewed from the perspective of any given country, its bilateral trade and financial connections with partners are comprehensible. But unpacking the chain of relations—direct and indirect—across a large network 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. As Figure 1 illustrates, mapping these bilateral connections, whether trade flows or financial exposures, invariably results in a dense mass. The importance of a subset of economies at the center of the map is immediately apparent (illustrated by red dots). These "central" or "core" economies link directly to a large number of other economies (blue dots), and several links pass through them. However, beyond the dense links, the structure of the rest of the network is not immediately apparent.

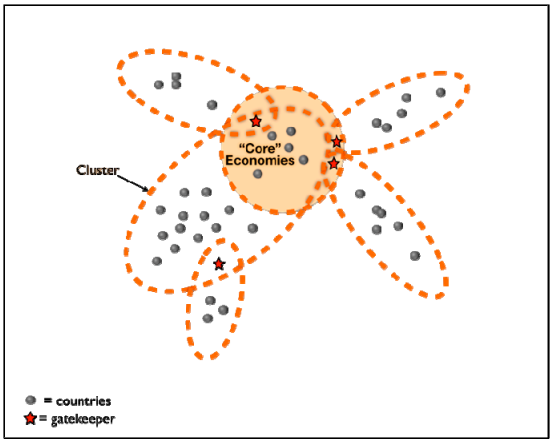
Figure 1. Dense Interconnected Network



10. **Cluster analysis**. To specify the interconnected global architecture, identify a country's place in that architecture, and discern at a glance the key direct and indirect trade and financial connections across partners, a graph-theoretic methodology is needed. Such a methodology allows for systematically deconstructing the network, irrespective of its complexity, by locating patterns in the connections across economies. The methodology used is a clustering technique called clique percolation (Background Paper, Chapter III). This technique condenses across various datasets the mass of bilateral trade and financial data into subgroups of economies among which connections are particularly strong. In particular, the system is partitioned into *overlapping* subgroups or clusters of economies. Overlapping clusters, as opposed to uniquely segmented clusters, help situate a country's relations across different subgroups of partners, rather than with just one subgroup (e.g., China with the Asian supply chain and with advanced economies). Otherwise, the richness of relations would be papered over.

11. **Stylized depiction**. The architecture that emerges is described in stylized form in Figure 2. The system comprises a number of overlapping clusters of economies. Some economies are situated in the intersection of a large number of clusters. These economies are central to the system and, as such, form the "core". Beyond the core, some economies connect clusters either to the core or to other clusters. These economies are termed "gatekeepers". Absent the presence of the gatekeepers, clusters would not necessarily be connected with each other or with the core, but would form groupings that are in the main separate from their connections with the rest of the system. Countries can be gatekeepers to multiple clusters. Groups of countries can also serve as gatekeepers; for example, economies in the core can individually and as a group serve as gatekeepers to different parts of the system.

Figure 2. Global Trade and Financial Architecture:
A Stylized Depiction



12. **Generating hypotheses**. In elucidating the structure of the network, cluster analysis can also lead to hypotheses about the role of economies in the stability of the system. Of interest is the potential role of the core economies and other gatekeepers in dampening or amplifying and propagating shocks (whether positive or negative) across clusters and throughout the system. If, depending on circumstances and policies, their role as dampeners or amplifiers is confirmed through further analysis, there are implications for *where* in the network policies and buffers could effectively limit shock propagation and for *what* instruments might be effective in doing so:

- ***Core***. Shocks and policies in the core can have global spillover effects, whether beneficial or deleterious and either individually or in combination, as the recent spillover reports have investigated (IMF, 2011b). The work on capital flows from a source country's perspective has similarly examined the potential role of policies to limit adverse external effects (IMF, 2011e).

- ***Clusters***. Shocks may have a larger impact on partners within a cluster, given the preponderance of connections, than those outside (at least initially). If true, this can focus attention on the policy instruments and space to cope with shocks, including possibly at the level of the cluster. Europe in the current juncture is a case in point, where these issues are germane at both the country and the cluster levels.

- ***Gatekeepers***. To the extent it is determined that gatekeepers play important transmission roles for shocks (internally within the cluster or from outside), attention could be focused on policies and buffers in gatekeepers to potentially dampen, rather than amplify, shocks. For example, in the run-up to the crisis, Austrian banks borrowed wholesale in global markets and passed through low funding costs to some Central and Eastern European (CEE) economies. It is hypothesized that they were thus conduits, passing through the effect of global conditions. A question is whether tighter prudential requirements in Austria would have limited this pass through. During the crisis, fiscal space in Austria was used to re-capitalize banks, which appears to have limited deleveraging and thus played a dampening role.

Stage II: Analyzing Clusters and Evaluating Hypotheses

13. **Delving deeper**. To test these hypotheses and further analyze the role of interconnections in affecting economic and financial stability as well as policies, it becomes necessary to delve deeper into the functional characteristics of a cluster. Cross-border links, be they 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 bear similarity to other members of the cluster—with different implications. Interconnections may also change the nature of shocks that an economy faces and the process of shock propagation in the cluster/system. They could dissipate certain types of shocks (e.g., as substitutes are found more easily) or amplify and propagate others (e.g., as in the global crisis), including via gatekeepers. For clusters that endure, and for new ones that form, it is reasonable to expect that shocks are perceived to be primarily dissipated by the relevant gatekeeper(s), or else membership in the cluster would eventually change (as links are diminished).

14. **Context matters**. The existing literature offers an ambiguous assessment on the impact of interconnectedness on macroeconomic outcomes (Background Paper, Chapter I). There is no consistent prediction, and the effects of trade and financial integration on output synchronization or volatility depend on the extent and nature of integration (e.g., inter- vs. intra-industry trade), types of shocks (e.g., industry-level vs. common shocks), the levels of economic and financial development (e.g., the ability to diversify risk), as well as the type of financial clustering, and the prudential frameworks (Background Paper, Chapter VI). The context matters.

15. **Considerations**. The second stage of the analytical approach must therefore involve understanding the economics and context underpinning a cluster. While each cluster has its specific features and issues that could be analyzed by event studies, structural macroeconomic models and the like, some initial considerations may be relevant for setting the context (Background Paper, Chapter VIII). These considerations and others raised in the theoretical and empirical literature on

interconnectedness and macroeconomic outcomes (Background Paper, Chapters I and VI) can inform discussions of cluster-relevant issues and policies.

16. **Policies**. In delving deeper into clusters, a further issue is how trade and financial linkages feed into policies. This is an area that the literature has not dealt with comprehensively:

- ***Trade***. In clusters where close trade linkages result in business cycles becoming more synchronized, policies may also become more closely aligned. The optimal currency area (OCA) literature suggests that regions facing common shocks and cycles will lose little from foregoing, e.g., monetary policy independence. This makes a case for coordinated policies. Closely aligned policies can in turn make integration closer—the OCA is endogenously reinforcing, making the case for foregoing independent policies stronger still. Where cycles are not synchronized, policy flexibility would be desirable, as rigidity could hinder adjustment and foster tension. But when policies are tied and outputs do not co-move, the result could be significant stresses. Bringing out these relationships and connections in surveillance, where relevant, would provide context and granularity to policy discussions and focus attention on potential policy "tensions" and levers. Background Paper, Chapter II provides some simple stylized facts on output synchronization across groups of economies.

