Toward a global risk map

Stephen G Cecchetti, Ingo Fender and Patrick McGuire[1]

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Abstract

Global risk maps are unified databases that provide risk exposure data to supervisors and the broader financial market community worldwide. We think of them as giant matrices that track the bilateral (firm-level) exposures of banks, non-bank financial institutions and other relevant market participants. While useful in principle, these giant matrices are unlikely to materialise outside the narrow and targeted efforts currently being pursued in the supervisory domain. This reflects the well known trade-offs between the macro and micro dimensions of data collection and dissemination. It is possible, however, to adapt existing statistical reporting frameworks in ways that would facilitate an analysis of exposures and build-ups of risk over time at the aggregate (sectoral) level. To do so would move us significantly in the direction of constructing the ideal global risk map. It would also help us sidestep the complex legal challenges surrounding the sharing or dissemination of firm-level data, and it would support a two-step approach to systemic risk monitoring. That is, the alarms sounded by the aggregate data would yield the critical pieces of information to inform targeted analysis of more detailed data at the firm- or market-level.

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[1] Cecchetti is Economic Adviser and Head of the Monetary and Economic Department, Bank for International Settlements (BIS), Research Associate of the National Bureau of Economic Research, and Research Fellow at the Centre for Economic Policy Research; Fender is Special Adviser and McGuire is Senior Economist at the BIS. This is a revised version of a paper prepared for the Fifth European Central Bank Conference on Statistics "Central bank statistics: What did the financial crisis change?". The authors would like to thank Claudio Borio, Dietrich Domanski, Philippe Mesny, Philip Turner and Paul van den Bergh for comments and conversations.

Contents

1. Introduction[2]

Data are the eyes and ears we use to see and hear what is happening in the financial and economic world. Anecdotes, introspection, personal experience and modelling can help us figure out where to look and organise our thoughts. In the end, though, it is the data that tell us what is going on. Without data, we are deaf, blind and, in both senses, dumb. The need for data is especially acute in macroeconomic analysis for policy, where a bird's eye perspective is indispensable. Aggregate data on prices, output, employment, credit, money and the like provide monetary and fiscal policymakers with the information that allows them to monitor and meet their stabilisation objectives.

As the financial crisis deepened in the 18 months from August 2007, it quickly became apparent that we were partially blind because of significant gaps in our statistics. In some cases, we weren't collecting the right data, and, in others, we weren't using effectively what we had. While it remains unclear whether improved analysis could have reduced the intensity of the crisis, better and more timely information would almost certainly have simplified the task of managing and containing the crisis as it evolved. Filling these gaps in the data is thus an important challenge on our way towards improving our monitoring of systemic risk and hence the regulation and supervision of financial institutions.

It is worth emphasising at the outset that, because of the global nature of the financial system, systemic risk is a global problem. This means that our measurement and monitoring of risk must have a global dimension, unless we wish to give up on the benefits of globalisation and return to a financial system where institutions and markets are restricted to operating inside national boundaries. As a result, and as will be apparent from our arguments below, a clear need exists for increased sharing of international information and for enhancement of the centralised analysis that is already pursued in a variety of organisations, including the Bank for International Settlements (BIS).

Over the past year or so, the problem of data gaps has attracted an increasing amount of attention. Numerous exercises are under way to identify and fill the gaps revealed by the crisis.[3] This is an enormous challenge, and what can get lost are the big picture implications. That is, implications going beyond any specific gaps in the data for a particular market or set of institutions. Are there *datasets* or statistical *concepts* that hold lessons for how data should be collected in the future? In this paper, it is our intention to step back and look for the broader *strategic lessons* of the crisis that we can then use to guide us in developing specific data requirements for identifying and measuring the accumulation of risks in the financial system as a whole.

In this spirit, we proceed as follows. In section 2, we describe what we see as the primary lessons for statistics that emerge from the crisis. High on the list is the need to see both the entire balance sheets of financial institutions and the interconnections and common exposures arising from them. In section 3, we present some recent work that builds on these lessons. While our primary focus is on the BIS's well known and widely used international banking statistics, we also touch on the lessons the crisis holds for datasets beyond those collected by the BIS. With this analysis in hand, in section 4, we turn to the problem of building a global risk map, as well as the challenges this poses for the international exchange of data and the need for a broader statistical reporting framework to support it. The final section concludes.

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[2] This paper was prepared for the Fifth ECB Conference on Statistics on "Central Bank statistics: What did the financial crisis change" in Frankfurt am Main on 19-20 October 2010. It has also been published in the *BIS Working Papers* series (No 309, May 2010).

[3] See, for example, FSB and IMF (2009), which includes a list of 20 detailed recommendations for improving data collection and analysis.

2. Systemic risk: lessons from the crisis

Events during the fourth quarter of 2008 underscored the importance of understanding the scale of risk exposures within and between large globally active financial institutions. We now know that in the run-up to the crisis, much of the explosion in borrowing was underpinned by cross-currency funding arrangements and large-scale maturity mismatches. While the trigger for the crisis was common exposure to a particular class of assets, the US subprime mortgages simply acted as the match that lit the fuse on the combustible mix of long-term illiquid dollar-denominated assets financed by a combination of short-term dollar liabilities and foreign currency swaps. When European banks in particular started to experience losses, concerns about counterparty risk disrupted funding relationships and turned what should have been a small brush fire into a global conflagration.[4]

Looking back at this experience, we can say that the entirety of financial institutions' balance sheets – their assets *and* liabilities, their *off-balance sheet* positions, including lines of credit and derivatives positions, and their *counterparty arrangements* – all played a role. The challenge now is to find a way to monitor these factors. Doing so means both changing the way we use existing data and changing the data that we collect.

To understand the problem, we find it useful to start with a set of *core questions* that surfaced during the crisis. Every one of these is difficult (or impossible) to answer using the data we currently have available. Here is a list of *three* big questions that help organise our thinking:

Question 1: *How can a **central bank** monitor the global use of its currency?*

- If there were an international lender of last resort, how much of each currency would it need to stockpile in advance?
- In the absence of such a lender, how large are the funding requests that I would face in a crisis, and where would they come from?
- How large are speculative carry trade positions in my currency? Are these trades contributing to volatility in my exchange rate?

Question 2: *What information do **policy makers** need (in addition to home country supervisory data) to monitor systemic financial stresses?*

- How reliant on cross-border financing are my corporate borrowers? How reliable are the lenders?
- How similar are the international portfolios of financial institutions headquartered in my country to those of equivalent entities in other countries? Are there clustered exposures or crowded trades?

Question 3: *What data could help **financial market participants** improve market discipline?*

- We now know that, before the crisis, European banks had long (and long-term) US dollar positions they had funded using short-term FX swaps. Would euro-dollar swap spreads have been 20 basis points wider in 2006 if the global asymmetry in the size of these positions had been widely known and publicised?
- Would pricing for interbank funding be more efficient if participants could see the build-up of system-wide funding stresses? If, for example, institutions had known the extent of reliance on short-term wholesale sources of funds, would prices have been different? How about concentrated asset exposures?

[4] See BIS (2008), chapter VII, and BIS (2009), chapter II, for a detailed description of these events.

Box 1: Systemic risk—definition and measurement

Definition

Systemic risk in the financial system is analogous to pollution. It is an externality that an individual institution, through its actions, imposes on others. As commonly understood, this externality takes two forms. The first is the joint failure of institutions at a particular point in time resulting from their *common exposures* to shocks from outside the financial system or from *interlinkages* among intermediaries. The second is what has come to be known as *procyclicality*. This is the term used to describe the phenomenon that, over time, the dynamics of the financial system and of the real economy reinforce each other, increasing the amplitude of booms and busts and undermining stability in both the financial sector and the real economy. Each has different policy implications and involves different challenges in terms of monitoring and measurement (see, eg, Caruana (2010)).

