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Financial Stability Paper No. 36 – February 2016

Stitching together the global financial safety net

Edd Denbee, Carsten Jung and Francesco Paternò



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Stitching together the global financial safety net

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Financial globalisation and the expansion in global capital flows bring a number of benefits — more efficient allocation of resources, improved risk sharing and more rapid technology transfer. But they can also increase the risk of financial crisis. In recent years, to reduce these risks to stability, countries have reformed financial regulation, enhanced frameworks for central bank liquidity provision and developed new elements, and increased the resources, of the global financial safety net (GFSN).

A comprehensive and effective GFSN can help prevent liquidity crises from escalating into solvency crises and local balance of payments crises from turning into systemic sudden stop crises. The traditional GFSN consisted of countries' own foreign exchange reserves with the IMF acting as a backstop. But since the global financial crisis there have been a number of new arrangements added to the GFSN, in particular the expansion of swap lines between central banks and regional financing arrangements.

The new look GFSN is more fragmented than in the past, with multiple types of liquidity insurance and individual countries and regions having access to different size and types of financial safety nets. These new facilities provide many benefits, such as increasing the resources available to some countries and providing additional sources of economic surveillance. However, many facilities have yet to be drawn upon and variable coverage risks leaving some countries with inadequate access.

This paper considers the features, costs and benefits of each of the components of the GFSN and whether the overall size and distribution across countries and regions is likely to be sufficient for a plausible set of shocks.

We find that the components of the GFSN are not fully substitutable: different elements exhibit different levels of versatility, have been shown to be more or less effective depending upon the circumstances, have different cost profiles and have different implications for the functioning of the international monetary and financial system as a whole. We argue that while swap lines and RFAs can play an important role in the global financial safety net they are not a substitute for having a strong, well resourced, IMF at the centre of it.

By running a series of stress scenarios we find that for all but the most severe crisis scenarios, the current resources of the GFSN are likely to be sufficient. However, this finding relies upon the IMF's overall level of resources (including both permanent and temporary) being maintained at their current level.

Our analysis also highlights that the aggregation of global resources can mask vulnerabilities at the country, and even regional, level. In other words, while the current safety net might be big enough in aggregate, there is a risk that, for large enough shocks, gaps in coverage could be revealed. Steps should be taken to ensure the different components of the safety net function effectively together to reduce the risk of gaps appearing.

Policymakers should consider measures which (i) reduce vulnerabilities in external balance sheets which leave countries exposed to volatility in cross-border capital flows and increase potential demands on the safety net; (ii) secure the availability of appropriate GFSN resources, including the IMF's resource base; and (iii) make more efficient use of the current GFSN resources by ensuring the elements of the GFSN more effectively complement one another.

1 Introduction

1.1 The expansion of global finance

Financial globalisation and the expansion in global capital flows bring a number of benefits — more efficient allocation of resources, improved risk sharing and more rapid technology transfer. But they can also increase the risk of financial crises. This was the case both in the first era of financial globalisation (between 1880 and 1913) and the second one (between 1970 and today) (Obstfeld and Taylor (2004)). In recent years, to reduce these risks to stability, countries have reformed financial regulation, enhanced frameworks for central bank liquidity provision and developed new elements, and increased the resources of, the global financial safety net (GFSN). The GFSN is the focus of this paper.

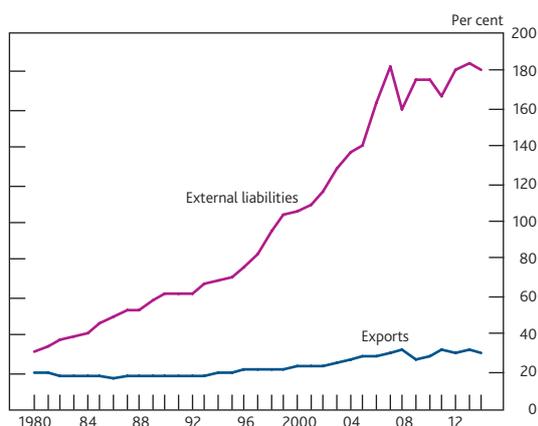
A comprehensive and effective GFSN can help prevent liquidity crises from escalating into solvency crises and local balance of payments crises from turning into systemic sudden stop crises. Since the global financial crisis there have been a number of new arrangements added to the GFSN. Our first contribution is to take stock of the current arrangements and assess the characteristics of the current GFSN, such as its size, distribution and range of instruments, and then consider how the elements of the GFSN fit together. Our second contribution is to run a series of stress scenarios to quantify potential calls on the safety net and assess whether existing arrangements are likely to be adequate in size and country coverage. We highlight policy options to reduce potential calls on the GFSN and to ensure that all countries have access to sufficient resources in the event of liquidity crises.

The past three decades have witnessed significant growth in cross-border financial flows. Consequently, external liabilities have grown from 30% to 180% of global GDP between 1980 and 2014, far outpacing the growth in global trade (from 19% to 30% over the same period) (Chart 1). This growth was driven in particular by cross-border banking flows, which made up about one third of global capital flows in the decade prior to the financial crisis.

On a net basis, more gross capital inflows than outflows have allowed many countries to run current account deficits. Global current account imbalances (measured as the sum of the absolute values of all current account surpluses and deficits) tripled from around 2.3% of global GDP between 1980 and 1997 to 5.5% of global GDP in 2006–08 and were 3.5% in 2014 (see Bush *et al* (2011)). But net flows concealed even larger increases in gross flows.

On a gross basis, the boom in global capital flows has provided additional sources of finance for governments, banks, corporates and households. This may have increased the efficiency of capital allocation, with capital increasingly able to flow to where it is most productive. Gross capital flows

Chart 1 Global exports and external liabilities as percentage of global GDP, 1980–2014



Sources: IMF *International Financial Statistics*, IMF *World Economic Outlook*, updated and extended version of dataset constructed by Lane and Milesi-Ferretti (2007) and Bank calculations.

increased to over 20% of global GDP in 2007 up from around 3% in 1980. Cross-border banking was one of the main drivers of this increase in cross-border flows. Most of this expansion came from flows between advanced economies (AEs) and, in particular within advanced Europe (Chart 2). But flows to and from emerging market economies (EMEs) have also increased significantly. Despite falling sharply post-crisis, gross flows have settled above the historical average at around 6% of global GDP.