- ***Finance***. In the case of financial clusters, the close integration of financial systems could drive capital inflows and expansion in upturns and sudden stops or even reversals in downturns. In this case, there may be a case for information sharing and coordination of policies to manage inflows (IMF, 2011e). First, when regions are closely linked, reactions to capital inflows in one country could divert flows elsewhere, creating problems there. But there is also a case for coordinating with the country or countries from which the capital inflows originate—both to enhance awareness of the external effects of cross-border flows and to maximize the effectiveness of policy responses.

III. CLUSTERS AND GATEKEEPERS

17. **Data**. For the cluster analysis, detailed bilateral *trade* data are used from the IMF's Direction of Trade Statistics on aggregate data and from UN Comtrade on various commodities, capital goods, and manufacturing goods. Bilateral *financial* exposures are obtained from the Bank for International Settlement's (BIS) consolidated and locational banking statistics, the IMF's Coordinated Portfolio Investment Survey (CPIS), and the IMF's Coordinated Direct Investment Survey (CDIS). All the data are as of end-2009, the latest point at which all three are available. Only relatively significant connections are used, defined as bilateral connections that are above 15 percent of a country's overall connections in that category (this threshold was determined endogenously to maximize overlaps across clusters). So, country A's trade in capital goods with country B is included only if that trade is above 15 percent of A's overall trade in capital goods.

18. **Finance and trade**. Taking these datasets separately, the cluster analysis reveals an architecture of global finance that is different from that of trade. Finance has a nested core-periphery structure—highlighting the central role of a handful of economies in intermediating

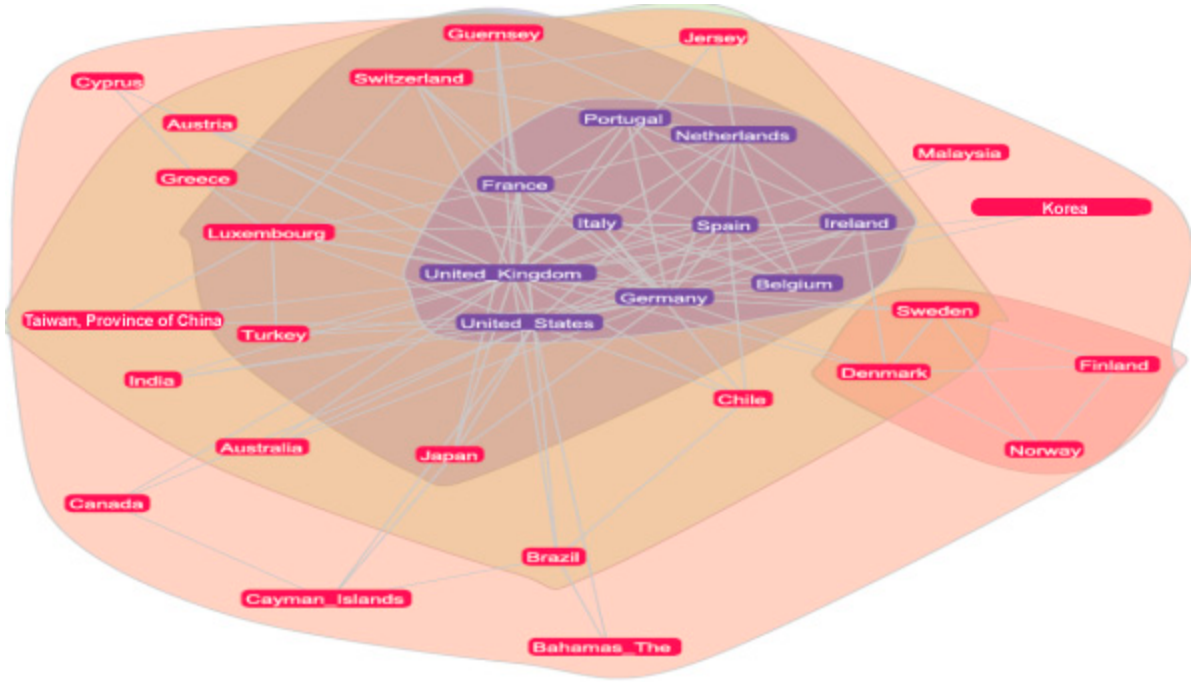
global finance (IMF, 2010b). Figure 3A illustrates this architecture for the BIS's locational banking statistics. The core is connected to all other economies, and is a part of almost all clusters (different clusters are identified by different colors and sets). By contrast, the architecture of global trade comprises a core of some of the largest economies, but in a non-nested structure and with fewer overlaps among clusters. Figure 3B displays the architecture for aggregate cross-border trade. This architecture varies by type of good (e.g., machinery vs. commodity), with different numbers and types of clusters and overlaps (Background Paper, Chapter VIII). These differences highlight the varied roles of economies in different products and networks, which in turn point to their potential to originate and amplify or propagate different kinds of sectoral or aggregate shocks.

19. **Overall architecture**. Together, the trade and financial connections provide an aggregate architecture of cross-border interconnectedness. The bilateral links of each economy are summed up across the different trade and financial dimensions. (These links are weighted by the relative shares of each link in its respective dataset, which ensures that absolute numbers are not added up, given the different scales across datasets.) Gatekeepers are identified through a process of iteration: if removing an economy from the network results in a cluster dropping out, then the economy connects that cluster to the rest of the network. The resulting architecture of overlapping clusters—projected onto 2-D—is presented in Figure 4. The key points that come through are:

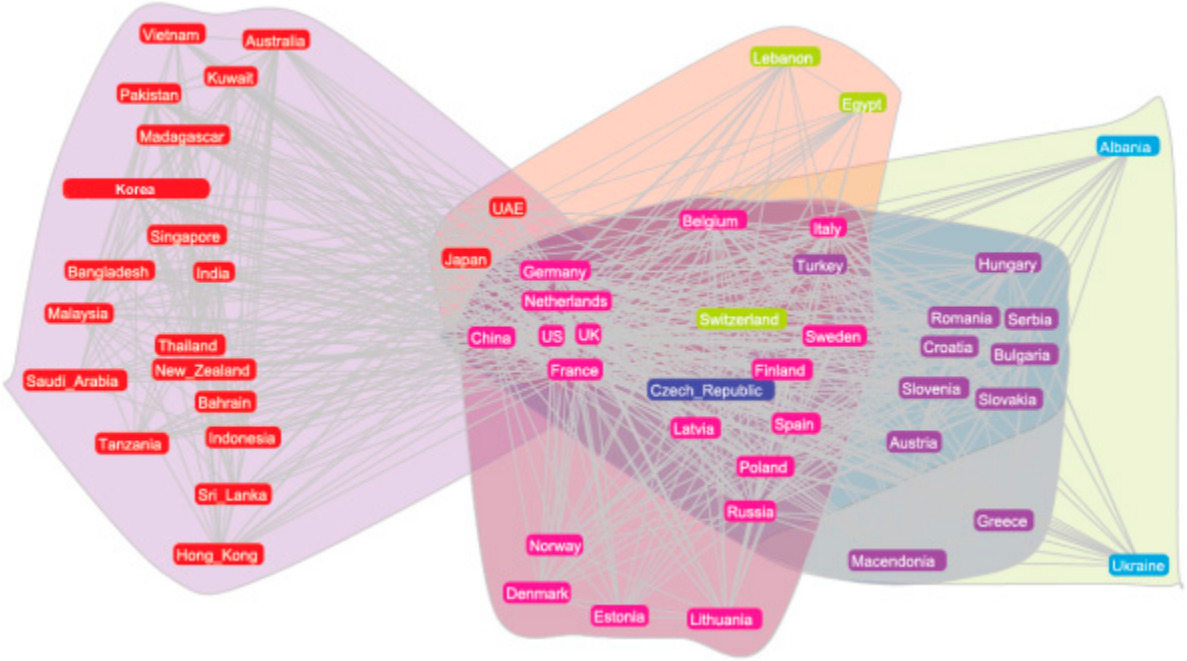
- there are a large number of overlapping clusters;
- the global core economies, comprising mainly the systemic-5, are connected to most other economies and many of the clusters;
- in several clusters, there are more than one gatekeeper; multiple gatekeepers point to the potential for negative feedback effects within and between clusters as a shock transmitted from any one point must go through multiple "gates" to spread throughout the system; and
- economies that do not appear in any of the individual clusters are part of the entire global system. This may also reflect limited data on some dimensions, such as cross-border finance.

Figure 3. The Architecture of Cross-Border Finance and Trade—A Snapshot

A. Cross-Border Banking (BIS locational banking statistics, 2009)

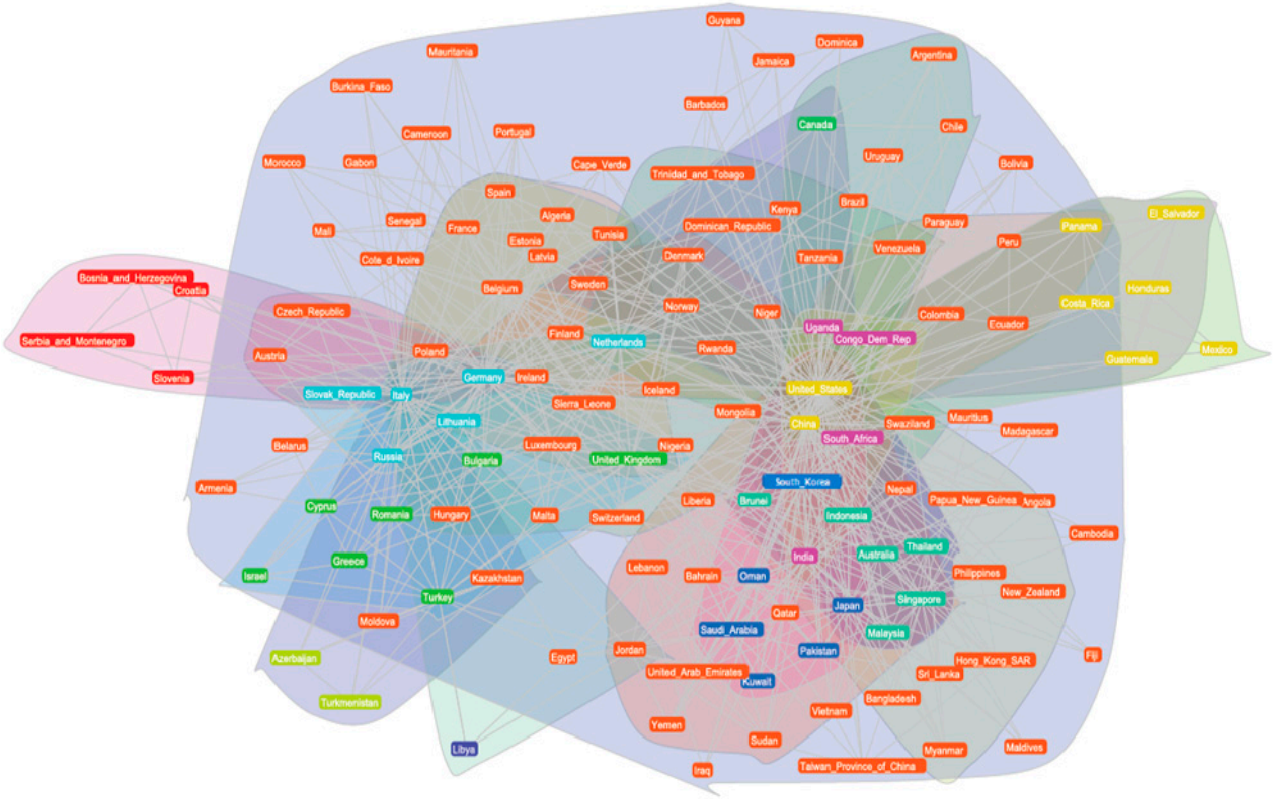


B. Aggregate Trade (Direction of Trade Statistics, 2009)



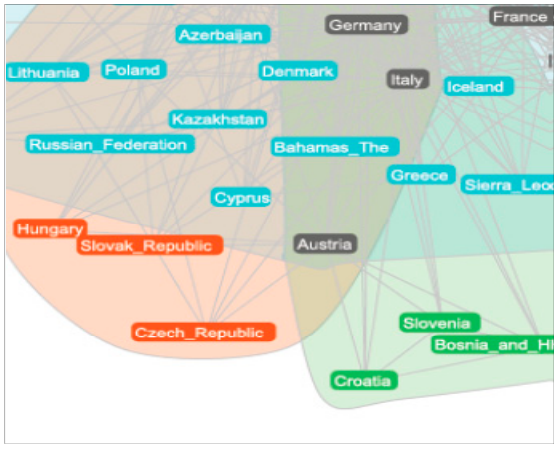
Note: Clusters are identified by unique colors. Overlapping clusters mirror the color of the component cluster that has the stronger or overriding weight in defining the overlap. Distances convey no special meaning.

Figure 4. A Cluster Analysis of the Global Trade and Financial Architecture



20. **Clusters and gatekeepers**. The economies in the core are intuitive, identifiable from the density of their connections, their centrality in the network, and their presence in several clusters. They have been highlighted in numerous recent Fund documents (e.g., IMF, 2010a, b, 2011a, b). The clusters identified are also intuitive, with key gatekeepers that are sometimes in the core: e.g., an Asian cluster around China and the United States; a Euro Area cluster around Germany; Austria linking CEE economies as well as South Eastern Europe (Bosnia and Herzegovina, Croatia, and Slovenia)—the CESEE—to other large European economies (Figure 5); Sweden linking Latvia and Estonia to other large European economies; and Central America clustered around the United States. These broadly intuitive results provide comfort about the methodology used. But there are also surprises. For instance, Lithuania is closer to other CEE economies, such as Poland, rather than Estonia and Latvia; some Middle Eastern economies such as Algeria, Egypt, Lebanon, and Tunisia are closer to European clusters, whereas other Middle Eastern economies are clustered more with Asia and the United States. These patterns,

Figure 5. Austria as a Gatekeeper



which derive from available data that are not always comprehensive, point to underlying connections and groupings that go beyond standard regional ones.