Common exposures and interlinkages create the risk of joint failure. Assessing their importance means focusing on both how risk is distributed and how the system responds to either an institution-specific shock or to a common shock that damages everyone. In the first case, we need to assess the risk of contagion through credit or funding exposures on the one hand, and the possibility of asset fire sales on the other. In the second case, systemic effects would arise as a direct consequence of similarities in the structure of institutions' balance sheets and funding patterns.

In the context of systemic risk, procyclicality is about the progressive build-up of financial fragility exacerbating booms and increasing the risk of catastrophic collapse. As costly experience has taught us, the financial sector can endogenously generate systemic risk in ways that are often difficult to capture. New financial products with unseen risks can be introduced. Margins and haircuts, increasingly lax during booms and progressively more stringent in busts, will exacerbate price fluctuations in markets. And institutions have a natural tendency to become less prudent during cyclical upturns and more prudent during downturns. Add to this the fact that during periods of steady, high real growth, financial market volatilities tend to be low and risk premia compressed. Taking all of this together, the implication is that traditional measures of aggregate risk tend to look lowest precisely when risk is at its highest.

Measurement

Over the past several years, research has progressed along four broad tracks: *distributional models* and *stress testing*, which are designed primarily to address the risk arising from common exposures and interlinkages; *leading indicators*, focusing on countercyclicality; and *vulnerabilities analysis* that combines everything. We briefly describe each of these in turn.

Distributional models. Using a variety of methods based on assumptions about individual firms' probabilities of default or failure, and the correlation of default events, researchers first measure the extent of systemic risk in the system, and then allocate it across financial firms.[①] These methods capture systemic risk arising from both common exposures and interconnectedness.[②] Crucial inputs into the current versions of this analysis are some combination of equity prices and credit spreads. These are used for the dual purpose of estimating the likelihood of firm-level failure (where balance sheet data is another crucial input) and the bilateral correlations that deliver the systemic risk estimate. A key advantage of the distributional models is that they generate explicit loss estimates from widely available data. In addition, since they are based on price data, these methods embed both the extent of institutions' leverage, which is very difficult to capture directly, and its distribution across the system. Unfortunately, the advantage gained from using price data is balanced by the disadvantage that prices used as measures of risk are at their least reliable when the risks are highest. In other words, price-based, distributional models of systemic risk are going to be at their worst when we need them most. This leads us to ask: what could help? The answer is bilateral exposure data.

Stress testing. The goal of stress testing models is to measure how a financial system will respond to negative shocks and to trace the effects of common exposures and interlinkages.[③] While the analysis can be done at the sectoral level, completing the job requires granular exposure data at the individual firm level. This, in turn, requires access to detailed

supervisory information. Researchers have done such work in some jurisdictions and for some institutions.[4] Depending on the methodology, it is then possible to distinguish defaults directly caused by external events from those triggered by defaults of other banks. Interestingly, the results available thus far, which use national data, suggest that second-round effects associated with counterparty risk are of second-order importance.[5] But, as we think of the need to evaluate systemic risk at the global level, we are naturally led to ask whether the same would hold true in a cross-border context. Is the probability of joint bank failure for large international institutions driven primarily by common exposures? Answering this question obviously requires that we have data to perform stress tests on the global system level. At this point, any such exercise would be restricted to using sectoral data or would founder due to the lack of sufficient firm-level information across national jurisdictions.

Leading indicators. Regarding time series measures, a growing body of work focuses on building leading indicators designed to capture the build-up of systemic risk over time.[6] Based on broad, macro variables such as credit-to-GDP ratios, property prices, equity prices and the like, the objective is to identify and measure misalignments that can be used to provide warnings of financial sector distress. Balanced against the clear advantage of their relative simplicity is the fact that early warning indicators constructed using historical episodes may have difficulty in tracking the build-up of risks as the financial and economic environment evolves. Nevertheless, given the potential benefits, it is surely worth looking for ways to improve what has already been done. And here, we suspect that systematic treatment of cross-border exposures could help, as could credit and asset price data with greater international comparability.

Vulnerabilities analysis. Finally, we have vulnerabilities analysis. This is less a model-based approach to data analysis than it is a mindset or a lens through which to look at the world. We think of it as a collection of qualitative and quantitative techniques (including, but not restricted to, the ones mentioned above) that are used to gauge all types of systemic risk.[7] The idea is to track developments for a wide variety of markets and institutions, using information on both prices and quantities in an effort to spot pressure points in the financial system as early as possible. Because price data are so plentiful, and quantity data are scarce, the indicators employed often use pricing models to infer market assessments of risks and vulnerabilities. Examples include the use of contingent claims models, such as the one in Merton (1974), to generate market-implied default probabilities for individual institutions and efforts to extract information on financial risks, such as implied volatilities, from option prices.

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[1] This raises the crucial issue of choosing the appropriate delineation of the system on which to focus. See BIS, FSB and IMF (2009) for more detail on the challenges involved in this context. [2] Examples include the portfolio credit risk models that are being adapted for systemic risk analysis. See, for example, Huang et al (2009). [3] See Borio and Drehmann (2009b) for a review of the literature. [4] Examples include Blåvarg and Nimander (2002) and Graf et al (2005). [5] See Elsinger et al (2006), based an analysis of comprehensive data for Austria. [6] See, for example, Borio and Drehmann (2009a). Davis and Karim (2008) provide a survey. [7] Examples include the financial stability reports now published by most central banks and the IMF's Global Financial Stability Reports (GFSRs).

What data do we need to construct a global risk map that can answer these questions? To what extent do existing statistics suffice? Where are the gaps that need to be filled for us to get the answers we need? While we postpone a more detailed discussion of these questions until later, a cursory review of the models and approaches commonly used for systemic risk analysis (see Box 1) suggests that five *principles* are key to finding the answers:

- **Quantities.** Simple aggregate statistics go quite some way towards conveying a broad sense of the build-up of risks. But to move beyond leading indicators to more sophisticated measures of systemic risk, more and better *quantity* data are essential. We see an immediate need for information on the extent of financial institutions' exposures with respect to their peers and their participation in various markets. As should be obvious, this means collecting data in a manner that preserves counterparty information. Importantly, to the extent that trading is

channelled through central counterparties and organised exchanges, they would be a natural source for such data.

- **Financial intermediaries.** Ultimately, systemic risk comes from the maturity transformation that arises in the process of allocating savings to their most efficient investment uses. This is the function that intermediaries perform for the economy. Thus, we need to monitor the activities and risk profiles of all the major international financial institutions, regardless of their legal form of organisation, and their most important counterparties.[5] At the time of writing, timely, comprehensive and reliable firm-level information on, say, the world's top 50 banks is not publicly available. While commercial data providers, such as *Bankscope*, offer information on a large number of balance sheet items (often at a very high price), these data are available only with significant lags and with insufficient detail on such essential items as capital composition, currency and maturity breakdowns of assets and liabilities, and off-balance sheet risk exposures.

- **Consistency.** Across the globe, it is fair to say that mountains of information are available. The problem is that compilation methods across datasets and data providers differ in ways that often make it difficult, or even impossible, to combine information. For example, the compilation of a complete risk profile for a large internationally active institution would almost certainly require combining supervisory information from a variety of jurisdictions. Doing this means having consistent reporting standards. Broadly speaking, we need better and more detailed disclosures across institutions. Existing aggregate datasets (eg the BIS international banking statistics, balance of payments and the flow of funds statistics discussed below) also need to be (further) harmonised so that they provide information in a consistent and comparable fashion.