There is a flip side to the rapid rise in cross-border capital flows and external assets and liabilities — countries are more exposed to the willingness of foreign investors to continue funding their financing needs. Cross-border capital flows can be fickle, with foreign investors withdrawing funding in the event of an economic or financial crisis (for example, Claessens and Kose (2013), Fratzscher (2012) and Caballero and Krishnamurthy (2006)). And, in recent years, financial conditions in EMEs — especially long-term interest rates — appear to have become more synchronised with those in AEs (for example, Obstfeld (2015), IMF (2014a), Cerutti *et al* (2014) and Fratzscher (2012)). Moreover, the evidence suggests that gross external balance sheets, particularly high external debt, are important in explaining the incidence of financial crises across countries (Al-Saffar *et al* (2013)).

Concerns about an increase in foreign currency borrowing in emerging markets through international bond markets — mainly by the corporate sector — have recently been centre stage in debates about global financial stability (IMF (2015)). And it has become increasingly clear that the structure of a country's external balance sheet is a key determinant in how vulnerable it could be to external financing crises, as we discuss in Section 4.

Forbes and Warnock (2012) provide a taxonomy for sharp changes in capital flows: surges, stops, flights and retrenchments. Such adjustments in capital flows impact on

Chart 2 Evolution of cross-border banking^(a)

Chart 2a 1990 Q4

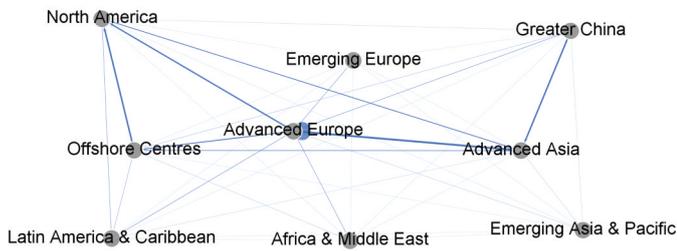


Chart 2b 2000 Q4

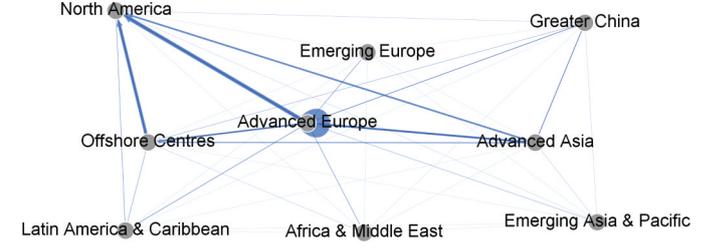


Chart 2c 2007 Q4

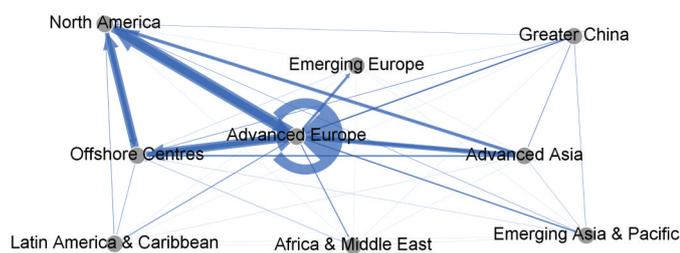
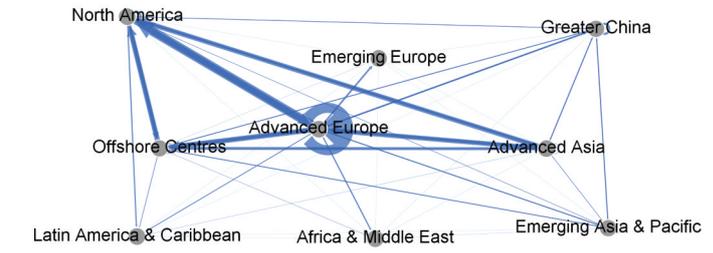


Chart 2d 2015 Q2



Source: BIS international banking statistics (residency basis).

(a) The arrows indicate claims. The thickness of the lines corresponds to the size of claims between banking sectors. Lines which start and end in the same region represent intra-regional banking claims. For example, the apparent blue circle for Advanced Europe is in fact a line which starts and ends in Advanced Europe, representing intra-Advanced Europe banking claims.

the domestic economy through the balance of payments identity.⁽¹⁾ Cross border financial flows expose countries to the risk of a **balance of payments crisis** either from an increase in gross capital outflows by domestic residents (capital flight), or a reduction in gross capital inflows from foreigners (sudden stop). That is, if private sector counterparts to the balance of payment identity cannot make up for these shocks (if a decrease of private gross capital outflows cannot compensate an unexpected decrease of gross capital inflows), official financing may be needed to prevent a disorderly adjustment (**Table A**).

Table A Taxonomy of capital flows from the home country perspective

Type of shock	Change in capital flows	Role of GFSN
Surges	Sharp increase in gross capital inflows	
Stops	Sharp reduction in gross capital inflows	Provide offsetting financing if FX reserves insufficient
Retrenchment	Sharp reduction in gross capital outflows	
Flight	Sharp increase in gross capital outflows	Provide offsetting financing if FX reserves insufficient

Source: Forbes and Warnock (2012).

If a country loses access to financing from abroad it has to (i) sell private foreign assets; (ii) sell official foreign assets (FX reserves); or (iii) increase net saving and shrink its current account deficit. These adjustments can be made more or less difficult by the reaction of the country's exchange rate.

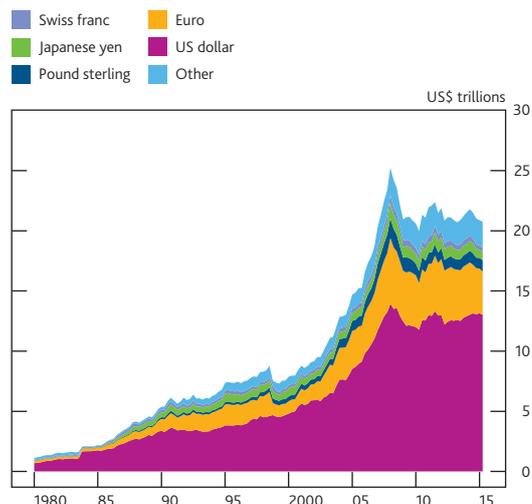
If private sector sales of external assets are not sufficient, and the official sector safety net is inadequate, adjustment of the current account is necessary. This can lead to painful economic conditions as a contraction in domestic demand is often required to reduce import demand (Cardarelli *et al* (2010)). That can be led by fiscal consolidation or higher private saving and reductions in consumption and investment (Avdjiev *et al* (2015)).