21. **Results**. The list of gatekeepers emanating from the aggregated trade and financial network is provided in Table 1. *The table presents groups of countries that need not be clustered together but that collectively share gatekeepers*. In reading the table, keep in mind that: (i) a gatekeeper links the economies in any particular group, together and to others; and (ii) a gatekeeper's potential impact is bi-directional, i.e., causality may not be fixed. For example, clusters that contain the countries in group A have the United States as a gatekeeper.

- In total, this aggregated network yields 21 groups of gatekeepers connecting countries across clusters; 18 cut across regions. Only 3 fit into regional categories—two connect advanced Europe with emerging Europe and the remaining one relates to Southern Africa.

- Most groups include some of the systemic-5 (core) economies as gatekeepers. For instance, the analysis reveals the United States as a gatekeeper to 16 groups, and China as a gatekeeper to 12 groups. The large European economies are gatekeepers to a smaller number of groups, but these groups contain many large economies, suggesting that beyond the number of groups, the economic size of the groups are relevant to discerning their role in systemic stability.

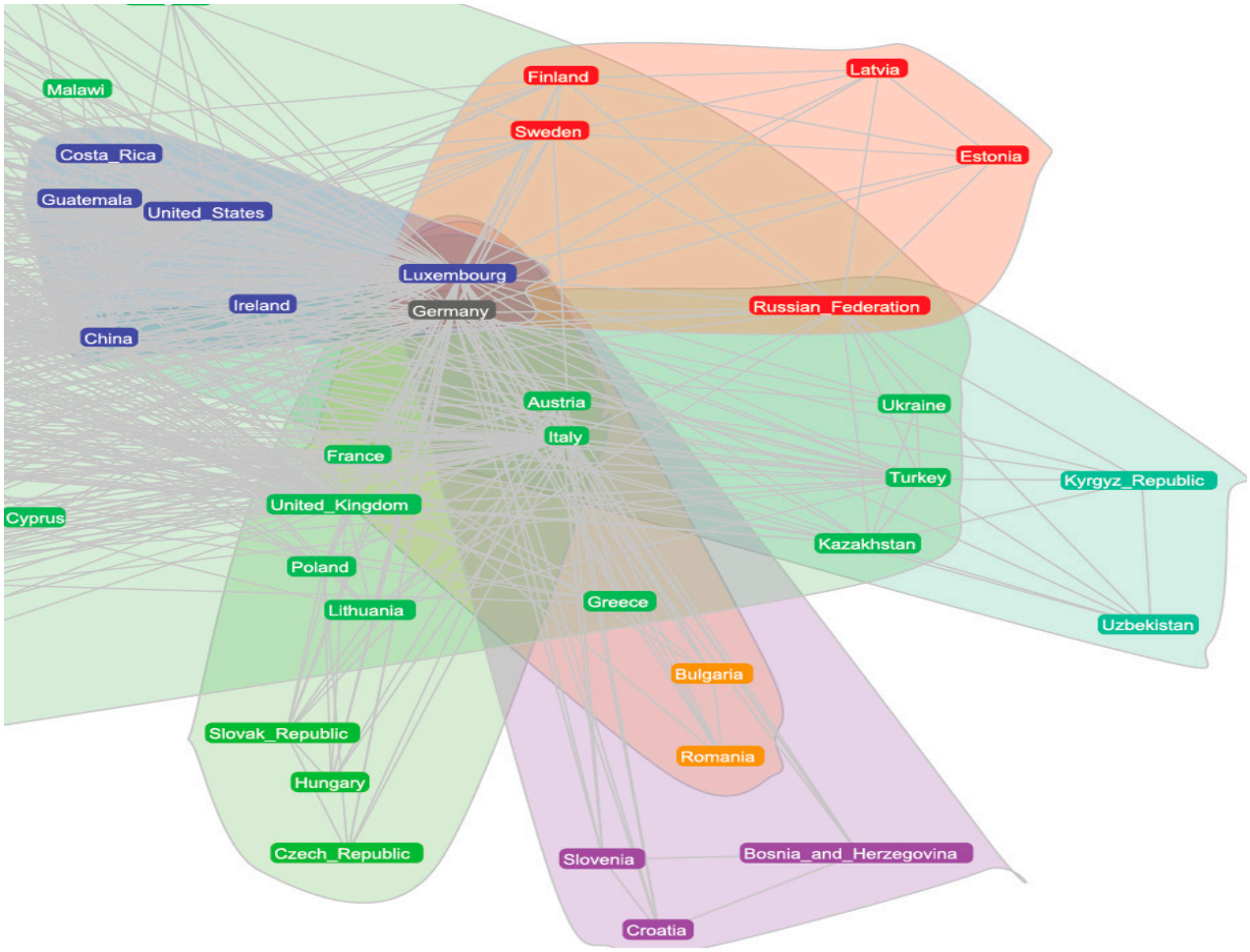
- Group P: the problems in Greece can have significant spillover effects beyond its cluster insofar as its gatekeepers—Italy and Germany—are adversely impacted. If the gatekeepers become vulnerable, e.g., if Italy lacks adequate policy buffers and comes under stress, then the problems could spill over widely, given Italy's connections across Europe, the Middle East, Central Asia, and sub Saharan Africa.

- Group O: Italy is a gatekeeper, along with Germany and Austria, into some CESEE economies (Figure 6). Stresses in Italy could have a direct adverse impact.

- Group N: similarly, Egypt, and some others in the Middle East, could be adversely impacted through their strong, direct linkages to Italy. These spillovers could compound domestic strains and exacerbate existing economic challenges.

- Group J: wider, global effects of challenges in Italy could be expected to the extent that its large partners and gatekeepers in group J are impacted. As a conduit of shocks to Belgium, France, Germany, and the Netherlands, secondary reverberation effects among these core European countries could further impact other clusters, such as the CESEE. If, however, domestic policy buffers were sufficiently robust in these economies, broader spillovers could potentially be contained.

Figure 6. Italy as a Gatekeeper



- Group Q: Unlike core Europe and the CESEE economies, however, the CIS economies may not be as susceptible to secondary reverberation effects, except in so far as certain other emerging market economies are impacted.

- Group U: Italy, together with some large advanced and emerging economies, links a number of sub Saharan African economies with the global network. While strains in Italy could adversely impact them, the impact could be attenuated to the extent that some of the other gatekeepers have policy space. But the impact could be very large if adverse feedback loops among the gatekeepers ensue.

- Group K: Traditionally, Hong Kong SAR is viewed as a financial hub that is responsible for intermediating Asian savings. The above analysis contextualizes this and adds further granularity. Hong Kong SAR may have become an equity financing center to accommodate the economic dynamics of the Asian economies (which are subject by varying degrees to capital flow restrictions) on the one hand, and the investment opportunities of the United States via the G-SIFIs on the other hand.