- **Maturities and currencies.** If we are to adequately capture maturity transformation and (on-balance sheet) leverage, as well as the maturity mismatch embedded in cross-currency positions, then we need information on the maturity and currency composition of both assets and liabilities. To understand just one risk we need to monitor, note that when long-term foreign currency assets are financed by short-term domestic currency liabilities, which are then swapped into the target currency via foreign exchange (FX) swap markets, this creates roll-over risks for the liabilities and possibly the swap position. (This risk relates closely to questions 1 and 3 above; we will return to this shortly). Such embedded mismatch can only be monitored with data on combined maturity and currency breakdowns.[6]

- **Consolidated data.** Many datasets suffer from the fact that they are entirely residency-based. This may be less important for GDP – we really do want to know *where* things are produced – but it is a problem for financial information. Take the case of a bank (or even a non-financial corporate) operating globally, borrowing and lending in many countries. If all we know is the location where a loan is made, then we cannot consistently relate the bank's exposures to the capital base ultimately supporting it (or the headquarter location where key funding and risk-taking decisions are made). And, not only do we need consolidated data, but we need these data with geographical detail. That is, supervisors in Germany need to be able to see both the subsidiaries of UK banks operating in Germany, which they already

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[5] This links closely with ongoing work on identifying systemically important institutions; see eg BIS, FSB and IMF (2009).

[6] Note that information on the instrument type or counterparty type of assets and liabilities (eg money market funds, central banks, other banks, non-banks etc) can be used to infer information about maturities and may be easier to collect than actual maturity detail.

know, and the exposure and funding-related activities of German subsidiaries in the United Kingdom, which they may not know (at least not in sufficient detail). This is not only an obvious argument in favour of supervisory exchange of information; it also shows that systemic risk assessment cannot proceed adequately without consolidated exposure and funding data (see question 2 above).[7]

To summarise, taking the lessons of the crisis, we believe that relatively simple aggregate statistics, used properly, can help us to gauge the build-up of systemic risks nationally and globally. But, to improve our understanding, to fully exploit the potential of the various approaches used to conduct systemic risk analysis, we need more. We need consistent and comparable data across institutions. We need information on the level of common exposures. And we need data on interlinkages.

But how detailed and complete does information on quantities need to be? There are well known trade-offs between the macro and micro dimensions of data compilation and dissemination. While more granular data enables better analysis, compiling and sharing information becomes progressively more difficult as the number of institutions covered and the detail requested increase. Costs as well as legal restrictions stand in the way. This suggests that it would be wise to start with a focus on detailed data for a small number of key institutions (eg the 50 largest). In parallel, broader sets of statistics need to be improved to provide more and better aggregate (ie sectoral) data. The ultimate goal is a consistent set of *aggregate* statistics that will allow us to identify *pressure points* at the *sectoral* level, and to then follow up on these signals with a more targeted analysis of detailed (supervisory or ad hoc collections of) data at the firm or market level. This is where the BIS's experience with its international banking statistics can play an important role.

3. Elements of a strategy: lessons from the BIS banking statistics

The BIS maintains an established reporting framework covering the international activities of some 7,000 banking entities from about 40 countries. As such, these international banking statistics (the BIS banking statistics) cover the core of the global financial system. The relatively long time series that they provide can be used for historical comparisons and statistical analysis. Furthermore, it would be possible, at least in principle, to increase the perimeter of reporting to include key non-bank financial institutions. The BIS also maintains information on derivatives and debt that can be used to complement and enhance any analysis utilising the BIS banking statistics.

Critically, the BIS banking statistics largely conform to the five *principles* identified above. Not only do they cover the core financial system but they are also available on a consolidated (headquarter-based) as well as a locational (residency-based) basis.[8] Furthermore, since

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[7] More precisely, uncovering the geographical exposure and funding patterns of financial institutions requires joint availability of consistent consolidated data summed worldwide over the home office, all branches and subsidiaries, and consistent locational data, in which activity is reported separately based on the country where it is taking place.

[8] The BIS banking statistics consist of four complementary datasets: (i) residency data: locational banking statistics by residency; (ii) nationality data: locational banking statistics by nationality; (iii) consolidated (IB) data: consolidated banking statistics, immediate borrower basis; (iv) consolidated (UR) data: consolidated banking statistics, ultimate risk basis (ie adjusted for risk-transfers). The residency and nationality data follow balance of payments reporting concepts (tracking the international asset and liability positions of banks' offices located in a particular country with respect to counterparties in other countries, and positions with respect to residents of the host country in foreign currencies). In contrast, the consolidated statistics track the worldwide asset exposures, broken down by residency of counterparty, of banking systems, or the set of internationally active banks headquartered in a particular country (eg Swiss banks, UK banks etc).

they provide some detail on currencies and information that allows maturities to be inferred, we can examine the mapping of geographical exposure and funding patterns for consolidated national banking systems. These, in turn, can be used to track the evolution of common exposures and interlinkages. They also enable an analysis of positioning (ie net short and net long positions) on both sides of any given market covered by the data. Activities in other markets can, to some extent, be inferred by making a number of assumptions.

Before turning to the implications for statistical reporting at the BIS and beyond, we illustrate how current data can be used to assess two sorts of systemic risks: those emanating from cross-currency funding and maturity mismatches (our questions 2 and 3 above), and those arising from speculative carry trades (question 1).

3.1 Monitoring banks' funding vulnerabilities[9]

A prominent feature of the recent financial crisis was the dislocation in *funding markets*. Arising from the *liability* structure of banks' balance sheets, the problem developed when a large number of institutions found themselves in need of US dollars that they had incorrectly assumed they could either borrow directly or obtain through the foreign exchange swap market. Indeed, it was the resulting scramble that led to the need for central bank swap facilities. As already mentioned, the measurement of funding vulnerabilities requires knowledge of commercial banks' globally *consolidated balance sheets*, rather than the balance sheets constructed along national borders. Consolidation matters because (i) stresses build up *across* the balance sheet (as mismatches between the maturity, currency and counterparty of assets *and* liabilities) and (ii) the balance sheets of the relevant decision-making economic units (ie, internationally active banks) *span national borders.*

It is important to keep in mind that international funding stresses can only be identified by tracking the patterns in *cross-currency* funding – that is, the degree to which banks' assets are denominated in a currency different from the one in which they issue liabilities. Picture, say, a German bank with a large euro deposit base. This bank would like to invest in long-maturity US dollar-denominated mortgage-backed securities (MBS). To hedge the exchange risk that naturally arises from this position, the bank uses some combination of FX swaps and futures. But the swaps and futures are, by their very nature, *short-term contracts*. The bank will need to roll them over regularly during the period for which it holds the US dollar MBS. What this means is that, regardless of the maturity structure of the euro-denominated liabilities (they could be the same as the MBS) the mere fact that the bank engages in cross-currency financing creates a *funding risk*. Put another way, these positions have a maturity mismatch embedded in them. And, if a large number of institutions are doing the same thing – taking euro or yen deposits, swapping them into US dollars and buying US dollar assets – then they will pose a systemic risk.[10]

To see the build-up of this risk, we need data on the FX swap market. Some information is already available in the BIS semi-annual OTC derivatives statistics. But these data only include gross figures, so they do not allow us to see the position's direction. That is, from gross FX swap positions we cannot tell whether the reporting entity provided or received a particular currency in the FX swap market.[11] And without knowing the direction, we cannot

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[9] For an extension of the analysis presented in this section, see Fender and McGuire (2010).

[10] This is the funding equivalent of a crowded trade; see McGuire and von Peter (2009) for details.