Borrowing in foreign currency often complicates adjustment. International banks' borrowing in foreign currency (both domestically and cross-border) has doubled since 2002, despite a 20% reduction since the peak in 2008. There are now over US\$20 trillion foreign currency denominated bank liabilities (**Chart 3**). And since 2008, outstanding US dollar denominated credit to non-banks outside of the United States has almost doubled to US\$9 trillion.

This exposes banking sectors to the risk of a **foreign currency liquidity crisis**, unless they have natural or financial hedges. A reduction in foreign currency funding can put pressure on bank balance sheets, potentially causing them to firesale assets and

(1) Current account balance = Financial account balance + Capital account balance + Net change of reserve assets. More specifically, financial account balance = FDI gross inflows + Portfolio investment gross inflows + Other Investment gross inflows – FDI gross outflows – Portfolio investment gross outflows – Other investment gross outflows + Financial derivatives net inflows. Note that gross inflows are defined as net sales of domestic financial instruments to foreign residents and gross outflows are defined as net purchases of foreign financial instruments by domestic residents.

Chart 3 Banking sector foreign currency liabilities, 1980–2015



Source: BIS international banking statistics (residency basis).

reduce lending. This can impact financial markets, risking a drying up in liquidity and asset price spirals, and reduce access to finance for firms and households. For example, in 2008 European banks were unable to access sufficient short-term US dollar funding in either the wholesale funding or FX swap markets (McGuire and von Peter (2009)). As central banks only issue domestic currency, they are less easily able to provide market-wide emergency liquidity in foreign currency. If the borrowing is also cross-border then this also has balance of payments implications. Even where a country is not initially faced with balance of payments difficulties, foreign currency mismatches in some parts of the economy could lead to both a liquidity shortfall and solvency problems.

Finally, governments are exposed to the risk of a **sovereign debt crisis**. Where public debts are high, or fiscal deficits increase to unsustainable levels, investors may be unwilling to continue to finance governments. This is particularly true for foreign investors who may be more likely to withdraw financing if risks are perceived to have increased. With falling demand, bond spreads can rise to levels which effectively shut governments out of the private debt markets, unless domestic investors are willing to absorb a substantially larger share of the country's public debt. In such circumstances, the provision of financing from external sources can remove governments from these markets and give them time to undertake adjustments which would allow them to regain market access.

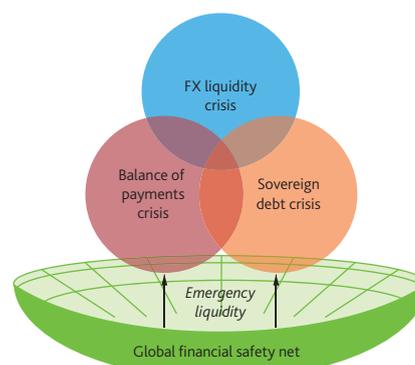
These types of crises are not independent of one another. For example, foreign currency liquidity crises and sovereign debt crises can be the result of sudden stops in capital flows and balance of payments crises. And feedback loops between banks and sovereigns can lead foreign currency liquidity crises to contribute to sovereign debt crises.

1.2 Reducing the costs of crises through the global financial safety net

To prevent liquidity crises from escalating into solvency ones and local balance of payments crises from turning into a systemic sudden stop crises, financial safety nets have been put in place (**Chart 4**) (Shafik (2015)). There are four forms of liquidity insurance:

- Self-insurance, via accumulated foreign exchange reserves.
- Bilateral insurance, via swap lines between central banks.
- Regional insurance, via regional financing arrangements, which either pool reserve holdings or combine countries' borrowing capacities.
- Multilateral insurance, via the IMF.

Chart 4 Crises and the global financial safety net



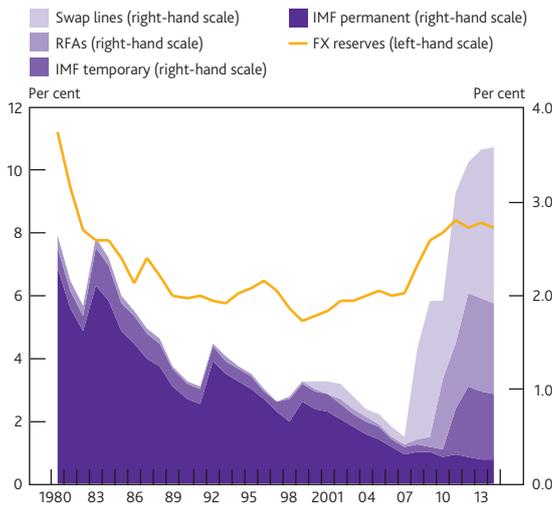
Each of these sources of liquidity can provide a country with capital inflows to offset net private sector outflows. Where the resources are denominated in foreign currency, any source could also be used to provide temporary market-wide liquidity support where there are disruptions to foreign currency funding markets.

The existence of a sufficiently resourced GFSN may also have a positive signalling effect and help to weaken the link between global factors (eg global risk aversion and global interest rates) and extreme capital flow episodes (Forbes and Warnock (2012)). But building financial safety nets comes with costs as well as benefits, both for individual countries and more broadly for the international monetary and financial system. The adequacy of the GFSN will depend upon the size and coverage of resources, and also the features of the instruments and their reliability.

Compared with historical levels, the external elements of the GFSN, in aggregate, do not look particularly small relative to global external liabilities (**Chart 5**). But the GFSN has become more fragmented, with multiple types of liquidity insurance and individual countries and regions having access to different

size and types of safety nets. The new facilities provide some benefits, such as increasing the resources available to some countries and providing additional sources of economic surveillance. However, many facilities have yet to be drawn upon and variable coverage risks leaving some countries with inadequate access.