22. **Durability**. How does the aggregate network change over time? To check the durability of the architecture, the cluster analysis was conducted over 6 different time periods from 2000 to 2009. Based on the data that are available, the resulting cluster structure appears to be broadly stable, with the exception of China that grew rapidly and more central to many clusters. As a consequence, the Asian supply chain has become both more central to global trade and more concentrated. That said, data limitations pre-dominate, particularly on financial exposures. As more complete data are made available, the cluster analysis results may need to be re-visited.

23. **Other properties**. Some other properties and characteristics of the cluster-based architecture are as follows:

- *Output correlations*. Clusters by construction constitute groupings with relatively dense trade and financial connections. As such, a shock to a member of a cluster would be expected to directly impact others in the cluster. Output co-movements are more correlated within clusters: the average real GDP growth correlation over the past 20 years is three times higher in clusters (0.37) than for the world (0.12). However, this is not more than a standard deviation apart, suggesting that countries in a cluster, while experiencing greater co-movement, may often mitigate rather than amplify the impacts of local shocks. In fact, if clusters are to endure, the overarching hypothesis should be that shocks are dampened rather than amplified (or else membership in the cluster would change).

- *Context*. Since context matters, whether a shock is amplified or dissipated would depend on the nature of the shock, the economic and financial depths of the cluster members, and policies. Financial shocks may have widespread effects, particularly if they originate in or impact the core, which is nested in nearly all clusters (IMF, 2011b). Real/trade shocks may have more localized effects, as trade clusters have significantly fewer overlaps and trade patterns may overall be more stable. The extent of real sector and financial diversification also matters, as does the ability to undertake counter-cyclical policy.

24. **Sectoral and other clusters**. The results above are based on an aggregated trade and financial network. For sub-networks, as for instance machinery or capital goods, or particular types of financial exposures (e.g., through G-SIFIs), the clusters and gatekeepers could be more granular than illustrated above. For countries with products or assets concentrated in specific sectors and types (e.g., exporters of a commodity or manufacturing sector), analyzing these granular clusters and gatekeepers could provide more detailed information. The basic network could be augmented with information along these and other dimensions, such as membership in formal currency areas. This would bring out further relevant information. Clusters based on correlated asset prices could also provide richer insights into cluster and gatekeeper identification. In this case, similarities, rather than direct exposures, are key to determining clusters, and could get at the issue of contagion.

Table 1. 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
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			Senegal Cote d'Ivoire Sierra Leone Liberia Guinea Bissau Lesotho Namibia
H	U.S., China & Japan	Singapore Australia Indonesia Malaysia Thailand	P	Germany, Italy, United Kingdom & Turkey	Bulgaria Cyprus Greece Israel Romania			Ethiopia

25. **Vulnerability or stress test**. A further application of the cluster analysis is to vulnerability or stress exercises. A sensitivity analysis of the clusters formed when the links change as a result of shocks could allow for identifying *pressure points* or *circuit breakers*, that is, key connectors who help maintain the overall cluster configuration of the system. As is standard in vulnerability exercises wherein exogenous shocks are imposed to rollover rates, deposit flows and trade flows, exogenous or mechanical reductions of links from a given economy are imposed in this exercise, and the resulting clusters and gatekeepers are compared with the pre-perturbed system. (The cluster methodology allows for endogenously determining a minimum threshold for links below which, if the links are pruned, the cluster features of the system remain unchanged.) Applying a uniform stress to all trade and financial links (15 percentage points) causes some links to fall below the threshold. Figure 7 provides a description of the results.

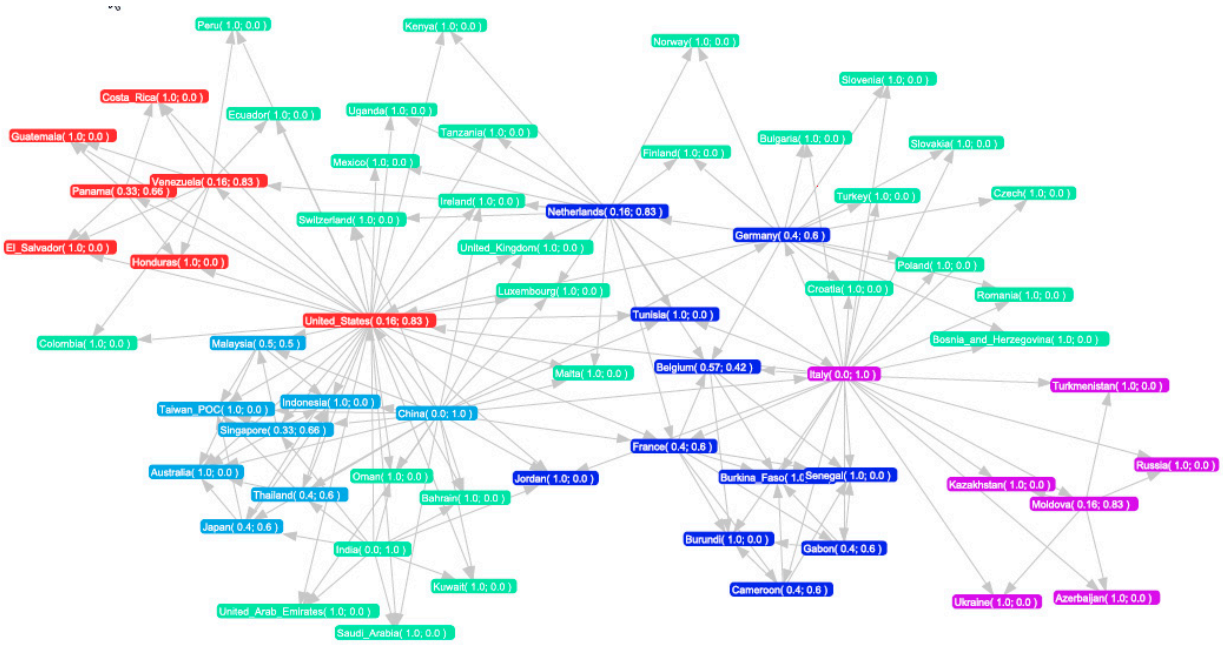
- In the figure, each country is associated with two numbers. The left number represents the share of the envisioned shock transmitted to it (i.e., incoming from others, measured as inward directional links in proportion to the total), while the right number indicates the share of its effects on others (measured as outward directional links in proportion to the total). Note that directional connections are illustrated by arrows.

- The envisaged shock to Italy has significant effects on multiple regions (e.g., Egypt's and Greece's links fall below the threshold). It can thus be seen as a "pressure point" in the system. If pressure is applied and the links change, it can have important systemic effects. But if it has adequate buffers to withstand the shock, it can serve as a "circuit breaker".

- A number of partners are recipients of the shocks directly and indirectly through other partners. Others, including in the core, continue to transmit (potentially dampening or amplifying the shock) to others—thus also serving as potential pressure points and circuit breakers. These include, for example, the United States and large Euro Area economies such as Germany, France, and Belgium. But it also includes Gabon and Cameroon, which seem to have effects within their respective clusters (calling attention within these clusters to their impacts and policies).