[11] The BIS semi-annual OTC derivatives statistics contain information on forwards, swaps and options of foreign exchange, interest rate, equity and commodity derivatives. The BIS also releases statistics on concentration measures for foreign exchange, interest rate and equity-linked derivatives, and data on credit default swaps

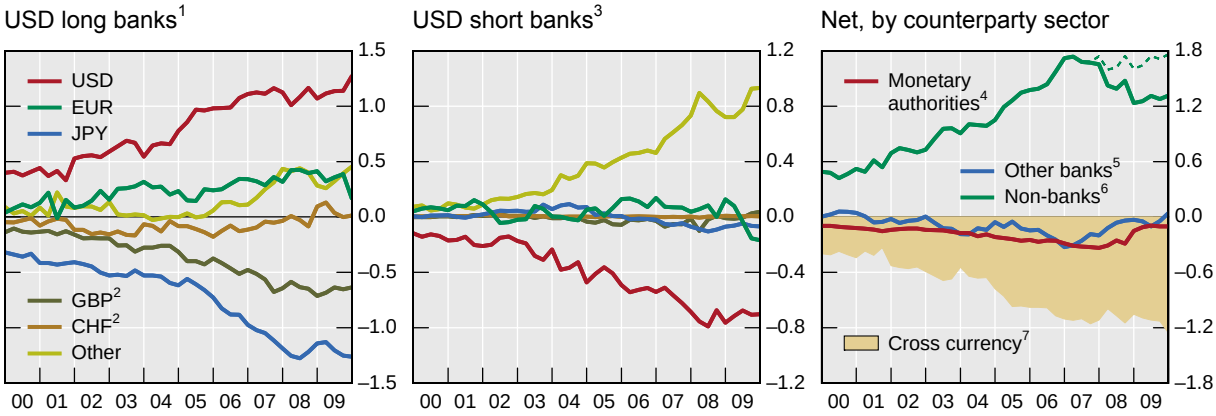
tell whether the derivatives positions mitigate or exacerbate the existing on-balance sheet mismatches.

Yet, by making what is an admittedly bold assumption, we can get a picture of what positions in the FX swap market might look like at the level of national banking systems. The BIS banking statistics allow us to see on-balance sheet net (assets minus liabilities) positions *by currency* for each national banking system. If we assume that banks have very small open FX positions, then any on-balance sheet long and short position in a particular currency provides an estimate of the banks' net FX swaps and futures positions in that currency. The left-hand and centre panels of Graph 1 aggregate these on-balance sheet positions by currency separately for two groups of banks: those with either more or less on-balance sheet US dollar assets than US dollar liabilities. We label these long-USD banks and short-USD banks. If banks hedge their foreign exchange risk, then these figures imply that long-USD banks (shown in the left panel) demand an estimated aggregate of $1.2 trillion (net) in US dollars from the FX swap market. In return, these banks provide an equal amount of euros, pounds, Swiss francs and other currencies in exchange. On the other side, the short-USD banks (shown in the centre panel) are net providers of roughly $800 million to the FX swap market. The difference of $400 billion is accounted for by non-bank participants that these data do now allow us to capture.

Graph 1

Long- and short- USD banks' positions, by currency

In trillions of US dollars



[1] Includes Canadian, Dutch, German, Japanese, Swiss and UK banks. [2] Positions booked by offices located in Switzerland (for CHF) and in the United Kingdom (for GBP). CHF and GBP positions reported by offices located elsewhere are included in "Other". [3] Includes Australian, Belgian, Danish, Spanish, Finnish, French, Italian, Luxembourgian, Norwegian, Portuguese, Swedish, Hong Kong, Greek, Turkish and Taiwanese banks. [4] Cross-border positions in all currencies and local positions in foreign currencies vis-à-vis official monetary authorities. Excluding liabilities to Japanese monetary authorities placed in banks located in Japan. [5] Estimated net interbank lending to other (unaffiliated) banks. [6] The net position vis-à-vis non-banks is estimated as the sum of net international positions vis-à-vis non-banks and net local US positions (vis-à-vis all sectors). By construction, net claims on non-banks is the sum of net positions vis-à-vis other banks, vis-à-vis monetary authorities and cross-currency funding, which is the lower bound estimate of the US dollar funding gap. The dashed green line is the estimate after adding back writedowns of assets. [7] Implied cross-currency funding (ie FX swaps) which equates gross US dollar assets and liabilities.

Sources: BIS consolidated statistics (immediate borrower and ultimate risk basis); BIS locational statistics by nationality.

Measured in any particular currency, total FX swap contracts must balance: total dollars supplied equal dollars demanded. But a whole range of ways exists in which supply can

(CDS) including notional amounts outstanding and gross market values for single- and multi-name instruments.

equal demand. And which one actually transpires can or might have implications for market pricing. For example, Graph 1 seems to suggest a growing asymmetry – diverging large net positions in the swap market across banking systems – as the crisis was building. That is, dollar borrowing via FX swaps became increasingly important for the long-USD banks. We now know what happens when the net providers of these dollars (the short-USD banks and non-banks) become skittish about lending to the net demanders when credit risk concerns arise. Are large price movements in a particular currency more likely when the market is asymmetric in this way? Perhaps. But we can hardly expect market prices to reflect such market risks *a priori* when the participants are blind to the overall structure of the market.

The funding risks faced by banks involve more than just rollover risk in the swap market, also including the rollover risk inherent in borrowing *directly* in foreign currencies. To get some sense of the size of this risk, we look at the long-US dollar banks' investment and funding positions in US dollars. The shaded area in the right-hand panel of Graph 1 indicates the size of cross-currency financing into dollar positions (ie FX swaps) by these banks – this is simply the inverted quantity plotted as the red line in the left-hand side panel. In addition to this funding, long-US dollar banks also borrowed dollars from the interbank market (the blue line in the right-hand panel) and from central banks (the red line), and then used these funds to finance their net investment in non-bank entities (the green line). While direct information on maturity is not available, we can safely assume that interbank borrowing and FX swaps are generally short term. Thus, Graph 1 suggests a significant degree of maturity transformation across the balance sheets of these long-USD banks. The estimated *funding gap* – the gap between the long-term US dollar holdings and the short-term US dollar financing implied by these figures – reached well over $1 trillion for these banks at its mid-2007 peak.[12]

Combining these numbers with the experience during the crisis leads us to conclude that the combination of currency and maturity mismatches creates systemic risks that need to be monitored at a global level. And that will require the provision of information on bank and non-bank institutions' globally consolidated cross-currency financing positions – something that is only available through international cooperative mechanisms such as the BIS banking statistics.

3.2 Measuring the currency carry trade–the Japanese yen

How big is the carry trade? The answer to this apparently simple question has eluded analysts for more than a decade. In part, this is because the term carry trade is used to refer to several types of financial activity: portfolio diversification by Mrs Watanabe in Japan, low interest rate foreign-currency mortgages in Eastern Europe, and high-frequency speculative positions held by hedge funds and other leveraged investors. Measuring the size of the latter, the *speculative positions*, has proven extraordinarily difficult largely because there are different ways to implement the same speculative trade. But, the potential for a disruptive unwinding of such positions – which is independent of the exact form a speculator may use for placing the bet – has been a long-standing policy concern.

As we will explain, we believe that the only way to gauge the magnitude of speculative carry trade positions funded in a particular currency is through the interactions in the FX swap market. As in the previous section, we have to infer these positions from mirror images of observable on-balance sheet positions. Using the example of the yen-funded carry trade, we sketch how this can be done.

[12] This is a lower-bound estimate which implicitly assumes that US dollar liabilities to non-banks are long term. The assumption that these liabilities to non-banks are short term gives an upper-bound estimate of $6.5 trillion.