Chart 5 Global financial safety net as percentage of external liabilities, 1980–2014(a)



Sources: IMF International Financial Statistics, IMF World Economic Outlook, RFAs, updated and extended version of dataset constructed by Lane and Milesi-Ferretti (2007) and Bank calculations.

(a) The recent ratification of the IMF’s 14th General Review of Quotas will see the IMF permanent resources double and the temporary resources fall by a similar amount.

The private sector can also impact upon potential calls on the global financial safety net. For example, by: (i) banks holding liquid asset buffers and better matching their longer-term assets with longer-term funding (ie the Basel III Liquidity Coverage Ratio and Net Stable Funding Ratio instruments); (ii) initiatives such as the Vienna Initiative which helped maintain bank lending in central and eastern Europe thus reducing the balance of payments pressures in these countries; and (iii) well managed sovereign debt restructurings, which can reduce delays and distribute losses with minimal risk of spillovers.

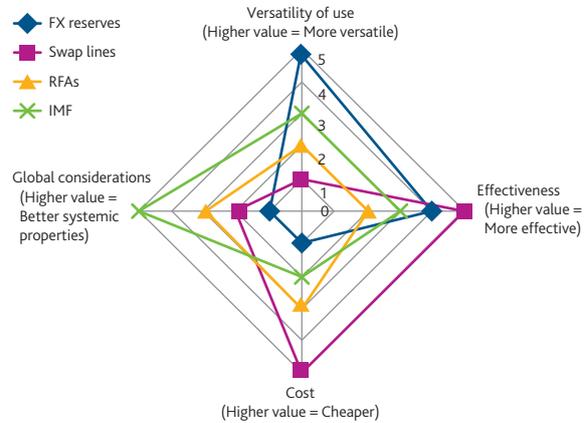
The aim of this paper is to scratch under the surface of the GFSN to consider the features, costs and benefits of each of its components and whether the overall size and distribution across countries and regions is likely to be sufficient for a plausible set of shocks.

2 Elements of the global financial safety net

In this section we discuss the official sector instruments of the global financial safety net in some detail; including how they have evolved and their key features. We evaluate them according to four broad criteria: versatility of use (how flexibly can liquidity be deployed); effectiveness (how powerful are they in addressing liquidity crises), cost and global

considerations. A stylised overview of our judgement is shown in **Chart 6**.

Chart 6 Stylised summary of the four key features of current GFSN tools(a)



(a) This provides an indicative illustration of the relative strengths and weaknesses of each of the tools in the GFSN. The assessment is based upon the current configuration and could change if the tools were used in a different way.

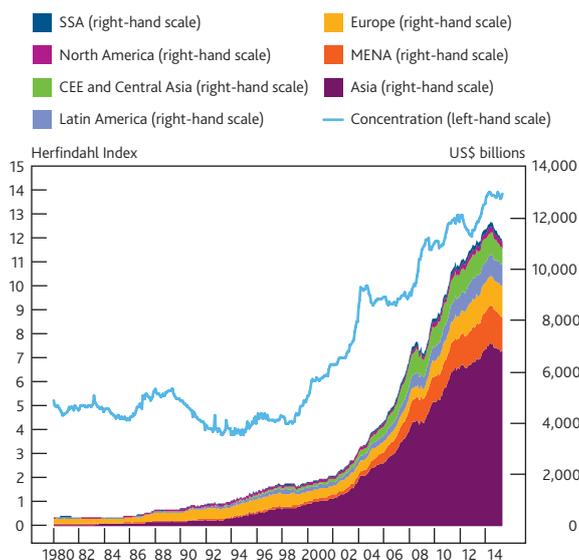
2.1 Self-insurance: foreign exchange reserves

For many countries, the first line of defence against an external liquidity shock is their FX reserves. Reserve balances have increased rapidly since the East Asian financial crisis in 1997. The severity of that crisis and the reliance on external official sector financing with its associated conditionality led many governments to increase their self-insurance. Countries may also accumulate FX reserves for other reasons, such as to maintain a fixed exchange rate or to distribute natural resource wealth across generations (Pineau *et al* (2006)). There is evidence that all of these motivations have contributed to FX reserve accumulation.⁽¹⁾

Rapid FX reserve accumulation has been particularly pronounced in Asia and the Middle East, led by China, Japan and Saudi Arabia. This is consistent with fixed exchange rate regimes, precautionary saving by Asian countries post 1997 and saving of wealth from — until very recently — high oil prices. The result has been an increasing concentration of FX reserve holdings, as measured by the Herfindahl index (**Chart 7**).

The majority of FX reserve assets are highly liquid securities. The IMF Balance of Payments Manual defines them as ‘external assets that are readily available to and controlled by monetary authorities for direct financing of payments imbalances, for indirectly regulating the magnitude of such imbalances through intervention in exchange markets to affect the currency exchange rate, and/or for other purposes’. Based on IMF COFER survey data (which covers about 50% of global FX reserves) the US dollar remains the dominant FX reserve currency, making up a steady 60% of allocated

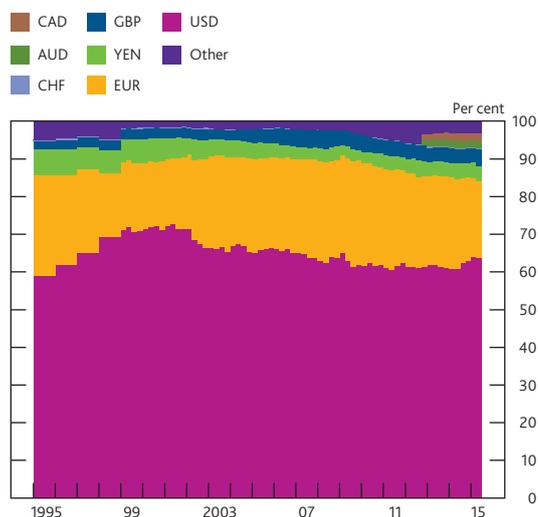
(1) See, for example, Aizenman and Lee (2005) or Jeanne and Ranciere (2011).

Chart 7 Regional distribution of FX reserves, 1980–2014^(a)

Sources: IMF *International Financial Statistics*, IMF *World Economic Outlook* and Bank calculations.