- The United Kingdom appears as a shock absorber from Europe. Owing to its unique role as a global intermediator of U.S. dollar assets, it appears to act as a conduit for shocks to the United States. However, on impact, the real effects are manifested in the economies which issued or whose financial sectors utilized them as funding vehicles, rather than the United Kingdom itself.

Figure 7. A Sensitivity Analysis of Clusters: Pressure Points and Circuit Breakers



Gatekeeper: US
Gatekeeper: Italy, Germany, Netherlands, US, and China
Gatekeeper: China
Gatekeeper: Italy
Gatekeeper: Belgium, France, and Italy

- Compared to the rest of the core, China's density appears to lie more within Asia, where stickiness in trade relationships could serve to mute the impact of certain shocks. However, if the Chinese economy were separately to come under stress, it could produce material effects on the countries in its clusters, including the United States.

- Caveat. This mechanical exercise maps out potential transmission routes through which a shock could propagate between clusters and the corresponding feed-back loops that might play out within each cluster. It is not a quantitative gauge of the relative intensity of shocks between countries, nor of actual propagation, for which careful identification of shocks and robust empirical work are needed.

IV. CASE STUDIES

26. **Cases**. To further analyze the issues arising in clusters, this section delves deeper into four case studies. Case studies have the advantage of bringing specific context to bear on the discussion, and can account more flexibly for dynamic changes in clusters. When the types of shock and circumstances matter to the episodes being investigated, standard econometric approaches may be more difficult to implement. The first study, the Asian supply chain, is primarily a trade cluster, and provides insights on the implications for policies of vertical trade linkages. The second study focuses on an oil exporter, Saudi Arabia, to illustrate how the dynamic nature of its links with countries in its cluster can impact its policies. The third note takes a closer look at general issues arising in financially integrated clusters and highlights the potential gains from coordination and information sharing in financial stability. The final case study, the Nordic-Baltic cluster, illustrates the role of gatekeepers in a primarily financial cluster. These studies provide a narrative, complemented with some empirical exercises.

The Asian Supply Chain—A Trade Cluster

27. **Structure**. The Asian cluster is a vertically integrated supply chain that comprises: China, Hong Kong SAR, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand, and Vietnam (Background Paper, Chapter V). The analysis reveals China as a gatekeeper, given its economic size, growing trade intensity with the region, and centrality in global trade (Table 1, group H). Prior to China's rising centrality, this role was played importantly by Japan, which remains a key player in Asian trade. Hong Kong SAR and Singapore link the cluster to global financial centers, such as the United States and United Kingdom, and intermediate financial flows from a wider set of countries to the rest of the region (Table 1, group K). However, trade linkages appear to dominate in the cluster.

28. **Cycles**. The Asian cluster is closely linked to the global electronics business cycle, given both the vertically integrated production structure, particularly for machinery and electronics, and the relatively high export similarity across several of the countries. China is also becoming an increasingly important source of demand in the region, as illustrated by its expansionary policies in 2008–09; it is no longer merely a processing center (IMF, 2011b). As a result, business cycles of countries in the cluster appear to be quite closely—though not entirely—synchronized with China's.

29. **Policies**. There is considerable co-movement of nominal exchange rates in the region, which may be attributed to the vertical integration underpinning trade linkages, the high export similarity, and co-moving business cycles across the region. It appears that, for countries somewhat further downstream in the supply chain, such as Malaysia, Thailand, the Philippines, or Vietnam, to the extent that consideration may be given to preserving their place in the production structure relative to China, the result could in part be maintaining relative currency stability vis-à-vis each other. In such cases, the availability of the exchange rate instrument as a policy tool in managing macroeconomic conditions could become limited (when faced with idiosyncratic shocks or cycles that diverge from China's), with the weight of adjustment falling to other policy instruments.

30. **Example**. An example of co-movement, and of the related policy trade-offs for countries in the cluster, can be gleaned from the reform of China's exchange rate policy. In July 2005, the Chinese authorities abandoned the peg to the dollar and announced reforms to the exchange rate regime to allow greater flexibility. Despite sustained capital inflows and large foreign exchange reserve accumulation, the renminbi appreciated by a cumulative 20¼ percent vis-à-vis the U.S. dollar by end-2008. China's investment-driven growth continually added to the economy's absorptive capacity and inflationary pressures remained relatively contained. This may have provided the space to pursue gradual appreciation, as monetary policy continued to rely heavily on administrative measures.

31. **Policy responses**. In the pre-crisis period, against the backdrop of a surge in capital inflows starting 2003–04:

- *Malaysia* abandoned its peg to the U.S. dollar coinciding with China's announcement. The exchange rate remained managed, and movements closely mirrored the pace of renminbi appreciation until mid-2008. Fiscal consolidation accommodated a slower pace of currency appreciation in the face of surging capital inflows.

- In *Thailand*, despite relatively prudent macroeconomic policies and notwithstanding the appreciation of the renminbi, currency appreciation outpaced other regional currencies against the dollar and the renminbi. This led to the imposition of capital controls in end-2006, some of which were reversed almost immediately and others removed gradually over the next 1½ years. Prudential measures therefore become an additional instrument in a situation where the traditional policy instruments, such as further currency appreciation, are effectively constrained by policies in the cluster.

- In the *Philippines*, on the other hand, 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. As a result, the currency appreciated the most against both the dollar and the renminbi by 2008.

32. **Cluster-based approach**. While the use of particular policy instruments could be affected by membership in the cluster and by the policies of the gatekeeper, the overall policy mix need not be constrained, if other instruments can be used. But if there are limitations in the use of these other instruments, there could be difficulties in achieving the desired policy mix, and important policy trade-offs could emerge. Instruments, such as macro-prudential and capital flow management policies, could be invoked to 'augment' the policy space. A cluster-based approach to surveillance would shed light on some of the policy trade-offs and tensions. It could also point to whether policy cooperation at the level of cluster—including by sharing information on the external effects of policies and possibly coordination—could mitigate these trade-offs.

Saudi Arabia—Commodity Cluster

33. **Structure**. Many commodity exporters have witnessed strong growth in demand in recent years driven, at the margin, by EMs such as China. Oil market dynamics have also witnessed such shifts. As a consequence, trade links of oil producers such as Saudi Arabia have evolved. As Table 1, group G indicates, its gatekeepers now include the United States, China, and Korea, besides Japan.

34. **Context**. Besides the increasing importance of EM demand in oil market dynamics, a second key development over the past two decades has been the development of the Saudi financial sector. Domestic financial deepening has strengthened the monetary transmission mechanism and, given the U.S. dollar peg, increased the influence of U.S. monetary conditions on the Saudi non-oil sector. Thus, even as growth and fiscal revenues are increasingly being influenced by the role of EMs in the global oil market, monetary policy conditions continue to be guided by U.S. conditions.