To avoid potential confusion, it is worth starting with a definition. We define a carry trade as the combination of borrowing at a low interest rate (a short position that we can think of as issuing a bond or taking out a bank loan) and lending the proceeds out at a high interest rate (a long position that is the purchase of a bond or the provision of a loan). For clarity, let's assume that the speculator is selling a bond and using the proceeds to purchase a bond. Importantly, borrowing and lending can occur at different maturities and in different currencies. If they do, we can decompose the carry trade into a yield curve position (which seeks to profit from any *term premium*, where typically the borrowing is shorter term than the lending) and an open exchange rate position (which seeks to profit from the failure of uncovered interest rate parity, ie the existence of a *forward premium* where the forward exchange rate does not accurately reflect the future expected spot rate).[13]

In the textbook version of the trade, the investor borrows in a low-interest rate currency, such as the Japanese yen. He then sells the yen in the spot market for US dollars, and purchases a US dollar bond with a yield higher than the rate paid on the yen-denominated loan. Provided that the dollar does not depreciate relative to the yen, the investor will earn at least the (maturity-matched) cross-currency interest rate differential – that is, the difference between the US dollar bond rate and the Japanese yen borrowing rate. If there is a maturity mismatch, then the carry trade investor is exposed to both interest rate risk and exchange rate risk. As a result, these trades are notoriously vulnerable to interest rate, yield curve, and exchange rate movements. And, when any of these starts to move against the position, there can be a rush for the exits as investors try to quickly rid themselves of both maturity and currency mismatches, thereby creating sudden jumps in interest and exchange rates.

How can we figure out how much of this is going on and whether it poses a systemic risk? First, even though textbooks discuss it this way, very little speculative carry trade activity is done exactly as we have just described. This implies that a simple look at cross-border lending in various currencies won't work. That is, you will not find evidence for carry-trade positions directly on the balance sheets of financial institutions.[14] Instead, a speculator will use derivatives – futures, forwards and swaps – to put on currency carry trade positions. A typical transaction might look like this. A dollar-based hedge fund borrows dollars (step 1) and swaps them for yen (step 2), where the swap rate is determined by the standard covered interest rate parity condition.[15] So far, the investor owes dollars at the dollar interest rate, and has yen. At step 3, the hedge fund sells the yen for dollars in the spot market (which puts downward pressure on the yen/dollar exchange rate), and takes the dollar proceeds and invests them (step 4). At maturity, the position is unwound. The dollar investment matures (undoing step 4), the investor takes the proceeds and buys yen (undoing step 3), which are then used to make good on the FX swap (step 2). Finally, the hedge fund repays the original loan (step 1). While the position is in place, the hedge fund shows a dollar liability and a dollar asset (probably of different maturities). In other words, the speculation that the yen will depreciate against the dollar (or, at least, not appreciate) and the income from the interest rate differential embedded in the FX swap will be invisible if all you see is balance sheet data.

Importantly, though, for the hedge fund to be able to put on the position in the first place, someone has to be willing to provide yen for dollars today in the FX swap market (step 2). And which institutions in the world have both the yen to provide and a need for dollars (and

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[13] On the forward premium, see, for example, Flood and Rose (2002).

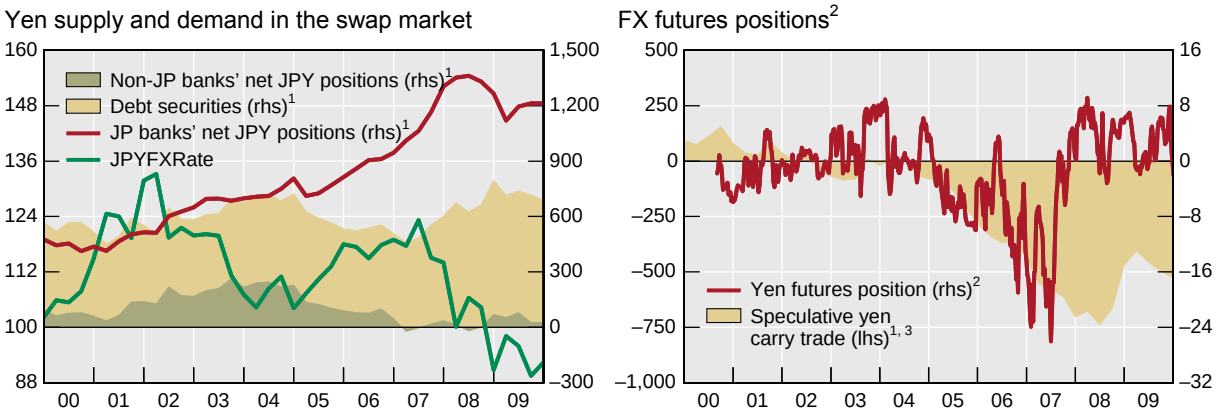
[14] Support for this assumption is provided by Galati et al (2007), who scoured the BIS locational banking statistics for yen lending/borrowing related to the carry trade, but did not find much evidence.

[15] That is, $(i - i^*) = \frac{(f - s)}{s(1 + i^*)}$, where i is the US dollar interest rate, i is the yen interest rate, s is the dollar/yen spot rate, and f is the dollar/yen forward rate at the same maturity as the interest rates.

other currencies)? Japanese banks and, perhaps, insurers come to mind. Indeed, estimates suggest that Japanese banks have been supplying upwards of $1 trillion worth of yen to the swap market over the last few years – this is the red line in the left-hand panel of Graph 2.[16]

Graph 2

Uncovering the speculative bid in yen carry trades



[1] In billions of US dollars. [2] Net non-commercial long positions on the Chicago Mercantile Exchange; derived using average exchange rates of March 2010; in billions of US dollars. [3] Calculated as the (negative of) the gap between Japanese banks' net JPY positions (red line) and the sum of the shaded areas in the left-hand panel.

Sources: CFTC; BIS calculations.

The natural counterparty to Japanese banks in the FX swap market is a foreign investor seeking to invest in yen assets. This could be a European or a US bank or a pension fund interested in investing in Japanese equities or bonds. Unlike the hedge fund above, these so-called *real money* investors want to buy and hold yen assets, so they do not sell the yen they get from the swap in the spot market (no steps 3 and 4). That means that their swap market transactions have no direct exchange rate implications.

How can existing data be used to figure out what is going on? Is there a way to estimate the size of the speculative yen carry trade from FX swaps? The short answer is yes, approximately. The trick is to infer the red line – an estimate of the size of the carry trade – in the left panel of Graph 2 from the information we have. We can do this by subtracting the amount of yen demand by real money investors in the FX swap market from the total yen volume supplied to the market by Japanese banks. To do this, we need to construct estimates of yen demand from real money investors. For (non-Japanese) banks, we again use the BIS banking statistics to gauge their on-balance sheet net position in yen-denominated assets. This is shown as the darkly shaded area in the left-hand panel of Graph 2, and you can see that it is rather small. If non-Japanese banks fully hedge exchange rate risk, this implies that they are not demanding much yen in the FX swap market, at least on a net basis.

What about the yen position of the *non-bank* real money investors? Unfortunately, the breakdowns available in the aggregate data covering non-banks (from sources such as flow of funds and balance of payments accounts) do not provide any equivalent measure of yen asset demand. So, for lack of better data, we use a measure from the BIS debt securities statistics: the outstanding stock of yen-denominated international bonds. If we assume that (a) none of these bonds are purchased by banks (ie no double-counting), and that (b) none of these are purchased by yen-based investors in Japan, then the outstanding stock of yen-

[16] See McGuire and von Peter (2009) and section 3.1 above.

denominated international bonds equals the total international demand for yen assets by non-Japanese non-bank investors. If these investors hedge their exchange rate risk, then this stock should approximate their demand for yen funding from the FX swap market. The result is the lightly shaded area in the left-hand panel of Graph 2.