(a) The Herfindahl index is a measure of concentration defined as the sum of the squared shares of global holdings of FX reserves. A higher number means greater concentration.

reserves (**Chart 8**). There is some evidence of countries diversifying into other currencies, in particular into Australian and Canadian dollar assets although this has had a marginal effect on the overall currency distribution of FX reserves.

Chart 8 Currency composition of foreign exchange reserves, 1995–2015^{(a)(b)}

Sources: IMF COFER and Bank calculations.

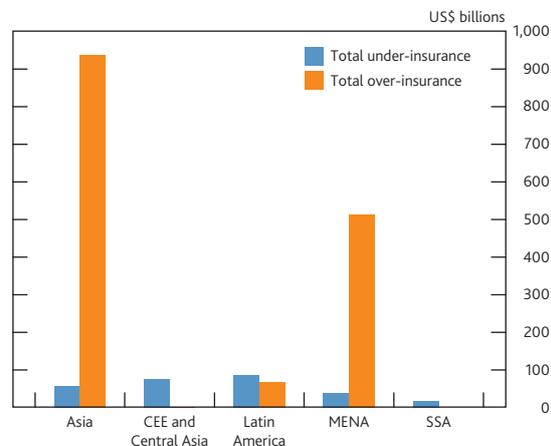
(a) COFER only covers between ½ and ¾ of reserves.
(b) Pre-1999 EUR is defined as the sum of French franc, Deutsche mark, ECU and Dutch guilder.

There are many ways to assess the adequacy of a country's accumulated FX reserves to cover precautionary demand. Reserves are compared to various metrics including three months of imports, 100% of short-term external debt plus the current account deficit (the so-called Greenspan-Guidotti rule) and 20% of broad money. The IMF uses a more comprehensive FX reserve adequacy metric

which combines several flow and external balance sheet risks: capital outflows from non-residents, capital outflows from residents and foreign currency shortfalls from reductions in export income.⁽¹⁾

Using the IMF metric as a benchmark, **Chart 9** shows the distribution of over and under-insurance across regions, calculated by summing the over or under-insurance of individual countries. The IMF recommends that countries hold 100%–150% of this metric. So over-insurance is measured in the chart as any FX reserve balance in excess of 150% of the IMF metric and under-insurance is any shortage of FX reserves below 100%.

In aggregate, FX reserves appear adequate. However, there is clear heterogeneity across regions: Asia and MENA appear, in aggregate, significantly over-insured and Central and Eastern Europe, Sub-Saharan Africa and Latin America appear, in aggregate, relatively under-insured. Mechanisms to redistribute FX reserves within regions would go some way to ensure all countries have access to sufficient FX reserves, but some redistribution between regions would be necessary for all countries to have access to adequate FX reserves on the IMF metric.

Chart 9 EME FX reserves: regional over and under-insurance, 2014^(a)

Sources: IMF *International Financial Statistics*, IMF *World Economic Outlook* and Bank calculations.

(a) Over-insurance (under-insurance): individual EMEs' reserves above 150% (below 100%) of the IMF reserve adequacy metric summed by region.

Key features of foreign exchange reserves

Versatility of use: A key feature of FX reserves is that the owner has full independence over their usage. Reserves can be used to dampen exchange rate volatility, to provide market-wide foreign currency lender of last resort (LOLR)

(1) This metric takes into account 'four components reflecting potential drains on the balance of payments: (i) export income to reflect the potential loss from a drop in external demand or a terms of trade shock; (ii) broad money to capture potential residents' capital flight through the liquidation of their highly liquid domestic assets; (iii) short-term debt to reflect debt rollover risks; and, (iv) other liabilities to reflect other portfolio outflows'. The weights assigned to each individual component in the case of fixed exchange rate regime (floating exchange rate regime) equal, respectively, 10 (5)%, 10 (5)%, 30 (30)%, 20 (15)%. The IMF shows this metric to be a better indicator of adequacy than the traditional metrics (IMF 2013a)).

facilities to domestic banks or corporates and to provide financing to governments facing short-term liquidity difficulties. Moreover, their availability is certain, they can be deployed almost immediately and their use is not subject to conditionality.

Effectiveness: Reserves can support a country's balance of payments position in two ways: (i) *ex ante* they signal that a country has sufficient liquid assets to be able to meet liquidity shocks reducing the probability of a sudden stop in capital flows (Krugman (1979)). The IMF shows that countries with sufficient FX reserves according to their reserve adequacy metric are significantly less likely to suffer a sudden stop (IMF (2013b)); and (ii) *ex post*, in the case of a stress event, they provide a first line of defence to cover foreign currency or balance of payments needs.

The evidence suggests, however, that not all FX reserves may in fact be used in a stress situation. Countries have been unwilling to allow their FX reserve balances to fall substantially in the event of a balance of payments need. Aizenman and Sun (2009) document that during the global financial crisis some countries exhibited a 'fear of losing international reserves'. Between July 2008 and February 2009, twelve of the largest EMEs experienced small or no reduction in FX reserves. The majority of EMEs were not willing to deplete their reserves by more than 25%. Assuming that this is the norm and that countries are also not willing to deplete reserves below the 100% of the aforementioned IMF metric, we estimate that only US\$1.6 trillion of EMEs' FX reserves are actually 'usable', less than one quarter of EMEs' US\$7.2 trillion total FX reserves. The recent concerns in financial markets about the reduction in China's FX reserves during the summer of 2015 (despite a very large stock) is further suggestive of the limits to using FX reserves.

Cost to the holder: Reserves are a costly source of liquidity insurance. To limit the impact of FX reserve accumulation on the domestic money supply, most central banks sterilise their intervention by draining liquidity from domestic financial markets through the issuance of central bank securities or by selling other liquid assets (eg Treasury bonds). The fiscal cost of FX reserve accumulation can be calculated as the difference between the interest paid on the sterilisation instrument and the interest received on FX reserve assets, which are typically low-yielding, low-risk foreign government bonds. The IMF estimated this wedge to be around 200 basis points on average (IMF (2011)). Reserve accumulation can also leave countries exposed to the risk of capital losses following exchange rate appreciations. Some have also argued that official FX reserves holdings take up an increasing amount of global safe assets which can give rise to distortions to market prices (eg Farhi, Gourinchas and Rey (2011)).