35. **Event**. In situations in which global oil prices move counter-cyclically with the U.S. business cycle and monetary policy, sharp trade-offs between policy objectives could result (Background Paper, Chapter IV). For instance, from September 2007 to October 2008, the U.S. Federal Reserve lowered its policy rate from 5.25 percent to 1 percent. During the same period, crude oil prices surged from over $65 per barrel in mid-2007 to over $130 per barrel by the summer of 2008, driven partly by increased EM demand. 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, to prevent speculative capital inflows and maintain the exchange rate peg to the U.S. dollar, the Saudi Arabian Monetary Agency cut its policy rate from 5 percent in October 2007 to 2 percent by mid-2008. Annual credit growth surged from 6 percent in early 2007 to over 30 percent in July 2008, while higher global commodity prices coupled with a depreciating dollar further contributed to inflationary pressure, resulting in double digit inflation by mid-2008.

36. **Cluster approach**. Global interconnectedness and the evolving links of Saudi Arabia with the rest of the world has had important impacts on the domestic economy and on policy choices. To the extent that global oil prices continue to move counter-cyclically with U.S. monetary policy, important trade-offs between policy objectives—of maintaining the dollar peg on the one hand and managing domestic credit growth and demand on the other—come to the fore. Taking a cluster-based perspective is inherent to adequately unpacking these tensions. They highlight the potential importance of strong fiscal management as well as further refining macro-prudential instruments to influence monetary conditions independent of interest rate policy.

Financial Clusters

37. **Stage of development**. An analysis of financial interconnections, the associated cross-border spillover of growth and instability, and feedback effects would need to take into account the different stages of countries' economic development (Table 2). Broadly speaking:

- At a relatively early stage in the development process, cross-border real sector interconnections—through international trade—precede financial interconnections.

- Also occurring reasonably early in the development process are financial interconnections resulting from the penetration of domestic credit markets by foreign banks, which reflect a combination of historical and geographic factors. The linkages often result in a one-way spillover of economic developments and policies from the foreign banks' home countries.

- Connections resulting from activities of the government and private sector in international equity and debt markets typically follow at a later stage of development, when the country's legal and corporate governance systems and standards of disclosure of financial information begin to conform to minimum standards necessary for investors and ratings agencies to perform due diligence. The nature of the financial linkage often changes at some point in time during this stage from the one-way spillover to two-way spillovers.

- Finally, advanced economies are financially connected to others via cross-border bank ownership linkages, bank funding flows, and market borrowing and lending in international capital markets.

38. **Exploiting synergies or arbitrage?** Assessing the nature of clusters shaped by financial market integration is complicated by the fact that some are driven by institutions' objectives to exploit economies of scale and scope and others by their incentive to exploit opportunities for tax and regulatory arbitrage. Examples and issues are discussed in the Background Paper, Chapter VI. Key points are as follows:

- The former case is explicated by the experience of the Nordic-Baltic countries or Austria and the CEE countries. Banks from the gatekeepers—respectively, the Nordic countries and Austria—expand outside their chartering jurisdiction ("home") to exploit diversification gains in external credit markets ("hosts") or to serve existing corporate clients who are expanding business operations abroad. Where banks' operations become systemically important for the host, they result in spillovers from home 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.

- To extract the maximum benefits of living in financial clusters, country authorities could share financial supervisory information, coordinate on prudential standards, and cooperate in the process of supervision and resolution of firms and markets. If such coordination, which recognizes 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.

Table 2. Financial Interconnections: A Taxonomy

	Trade-based linkage only	Foreign banks enter the local credit market	Firms/sovereign can borrow in the market directly	Advanced market economy setting
Nature of interconnection	Trade generated capital flows	Credit market penetration by foreign banks	Through financial market activity & foreign bank activity in the domestic financial sector	Integral part of global banking network and extensive activity in international capital markets
Stage of financial sector development	Deposit funded banks serving credit, government finance, and payments; most financial markets nascent or undeveloped	Still predominantly deposit funded banks. Asymmetric information & legal risk prevents direct market access by domestic firms. Foreign bank entry often in form of acquisition of local bank(s)	Domestic banking sector, money, equity, and g-sec markets typically well developed. Asymmetric information issues now resolved by stronger legal protection for investors and disclosure rules.	Well developed domestic banking sector and financial markets. Banks often have large funding/ credit/ hedging operations abroad
Shock propagation & transmission channels	One way inward spillovers of exogenous shocks and policy actions	One way inward spillovers of exogenous shocks and policy actions	Inward spillovers remain and more important now given reliance of local corporate and governments on international capital markets. Outward spillovers now feasible where domestic banking affiliates are systemically important for parent banks.	Both inward and outward spillovers feasible
Nature of spillovers	Inward spillovers reflect combination of factor price/terms of trade/supply shocks and typically amplify domestic cycle	Foreign bank capital can moderate amplitude of domestic credit cycles and make system robust to runs. But, make the domestic economy & financial sector more vulnerable to exogenous shocks	Stronger countercyclical policy tools in each country benefits the other as does availability of fiscal space in the network hub during a crisis. Conversely, weak/uncoordinated macro-prudential policy making can harm all connected countries.	Core global financial centers (e.g., U.S., U.K.) exercise policy and economic spillovers to others directly or through regionally important economies / financial centers. These countries can attenuate or amplify the impact in their networks depending on available policy space.

- Policy initiatives paving the way for cross-country financial integration, but unaccompanied by a correspondingly adequate degree of harmonization of prudential standards and of cross-border cooperation in supervision and information sharing, could create opportunities for regulatory arbitrage. Left unchecked, this could skew the distribution of benefits and costs, wherein the said-firms gain during upswings and the taxpayers pay during the downturns. Reduction in clustering generated by closure of regulatory arbitrage opportunities could, in such circumstances, represent a net gain to all countries.

Nordic-Baltic Countries—A Financial Cluster

39. **Structure**. To further elaborate some of the issues relevant to financial clusters, the Nordic-Baltic cluster is considered. This cluster is composed of a few gatekeepers, the home countries of Nordic banks (Denmark, Norway, and in particular Sweden) and the Baltic hosts of these banks (Estonia, Latvia, and Lithuania). The gatekeepers (as suggested by group M in Table 1) are connected to the global core on the financial sector side, reflecting Nordic banks' large funding operations in wholesale capital markets (Background Paper, Chapters VI and VII).

40. **Context**. Before the global financial crisis, parent banks passed on global liquidity to the hosts playing an increasingly important role in fuelling the economic and credit/asset market boom there. In turn, for most of these banks, each of the host markets became vital in terms of the impact on group liquidity or solvency of financial problems arising in that jurisdiction. Sourcing of financial capital from the core meant that the supply and cost of funds were driven in large part by macroeconomic developments and policies in the global financial centers rather than policy choices made within the cluster. In the EU context of open capital accounts, this clogged the credit channel of monetary policy. In hindsight, the problem of enfeebled macroeconomic policy instruments could have been addressed to some degree by a countercyclical policy stance in the Baltics that may have arrested overheating earlier. Financial stability policies in the Nordic countries could not adequately address the combination of risks posed by rising wholesale funding and intra-group credit exposures funding the Baltic boom that left their banks vulnerable.

41. **The shock**. 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. Extremely limited scope for the deployment of countercyclical policy in the Baltic countries, the attendant solvency risk for systemic Swedish banks, SEB, and Swedbank, and the refinancing pressure on these firms post-Lehman meant almost exclusive reliance on policy space in Sweden to back-stop banks commitment to their Baltic businesses. The decision by the gatekeeper (Sweden) to utilize this policy space—undertaking contingent exposures for its banks' Baltic exposures and the extension of swap lines by the Nordic central banks to the Baltic countries—was important in containing its own domestic recession and the impact of the crisis on the Baltic countries.