Putting everything together, we have a measure, albeit rough, of the speculative yen carry trade. What does it look like? Until 2004–05, yen volumes supplied by Japanese banks in the FX swap market roughly matched demand for yen assets from *real-money* investors, as proxied by the sum of non-Japanese banks' net on-balance sheet yen positions and total outstanding international yen-denominated bonds. After 2005, however, the gap, that is, the difference between the stacked shaded areas and the red line, widens considerably. Unsurprisingly, this corresponds to a period of yen depreciation (the green line) – the carry trade that we have outlined puts downward pressure on the yen – and, at least until the start of the recent crisis, is consistent with other commonly used indicators of carry trade activity. For example, analysts often rely on information on yen positioning by *non-commercial* entities (assumed to be hedge funds and other non-bank financial institutions) in the Chicago currency futures markets. While these data capture only a slice of the global currency futures activity (and miss all OTC positions), they are often used to get a sense of the *direction* of the speculative bid for yen. And, as shown in the right-hand panel of Graph 2, these net short non-commercial yen positions grew substantially after 2004, just as our gap measure widens.

What can we conclude from all this? Is it a coincidence? Or, is the gap that we infer a reliable measure of speculative carry trade activity? We don't know for sure (given, for example, the gap that opens up between the two measures in the right-hand panel for the most recent observations), but the bigger point is that carry trades are largely off-balance sheet. Without more consolidated information on derivatives positions, there is no way to track them directly. To better understand the FX swap market (and the relative importance of participants therein), what we need is net position data by currency and nationality. And, as in the example in the previous subsection, here again the necessary information can only come from datasets that cover all financial institutions and investors, and that feature both a locational (residency) and consolidated (headquarters) dimension.

3.3 Implications for statistical strategy: the BIS and beyond

Based on the two examples discussed above, it should be clear that the BIS banking statistics already have most of the properties that we would want from a statistical reporting framework geared at financial stability analysis. From this, we draw three sets of implications for the BIS and beyond.

Improving the BIS banking statistics: The crisis highlights the value of consistent banking system data for the analysis of systemic risk. For the BIS, this implies the need to focus on statistical improvements that increase the analytical value of the BIS banking statistics for central banks, the broader financial community and academic researchers. The BIS's experience is that relatively small changes to existing reporting frameworks can generate significant increases in analytical value.

Specifically, we see a need to enhance the ability of the BIS banking statistics to cover the maturity and currency dimensions of banks' (international) activities, and to provide aggregate measures of *on-balance* sheet leverage. In addition, we hope to be able to increase the granularity of existing data reporting, refining sectoral breakdowns and the like, to allow improved integration of supplementary statistics on key financial institutions, and to selectively add supplementary information on global markets. For the latter, specifically the integration of information on off-balance sheet activities, central counterparties and trade warehouses can be a useful additional data source (see Box 2 for a short description of the BIS's proposals in these areas; for concreteness, the Appendix sketches out a hypothetical reporting template, based largely on the existing structure of the BIS banking statistics, and proposes some broad market and counterparty breakdowns for consideration).

Box 2: Specific improvements to the BIS international banking statistics

Improvements to the international banking statistics are possible along the following dimensions:

- **Currency and maturity detail.** Our analysis of funding gaps[①] reveals scope for significant improvements based on relatively small reporting changes: specifically, more refined and consistent (i) currency breakdowns, (ii) counterparty breakdowns and (iii) maturity breakdowns across different parts of the BIS banking statistics.
- **De-masking and disaggregating.** A significant amount of data is actually collected by central banks but not on-reported to the BIS (either because of aggregation or because data is masked in the submissions). Compilation is thus possible at low cost, potentially allowing for significant enhancements of the analytical value of the BIS banking statistics.
- **Leverage and derivatives.** Additional enhancements are possible by explicitly covering on-balance sheet leverage (eg by including information on capital and total assets in the reporting), as already done by some reporters, and by trying to better capture derivatives-related exposures (as done, to some extent, in making ultimate risk adjustments).
- **Splicing.** Other existing datasets can be used to further enhance the analytical value of the BIS banking statistics (eg by relating exposures to measures of total assets or equity for individual banks, which can then be aggregated up in ways consistent with the BIS banking statistics). The same could be done with other BIS sets of statistics, to better integrate them with the BIS banking statistics and with information available from other sources. A key goal would be to get a sense of asset/exposure holdings, for which data from trade warehouses and central counterparties can be useful (eg ongoing work on improving the BIS's over-the-counter (OTC) derivatives statistics by combining the data on credit default swaps (CDS) with information provided by the Depository Trust and Clearing Corporation (DTCC). Similar work would be possible for the BIS securities statistics).
- **Supplementary data.** Further, supplementary statistics could be compiled selectively to enhance the existing focus on international banks and global markets. This could involve the preparation of global aggregates for key indicators already available on a national basis. Examples include ongoing work by the Committee on the Global Financial System (CGFS) on aggregate survey measures of credit conditions. Once a framework for compilation is in place, these efforts could be extended to cover margin requirements/haircuts and similar metrics that can be used to gauge changes in lending standards and to aid the monitoring of build-ups in risk.

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① See section 3.1 above and McGuire and von Peter (2009).

Core system data: As already mentioned, standardised information on the top 50 banks and financial institutions is not publicly available in a detailed and timely fashion. Different data providers provide different levels of detail, but these cannot be easily spliced together. Fixing this problem means redoubling efforts to improve standardisation and enhance disclosure. The goal is to provide better public information so that authorities can improve their monitoring and markets can improve their discipline.

Statistical design more broadly: Finally, if we are to take the crisis-related lessons coming out of the BIS banking statistics seriously, we need to design statistical frameworks so that the same sort of analysis of leverage, maturity mismatch and exposure/funding patterns that is possible for banks can also be done for other sectors. At the risk of repetition, the key here is consolidation. Specifically, existing aggregate data need to be collected to allow joint identification of the *nationality* of the reporting entities' headquarters and the *location* of any particular branch or subsidiary. If all our aggregate statistics follow this principle, we can then

complement the locational point of view with a consolidated view, which is necessary for the measurement of balance sheet stresses.

Fortunately, much of the necessary data are already being collected in existing reporting frameworks for the creation of the flow-of-funds and balance-of-payments statistics. All that may be needed are – admittedly non-trivial – changes to existing collection protocols, combined with adjustments to computation methods (see the Appendix for details). The payoff would be a complete set of consolidated and locational statistics at the sectoral level (for banks, other financial intermediaries, non-financial corporates and households) that could then be used to monitor systemic risk globally and nationally.

4. Implications for global risk maps and similar tools

Global risk maps are the holy grail of systemic risk monitoring. Defined as unified databases that provide data on risk exposures of financial institutions and markets, they would allow supervisors and market participants to monitor the evolution of risks in banks, banking systems and the broader financial market community.[17] Not only would these risk maps provide data inputs for financial stability analysis, they would also serve as the starting point and testing ground for the development of new systemic risk measurement and mitigation tools.

In practice, the creation of a global risk map would require giant matrices of bilateral exposure data to be assembled for a large set of financial institutions and other systemically important entities, possibly grouped by different risk categories. The usefulness, in principle, of such an exercise is self-evident. Done right, it would allow us to read directly from the matrix, at any point in time, the risk exposures among financial institutions and with respect to particular risk factors. This would make it possible, at least in principle, to calculate a whole range of risk and concentration measures both cross-sectionally and over time.