The cost of holding FX reserves can incentivise their usage. Unlike other forms of liquidity insurance, the use of FX reserves reduces the size of the FX reserve stock and so reduces the cost of holding them. However, this could be offset by future rebuilding of FX reserve stocks.

Global considerations: Excess FX reserve accumulation has been identified as one important factor that has contributed to global current account imbalances.⁽¹⁾ In the short term, when countries are in a liquidity trap, running current account surpluses to build up FX reserve balances can lead to low aggregate demand and lower output in other countries.⁽²⁾ As FX reserves are built up, excess demand for US treasuries compresses yields which may contribute to search for yield behaviour by investors.⁽³⁾ Moreover, there is some evidence that FX reserve accumulation can crowd out domestic investment as central bank sterilisation bonds compete for domestic savings.⁽⁴⁾

2.2 Bilateral insurance: central bank swap lines

Swap lines are contingent arrangements between central banks to enter into foreign exchange transactions. The liquidity-providing central bank provides its domestic currency for a fixed term at the market exchange rate, in exchange for the currency of the recipient central bank. On maturity, the transaction is unwound at the same exchange rate so, provided each party repays, neither party has direct exposure to exchange rate risk. The liquidity-providing central bank bears the credit risk of the borrowing central bank. In the event that the borrower is unable to repay, the lender is exposed to the exchange-rate risk on the currency taken.

Swap lines can also involve the liquidity provider lending to the borrowing central bank in a foreign currency. In this case, the liquidity providing central bank lends its FX reserves in return for the borrower's domestic currency, providing wider access to hard currency FX reserves.

Since the global financial crisis there has been a proliferation of swap lines. By October 2008, in response to the seizing up of global financial markets, the Federal Reserve (Fed) had extended swap lines to fourteen countries. Many of these have subsequently expired and not been replaced. The peak aggregate usage across all borrowers was US\$586 billion in December 2008.⁽⁵⁾ The Bank of England drew US\$95 billion from the Fed, which was on-lent to UK resident financial institutions. Other notable facilities were euro-denominated swaps by Sweden and Denmark to Latvia in December 2008, which they extended while simultaneously having swap

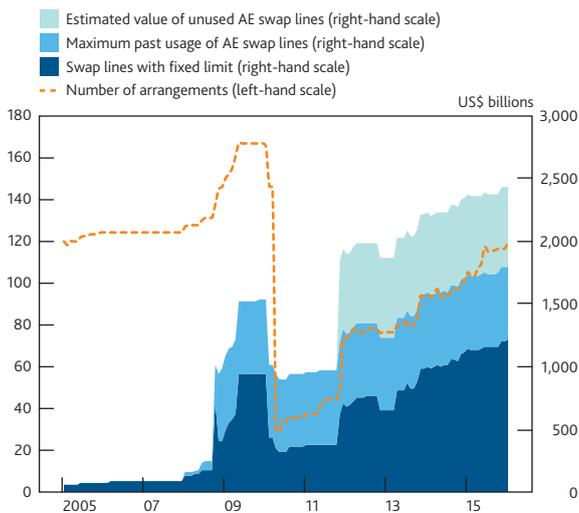
(1) Bernanke (2007). www.federalreserve.gov/newsevents/speech/bernanke20070911a.htm.

(2) See, for example, Blanchard and Milesi-Ferretti (2012).

(3) ECB (2006). www.ecb.europa.eu/pub/pdf/scpops/ecbocp43.pdf.

(4) Reinhart and Tashiro (2013).

(5) The main drawings at the time were from the ECB (US\$314 billion), the Bank of Japan (US\$128 billion) and Bank of England (US\$95 billion).

Chart 11 Estimated value of central bank swap lines^{(a)(b)}

Sources: Central bank websites and Bank calculations.

- (a) The value of the swap lines is equal to the sum of all bilateral swap line arrangements. The value of reciprocal (two-way) arrangements is counted twice (once for each currency provided). Maximum past drawings are calculated for swap lines in the AE central bank swap network; those which haven't been drawn have been estimated based on the average past drawings of those lines which have relative to their GDP.
- (b) The sharp fall in the number of swap lines is due to the multilateralisation of the Chiang Mai Initiative.

swap lines to three EMEs amounting to US\$85 billion and Sweden has a US\$500 million swap line with Ukraine. Currently the bulk of resources are among the six AE central banks (Chart 10c) although the PBOC has the most extensive network.

Key features of swap lines

For a central bank to be able to enter into a swap arrangement with another central bank, that facility needs to be consistent with the central bank's mandate. These mandates are typically focused on domestic monetary and financial stability.⁽¹⁾ Where swap lines are appropriate, they have been justified by the risk of disruption to financial stability with spillovers to the liquidity-providing central bank's economy and financial systems, including through disruption to key funding markets. An additional constraint is that many central banks' liquidity facilities are aimed at market-wide disruption rather than idiosyncratic problems at individual institutions. As such the scope of swap line liquidity provision is very narrow, and typically limited to facilitating market-wide liquidity provision to cross-border banks for the purposes of domestic financial stability.

Versatility of use: Access to swap line liquidity can never be fully guaranteed and available on demand since the liquidity-providing central bank needs to ensure consistency with its mandate and so has veto power over the issuance of its own currency. Swap line transactions also tend to be very short-term, with maturities up to three months, further limiting their use to short-term temporary FX liquidity problems.

Effectiveness: During the global financial crisis, swap lines appeared to have a strong signalling effect to markets.

Evidence from the timing of market price movements in late 2008 suggests that the US dollar swap line played a pivotal role in calming market concerns about a dollar shortage in South Korea (Aizenman (2010), Baba and Shim (2010) and Goldberg *et al* (2011)).

Cost to the borrower: Swap lines are the least expensive form of FX liquidity insurance for the borrower. The existing lines have no commitment costs. Some past Fed arrangements have charged a mark-up of 50 basis points over a benchmark interest rate.⁽²⁾ They are generally priced at a cost which is not attractive during normal periods, but is not prohibitively expensive during crisis periods. Although the Fed publishes their interest rates, borrowing costs are often not public.

Global considerations: Swap lines are not a substitute for IMF or RFA lending to fill balance of payments needs. And there is a risk of moral hazard as no conditionality is attached to borrowing. Central bank swaps are primarily used to allow central banks to provide foreign currency liquidity to their domestic banking systems. When the liquidity is used in this way, close ties with the banking supervisor and the features of normal market-wide lender of last resort facilities (financial sector regulation, pricing, haircuts and loan collateral) are used to reduce moral hazard.