42. **Damage control**. Subsequent actions by the Swedish authorities allowed the Swedish banks to act as a shock absorber. They provided liquidity in both kroner and foreign currencies through swap arrangements to replace the loss in liquidity from frozen wholesale funding markets, and also

directly supported banks under pressure. Participation in the Vienna Initiative also helped, while Latvia had an IMF-supported program. This stabilized the markets by easing the pace of deleveraging, and prevented the fire-sale dynamics from swamping the Baltic countries. 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.

43. **Gatekeeper—amplifier or circuit breaker?** To examine further the potential role of gatekeepers in transmitting shocks across the cluster, a structural VAR model was used. In particular, the effect of the gatekeeper's monetary policy on the transmission of shocks was analyzed by comparing two impulse responses: the first with the behavior of all model variables unrestricted and the second with the gatekeeper's money market rate restricted to a constant, i.e., shutting off the response in the gatekeeper policies to the shock (Background Paper, Chapter VII). For Sweden vis-à-vis the Baltic countries, the results show Swedish monetary policy generally lowered the spillovers from negative shocks to money market rates and GDP growth rates in the Baltic countries, especially in Estonia and Latvia. Differences in the conditional responses of destination countries can be accounted for by the varying strengths of financial linkages and the different policies adopted. For example, if Estonia had chosen to exercise its fiscal buffers 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 have been lower.

44. **Cluster approach**. What combination of policies within the cluster would have better served macro-financial stability objectives through the cycle? While the menu may not, in all likelihood, have contained choices that completely shielded the cluster from distress in the global core, greater containment may have been possible, which a cluster-based approach could have pointed to.

- A strengthening of fiscal stabilizers or adoption of structural measures in the Baltic countries would have contained the credit boom, and hence, limited the growth in exposures of Nordic banks, thereby lowering the assumption of contingent liabilities by the Swedish tax-payer when the crunch came.

- A more vigilant stance regarding growth in intra-group exposures of the banks by their home country authorities would have reinforced the benefits accruing from stronger countercyclical policies in the Baltics. This requires information sharing and coordination.

- Whereas policies/actions in the gatekeeper (Sweden) may have initially amplified the transmission of the global crisis to the Baltics, policy buffers (fiscal space) subsequently allowed it to act as a circuit-breaker and mitigate the impact of the crisis on the cluster.

V. IMPLICATIONS

45. **Summary**. To better understand the interconnectedness of the global economy, this paper has taken a two-stage approach.

- In the first stage, network analysis was used to map the architecture of cross-border trade and finance. This map revealed not only a global "core", but also "clusters" of economies among which connections are particularly strong. Clusters also are connected to each other through "gatekeepers". The analysis pointed to the potential role of gatekeepers in amplifying or dampening shocks and in impacting policies within the cluster.

- In the second stage, a handful of case studies were examined to bring out cluster-specific issues. It was argued that a cluster-based perspective is essential to analyze policy trade-offs in commodity exporters whose rising demand comes largely from dynamic EMs, whereas whose policy linkages remain with slower growing advanced economies. A cluster-based perspective can also shed light on the policy trade-offs for economies in a vertically integrated supply chain (the Asian trade cluster), such as when exchange rate flexibility and other instruments may be limited for some economies in the cluster. For financial clusters, sharing of information across the cluster could enhance the understanding of risks and the effectiveness of policies. Gatekeepers were also understood to have potentially important effects on the cluster—either amplifying or dampening the effects of external shocks, though these issues and the underlying structural and behavioral relationships would need to be explored further, possibly through pilot studies in surveillance of countries and clusters, to draw firm inferences and policy implications.

46. **Surveillance**. The 2011 Triennial Surveillance Review called for progress in incorporating the fact and implications of interconnectedness into the Fund's surveillance, with an increased focus on risk assessments and a broader sweep of economic and financial stability (IMF, 2011c). Currently, little is done systematically to situate the analysis of an economy's policies in the interconnected trading and financial system, or to draw implications for overall stability. The surveillance challenge, therefore, is to understand the architecture of interconnectedness, characterize its functional aspects and implications for shock propagation and policies, as well as track the evolving nature of the connections. This paper takes a first step toward understanding the architecture and implications of interconnectedness. Once the architecture and the functional and behavioral underpinnings are better identified and assessed, the implications for surveillance could be drawn, including:

- *Context setting.* Taking account of the policies of partners—in a cluster, of the gatekeeper, and in the core—has the potential to nuance the understanding of shock propagation, policy space, and stability. Providing such a context in the Article IV and Financial Sector Assessment Program (FSAP) discussions of countries is a first step. Grouping the Article IV and, where relevant, the FSAP discussions by cluster at the Executive Board is a related step.

- *Surveillance of clusters*. Broader surveillance of clusters could also be considered, if first on a pilot basis, beyond the formal currency unions, such as the Euro Area. Though not formally

in monetary policy arrangements, interconnectedness-based clusters such as the Asian supply chain or Nordic-Baltic cluster can give rise to stability and policy challenges at the country level that are better assessed at the cluster level. Such surveillance could be conducted through thematic reports as background to the relevant Article IVs. They could also be covered, where appropriate, in the multilateral surveillance and regional products.

- *Cooperation*. In time, and if value is gleaned from this approach, modalities for cooperation may also need to be established within the cluster, if these are not already in place. For instance, information sharing (e.g., on financial supervision) would be essential. Policy dialogue and cooperation may also become necessary, not only in crisis time (e.g., the Vienna Initiative) but also in normal times.

- *Circuit breakers*. Identifying potential "pressure points" and "circuit breakers" (such as Italy) would point to the need to focus particular attention—in terms of surveillance and building buffers/the safety net—on them so as to enhance the discussion of systemic stability. Ensuring the robustness of these circuit breakers could limit the extent to which adverse shocks spread through the system.

- *Data*. It should be noted that this is a data dependent exercise. The ability to map financial interlinkages across G-SIFIs, markets, economic sectors, and countries, while essential to the identification of clusters and ongoing assessments of developments therein, is severely constrained by information gaps. These gaps correspond to the unavailability of relevant information—on a comprehensive and consistent basis across the membership—in the public domain. Efforts would continue to be needed to close these gaps, including through the G20 Data Gaps Initiative.

47. **Further work**. Further work is needed on the relationships among interconnectedness, stability, and policies. This work could proceed on multiple, parallel tracks. At one end, the above approach could be piloted in a few cases, to discern and sharpen the value added that could be brought to bear in surveillance of better understanding how interconnectedness affects risk assessments and policies. To the extent that these relations are context dependent, knowledge of the architecture—of the core, clusters, and gatekeepers, which evolves over time—can focus attention on the circumstances in which shocks can be dampened or amplified and propagated. The above work could also be deployed in the vulnerability exercises. At the other end, alternative means of understanding shock propagation could be explored, including through structural models.

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