That is the theory. What about the reality? As we noted before, in approaching this sort of task, we face trade-offs between the macro and micro dimensions of data compilation and dissemination. The costs of collection and analysis will rise as the scope and scale of the enterprise increase. This means looking for a balance between the degree of disaggregation, the universe of firms included, and the amount of detail covered. This, in turn, relates to the boundaries of supervisory exchange of data and broader statistical frameworks aimed at public dissemination. Armed with our experience with the BIS statistics, we now turn to a brief discussion of each of these.

4.1 Supervisory information exchange

We have mentioned this several times because we believe it to be central to the whole process of systemic risk assessment. The experience of the last few years clearly revealed that supervisors did *not* have all the information they needed to track the build-up of risk going into the crisis. And, perhaps more importantly, they did not have the information they needed to better contain the crisis once it started. In a world with global banks and global financial markets, we have no choice but to set up robust frameworks for supervisory information exchange.

Generally, given the detail needed, such frameworks are likely to focus on a core set of internationally active institutions. That said, the goal has to be to capture these firms' risk

[17] See Issing Committee (2009).

profiles, not only individually but also with regard to concentrations of risk arising from common exposures among these institutions and from interlinkages between them and their main counterparties.

What are the main requirements of such frameworks? First, as emphasised above, comparability and consistency are key. This means standardising reporting across jurisdictions, including standardisation of any risk measures to be used and the methods for their construction.[18] Second, reporting will have to be flexible enough to allow regulators to react in a timely manner to market innovation, structural trends and moves by institutions to evade what they might see as injurious actions taken in response to the data they are obliged to report. Third, any legal constraints will have to be sorted out to allow international exchange of data. Essentially, what is required is a joint reporting template to be used by supervisors across jurisdictions for core internationally active institutions, based on common definitions for instruments, counterparties and risk measures.[19]

What types of reporting would this entail? Broadly, we can distinguish three types of risk on which detailed information would be needed: *market risk*, *funding risk* and *credit risk* (plus insurance risk, for institutions involved in non-life insurance activities).[20] The capture of exposures across all three risk categories requires detailed information by asset class and/or market as well as the names of the most important individual counterparties.

Derivatives exposures, which are insufficiently or not at all captured by existing sets of information and standard disclosures, are a natural starting point. To do the job, supervisors would need information on gross mark to market exposures (after counterparty netting) with respect to key counterparties, any collateral held, and net exposures (after netting and collateral). As market conditions can change rapidly, some measure of potential or worst-case exposure would also be crucial (based on an agreed methodology).

Next come *repurchase agreements, securities lending*, and *interbank markets*, and the list goes on.

Exploratory efforts to collect counterparty-level credit data for supervisory use are under way in the context of the so-called *Senior Supervisors Group*.[21] The idea is to identify the most important counterparties, to monitor their exposures and to analyse the interconnectedness among reporters. The resulting risk map, updated over time, will help identify changes in peer relationships, track the magnitude of these linkages and monitor any concentrations.

4.2 Public information dissemination

Public availability of a global risk map would allow the use of detailed exposure data in the calculation of system-wide measures of risk outside the strictly supervisory domain. This would enable investors, academics and authorities beyond supervisors to conduct their own analyses, improving the monitoring of systemic risks and enhancing market discipline. As a general rule, to the extent possible, both supervisors and the general public should thus be supplied with the same information. Where needed, aggregation can be used to address confidentiality constraints, and reduced reporting frequencies can limit the costs of publicly disseminated datasets.

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[18] This may require harmonisation of the regulation and supervision of the core institutions themselves.

[19] See Tarullo (2010) for details.

[20] See, for example, BCBS, CGFS, IAIS and IOSCO (2001).

[21] See also FSB and IMF (2009), especially recommendation #8.

The possibility of such reporting is currently being considered by the Financial Stability Board.[22] And the BIS is contributing to this effort. Yet public dissemination involves significant challenges. This is where the lessons from the crisis as extracted from the BIS banking statistics offer a viable alternative. For example, if *consolidated* (the *nationality* or *headquarter* dimension) as well as locational (the *residency* dimension) data were jointly available for the flow of funds and balance of payments statistics (including the IMF's Co-ordinated Portfolio Investment Survey), we could then see the entire balance sheet of households, nonfinancial corporates and financial institutions. This would allow for a rather detailed analysis of common exposures and interlinkages at the sectoral level, in both domestic and international terms.

Monitoring at the aggregate, sectoral level is but one step removed from what could be done with complete global risk maps. Importantly, it could help sidestep the complex legal challenges surrounding the sharing or dissemination of firm-level data, while supporting a two-step approach to systemic risk monitoring. That is, the alarms that sound in the aggregate data will yield the critical pieces of information – *nationality* of entity, *location* of entity and *risk type* (including funding and exposure risk) – to inform targeted analysis of more detailed (supervisory or other) data at the firm or market level.[23]

5. Conclusions

The recent financial crisis revealed important gaps in our ability to analyse financial institutions and markets at the system-wide level. Simple aggregate statistics can go some way in gauging the build-up of risks in a broad sense. But to understand, measure and mitigate systemic risk we need more. From the crisis experience, we take away five *principles* that we believe should guide future statistical collection efforts:

1. **Quantities**: As a complement to the price data we already have, we need to know quantities. We need on- and off-balance sheet information to evaluate common exposures, interlinkages and countercyclicality.
2. **Intermediaries**: As maturity transformers and funding liquidity providers, financial intermediaries are the ultimate sources of systemic risk. We need data that allows us to see what they are doing and how they are doing it.
3. **Consistency**: We need the ability to put together disparate datasets from different sources around the world. That means consistency of reporting frameworks.
4. **Maturities and currency**: Without information on maturity (perhaps inferred from counterparty information) and currency composition, we will not be able to see the risks that come from mismatches.
5. **Joint residency and consolidated reporting**: Officials in one country need to know what the subsidiaries of their banks are doing in another. Likewise, the regulators in a particular country will want to see stresses building up on the consolidated balance sheets of banks operating foreign offices in their jurisdiction.

Using these five principles, we can act to improve data in a way that will allow us to move significantly in the direction of producing a global risk map – the giant matrices of exposures and funding relationships that would, in principle, allow a measurement of virtually any vulnerability in the financial system. One example already in place is the use of the BIS

[22] See FSB and IMF (2009), particularly recommendation #9.

[23] See Eichner et al (2010) for a detailed description of a very similar approach.

banking statistics to produce what we might call a "global risk map in the small". While restricted to banks and then only to their international activities, this set of statistics already allows us to analyse (some) interconnections and common exposures at the sectoral level, over time. And relatively small adjustments to the existing reporting would further improve the capabilities of this particular dataset – improvements that the BIS intends to pursue actively over the coming months.

How about the set of three *core questions* we raised at the outset of this paper?

- Question 1: How can a central bank monitor the global use of its currency?

  Add up consolidated investment and funding positions in your currency across sectors and countries – these are the FX swap market and carry trade examples we described.

- Question 2: What information do policy makers need (in addition to home country supervisory data) to monitor systemic financial stresses?

  They need data on the geographical patterns of funding and investment relationships, including aggregate sources of funding for the domestic corporate sector, and asset and liability information, including currency and maturity mismatches, and information on all of the entities and sectors providing funding to financial institutions.

- Question 3: What data could help financial market participants improve market discipline?

  While we cannot be sure, our sense is that more information on funding sources and common exposures for consolidated entities, including all bank and nonbank financial firms, as well as nonfinancial corporates and household worldwide would help.

All of this leads us to draw an important inference for statistical reporting of *aggregate data* more generally. In particular, tremendous value would come from adding a consolidated (ie *nationality*) dimension to commonly constructed locational (residency-based) data. This would make it possible to adapt existing statistical reporting frameworks (such as the flow of funds and balance of payments statistics) in order to facilitate systemic risk analysis in ways that are only one step removed from what could be done with complete global risk maps. This, in turn, would help to sidestep the complex legal challenges surrounding the sharing of firm-level data. And it would improve our ability to use aggregate data for the identification of vulnerabilities (including information on the *nationality* and *location* of any entity and on the *risk type*) for a deeper drill-down on the basis of more granular data.