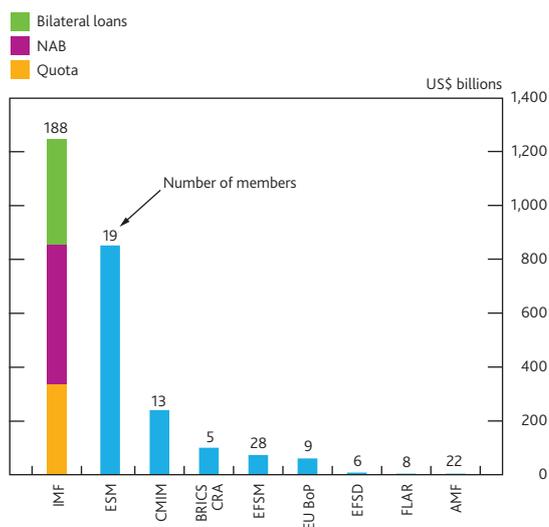
2.3 Regional insurance: regional financing arrangements

Triggered by painful financial crises and the stigma associated with IMF lending, regional financing arrangements (RFAs) have emerged as an important part of the GFSN. They are arrangements between groups of countries (usually, although not always, in the same region) to pool resources such that each member has access to more resources than it contributes. Most of them are set up to address foreign currency liquidity problems or balance of payments problems, for instance the Chiang Mai Initiative Multilateralization (CMIM). But some, notably the European Stability Mechanism (ESM), are designed for liquidity support in domestic currency.

There is no single model for an RFA and the existing RFAs are extremely heterogeneous (IMF (2013c)). Some, such as CMIM and the BRICS Contingent Reserve Arrangement (CRA) are built on a multilateral network of central bank swap lines, typically using members' FX reserves. Others, such as the ESM, are underpinned by sovereign balance sheets, with governments providing the full amount of funds themselves, or providing capital which is levered by the RFA through private sector borrowing. The ESM was developed as part of completing the euro area currency union and, as such, has quite different features to other RFAs.

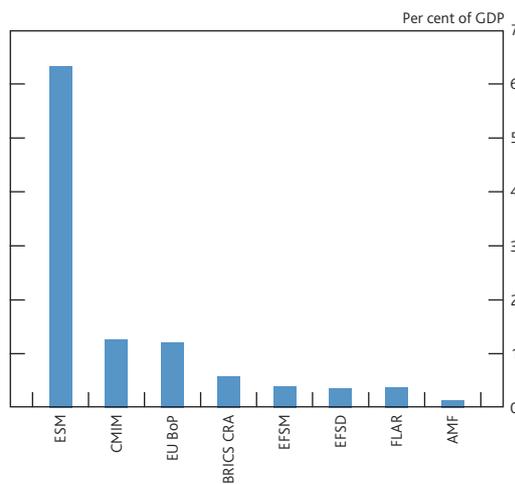
(1) Swap lines are generally, but not always, between central banks. For example, the Japanese US dollar swap lines use the government's FX reserves.

(2) www.federalreserve.gov/newsevents/press/monetary/20111130a.htm.

Chart 12 IMF and RFA resources, 2014^{(a)(b)}

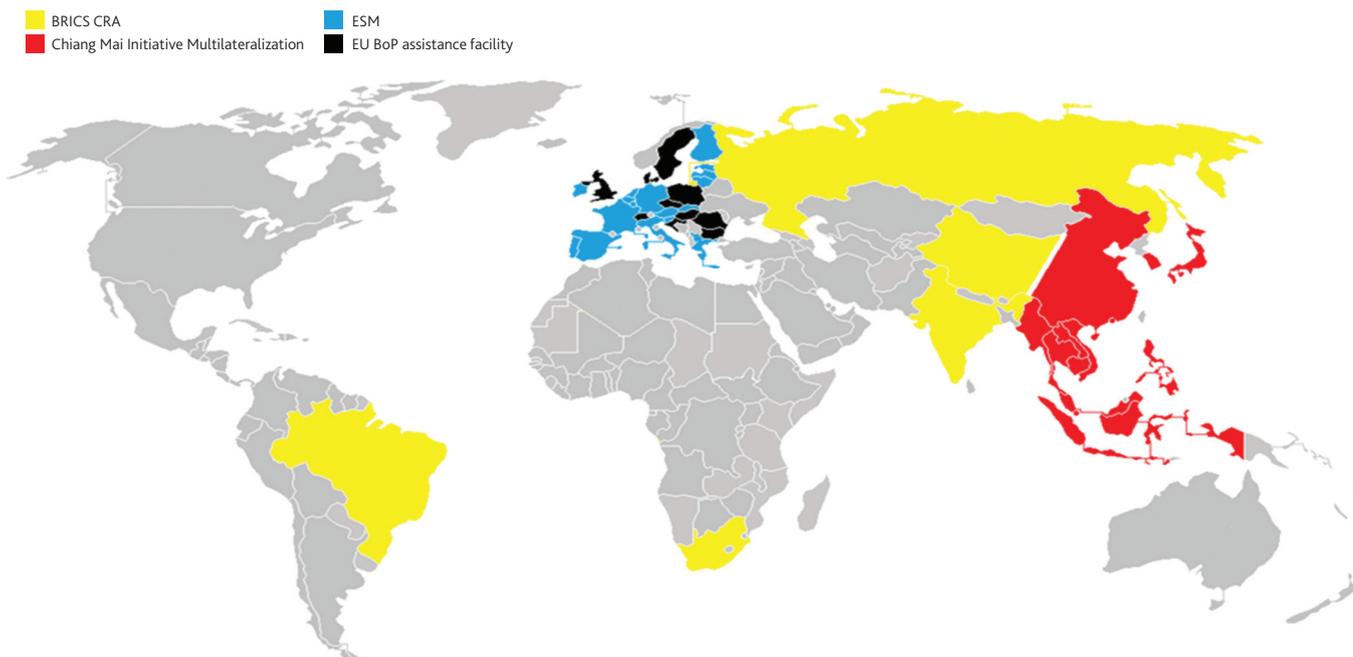
Sources: IMF *World Economic Outlook*, RFA websites and Bank calculations.