Appendix

What breakdowns of aggregate statistics do we need? Drawing on our experience with the BIS banking statistics, we outline some tentative answers to that question in this appendix.

In any data collection exercise, additional detail incurs greater costs. Not only that, but there are many paths to the same result. Our goal here is not to present what *is* the *right* or *best* template, but rather to provide a point of departure for discussions on what material improvements we can realistically hope to make. As a first step, we adopt a broad perspective, describing the maximum of what would be desirable.

Broadly speaking, aggregate data should allow us to assess, at the sectoral and systemic levels, *credit risk*, *country risk* and *market risk* on the asset side; and *currency risk* and *maturity transformation* across the balance sheet. Getting a sense of these risks requires measurement of *liquidity risk* on the asset side, and *rollover risk* on the liability side. This, in turn, means having information on markets, counterparty, instrument, maturity and currency.

The question that faces us is what combination(s) of information in our aggregate statistics would allow us to see where these concentrations of risks are building? Table A.1 presents a somewhat stylised balance sheet with four breakdowns (indicated in the column headings), or classifications, for assets and liabilities. Our basic argument is that combinations of quantity data combined with some comparative static analysis can go a long way in allowing us to uncover where important risks are located. At the very least, such data should help to focus targeted discussions with regulatory authorities in various countries that have (or are able to obtain) the underlying firm-level information. In this context, several points are worth highlighting:

- ***Reporting unit:*** The ideal underlying reporting unit must be a household or the office/branch/subsidiary of a bank, non-bank financial institution or corporate in a particular location (country). These are the reporter types. Ideally, the number of different reporting sectors is the same as the number of counterparty sectors, listed under counterparty types in Table A.1, column 2.
- ***Aggregation:*** The balance sheet positions should be aggregated by location (country), reporter nationality and reporter type. For example, Table A.1 could be viewed as the (aggregated) positions of, say, the 10 offices of Belgian-headquartered non-bank corporates located in Italy. When all countries and all sectors report, the underlying data blocks can then be further added up to produce (i) total positions for all entities located in Italy (country-level totals on a residency basis), (ii) Belgian-headquartered non-bank corporates' worldwide positions (consolidated global totals for a particular *national sector*), and (iii) Belgian-headquartered entities' worldwide consolidated positions (country-level consolidated exposure totals).
- ***Breakdowns:*** The breakdowns that we need to gauge things such as maturity-transformation risk, counterparty risk, and currency risk are illustrated by drilling down to a particular counterparty type. That is, for a reporting unit located in country X, the asset side of the balance sheet shows claims on *corporate* borrowers (Table A.1, column 2) located in *country A* (column 3), broken down by *currency* (column 5), *remaining maturity* (column 4), and *instrument type* (column 1). The liability side shows total liabilities to *non-bank financials* (column 10), with the same breakdowns.
- ***Off-balance sheet positions:*** FX swaps, interest rate swaps and credit default swaps are all shown at the bottom of the table – they are off-balance sheet. Along with other derivatives, these add an additional layer of exposures (both on the asset and liabilities side of the balance sheet) that can magnify, neutralise or reverse the reported on-balance sheet positions. Ideally, we would require separate reporting of all items in Table A.1 *before* and *after* off-balance sheet activities. In other words,

we would want to add a layer of *ultimate risk reporting* similar to what is already available for *credit risks* in the BIS banking statistics, but covering all risk categories. For example, for the maturity column we would have exposures after transformation through interest rate derivatives, for currency it would indicate all open foreign exchange exposures after FX swaps, and for credit risk, reporting would be by country location and counterparty type on an ultimate risk basis.[24]

Table A.1 **A stylised reporting template for aggregate (sectoral) statistics**

Assets					Liabilities				
1	2	3	4	5	6	7	8	9	10
Instrument type	**Counterparty type**	**Counterparty location**	**Remaining maturity**	**Currency**	**Currency**	**Remaining maturity**	**Counterparty location**	**Counterparty type**	**Instrument type**
	Bank	Country A	Short term	**USD**	**USD**	Short term	Country A		
		Country B							
		Country C							
		Country D					Country B	Non-bank fin	Debt security
		Country E					Country C		
Loan	Corporate	Country A	Long term			Long term	Country A		
Debt security							Country B	Household	
Equity					**Euro**	Short term	Country A		
Other							Country B	Corporate	
	Household					Long term	Country A		
	Non-bank fin						Country B	Corporate	
	Bank							Household	
	Public sector							Non-bank fin	Deposit
	Central bank								Debt security
	Interoffice								Other
		Country B						Bank	
		Country C						Public sector	
Loan	Corporate	Country A	Short term	**Euro**				Central bank	
	Non bank fin							Interoffice	
		Country B			**Book equity**		Country A		
Debt security	Corporate	Country A	Long term				Country B	Non-bank fin	Equity
	Interoffice							Public sector	
		Country B						Corporate	
		Country C					Country C		
Exchange rate swaps			**Interest rate swaps**			**Credit default swaps**			

[24] We realise that this is conceptually challenging and amounts to a very significant reporting burden, which implies that existing datasets (such as the BIS OTC derivatives statistics) might be enhanced to provide at least *some* of the detail mentioned above.

- ***Filling in the balance sheet:*** Reporting entities will have difficulty filling in all of the cells in Table A1. In particular, if the reporting institution issues a bond that is traded on the secondary markets, it is unlikely to know the counterparty that holds the bond at any point in time. Thus, columns 8 and 9 on counterparty location and type might be empty. Note that debt securities liabilities are different from, say, banks' deposit liabilities, where both the location and the type of counterparty are typically known by the reporting bank.

- In a world where all entities in all countries are reporters, what's missing in one place, can, in principle, be recovered somewhere else. This would require one additional breakdown (not shown in Table A.1) on the asset side of the balance sheet: the *nationality of the counterparty*. For example, the owner of a long-term bond issued by the London subsidiary of a US-headquartered auto company may not be known to the UK issuer, but would be picked up if the Saudi pension fund that owns it reports it as a claim on a US-headquartered corporate located in the United Kingdom.[25] That is, if the asset holder reports both the location and nationality of the counterparty.

How would this help identify the important risks and vulnerabilities? With a perfect consolidated view of each sector's worldwide consolidated exposure, it would be possible to read off many of the risks we have discussed. For example, in the case described in the text, we would be able to see the institutions covered by Table A.1 that have a long on-balance sheet US dollar position financed by short-term dollar funding and long-term euro funding. We would know if the on-balance sheet exposures were large and growing. And, we would be able to see the maturity profile of the position, including that of the FX swaps. On the asset side, we would be able to identify concentrations of particular types of assets and risks, and tell if they are large relative to capital. And, on the liabilities side, we would be able to see the scale, timing and frequency of required rollovers.

Finally, note that the breakdowns in Table A.1 are roughly in line with those already available in the BIS banking statistics, but with several important exceptions. First, comprehensive information on the maturity buckets is missing in the BIS data. Second, the currently available breakdown by counterparty type is far less comprehensive (only bank/non-bank; in some data, the public sector is split out). Third, information on book equity is not explicitly broken out on the liabilities side. And fourth, there is only limited information on banks' off-balance sheet positions.

[25] The IMF's CPIS statistics provide information on individual economy (ie country location) year-end holdings of portfolio investment securities (equity securities and debt securities), cross-classified by the country of issuer of the securities.

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