- (a) Based on total resources. These are not necessarily lendable resources.
 (b) The recent ratification of the IMF's 14th General Review of Quotas will see the IMF permanent resources double and the temporary resources fall by a similar amount.

Chart 13 RFA resources as percent of members' GDP, 2014^(a)

Sources: IMF *World Economic Outlook*, RFA websites and Bank calculations.

- (a) Based on total resources. These are not necessarily lendable resources.

Chart 14 Map of access to RFAs bigger than 0.5% of members' GDP, 2014

Sources: IMF *World Economic Outlook*, IMF (2013b), RFA websites and Bank calculations

In most RFAs the credit risk is shared across members. The exposure to uncollateralised credit risk has led many arrangements to require that countries take up an IMF programme before they can access the full amount promised under the arrangements. For example, under both the CMIM and the BRICS CRA only 30% of a country's total access can be disbursed without an IMF programme and the conditionality that comes with it.

RFAs provide for very heterogeneous coverage across countries. Taken together, the US\$1.3 trillion of committed RFA resources are very similar to those of the IMF (Chart 12).

Yet, RFA resources are unequally distributed. While the Eurozone countries have committed resources of over 6% of GDP, CMIM resources are worth 1.3% of members' GDP and the BRICS CRA resources are worth 0.6% of the BRICS' GDP (Chart 13). However, many EMEs do not have access to RFAs at all (Chart 14).

Key features of regional financing arrangements

Versatility of use: The versatility of RFAs varies by arrangement (see Table B for details of RFAs). The CMIM is built on a network of central bank swaps and partial drawing is permitted without oversight by other members. This suggests

Table B Summary of key regional financial arrangements, August 2015

RFA and year of establishment	Size (US\$ billions) and number of members	Funding source	Distribution	IMF involvement	Conditionality	Prior usage
ESM (2012)	785 total 560 lending capacity (19)	Member capital leveraged with capital market borrowing.	Loans, interventions in debt markets, precautionary assistance and loans to government for bank recapitalisations.	Expected but not necessary.	Yes.	Loans to Greece, Ireland, Portugal, Cyprus, Bank recapitalisation for Spain, Greece.
Chiang Mai Initiative Multilateralisation (CMIM) (2012)	240 (13)	FX reserves.	Central bank swaps. Precautionary lines possible.	If access >30% of maximum.	Yes, if access >30%.	–
BRICS Contingent Reserve Arrangement (CRA) (2014)	100 (5)	FX reserves.	Central bank swaps. Precautionary lines possible.	If access >30% of maximum.	Yes, if access >30%.	–
EU BoP assistance facility (established in its current form in 2002, predecessors in 1970)	56 (9)	Member capital leveraged with capital market borrowing.	Loans to non euro-area EU countries.	Not necessary, but post-2008 programmes jointly with IMF.	Yes.	Loans to Italy, Ireland, France and Greece in 1970–90s. Loans to Hungary, Latvia, Romania post-2008.
EU EFSM (2010)	54 (28)	Member capital leveraged with capital market borrowing.	Loans and precautionary financing to all EU countries. ^(a)	Yes.	Yes.	Contributed around one third to the recent Ireland and Portugal programmes and a bridge loan to Greece in mid-2015.
Eurasian Fund for Stabilisation and Development (EFSFD) (2009)	8.5 (6)	Fully paid by members.	Loans to member governments or for infrastructure projects.	–	Yes.	US\$3 billion loan to Belarus (2011), US\$70 million to Tajikistan (2010).
Arab Monetary Fund (AMF) (1976)	4 (22)	Member capital leveraged with capital market borrowing.	Seven facilities from short-term to seven years and for various purposes.	–	Yes, if loan >100% of paid-in capital.	Loans thirteen countries since 1978, most recently Egypt and Morocco drew both about US\$500 million.
Latin American Reserve Fund (FLAR) (1978)	6 (8)	Member capital leveraged with capital market borrowing.	Five loan types, including precautionary tools, up to three years. No conditionality in practice.	–	<i>Ex ante</i> for some loan types.	Six of its eight members drawn on the fund since 1978. Post-2008 Ecuador drew US\$2 billion.

Sources: Regional financial arrangement websites.

(a) Since the establishment of the ESM, euro-zone countries are expected to approach the ESM first, though 'there may be exceptional situations where practical, procedural or financial reasons call for use of the EFSM, generally before or alongside ESM financial assistance'. (Council Regulation (EU) 2015/1360). A case in point was the bridge loan for Greece in mid-2015.

that some of the CMIM's resources could be extremely versatile and accessible. However, the CMIM has never been drawn upon.

The ESM expects any euro area Member State requesting financial assistance '...to address, wherever possible, a similar request to the IMF'.⁽¹⁾ This may limit the versatility of financing to situations whereby *ex post* IMF lending is appropriate. The ESM offers precautionary lending facilities — the Precautionary Conditioned Credit Line (PCCL) and the Enhanced Conditions Credit Line (ECCL) — which are currently unused. Once a country has qualified, these are more flexible instruments which can be drawn at will.

Where RFA borrowing is conditional on an economic adjustment programme, there may be political difficulties associated with RFA members applying conditionality on neighbouring countries. Programme negotiation may therefore be rather complex which could reduce the flexibility and speed of access to RFA funds.

Effectiveness: There has been limited use of some RFAs to date which raises some questions about the robustness of the

arrangements. But in the euro area, the ESM (and its predecessor the EFSF) have been widely used with Cyprus, Greece, Ireland, Portugal and Spain having all received funds.

A significant limitation of RFAs is that shocks to members are likely to be correlated. If a country facing a crisis is unable to contribute resources, the RFA's lending capacity will fall at times when calls upon are likely to be high.

Cost to the borrower: RFAs that are built on FX reserves pooling can be significantly more cost-effective than FX reserves accumulation by individual countries. If shocks hit individual countries (but not entire regions), then a regional FX reserve pool works like an insurance mechanism: countries can access the FX reserves pool when necessary and hence need to accumulate fewer reserves themselves. This saves fiscal costs incurred through sterilisation.

Borrowing costs are often unspecified. The ESM pools the creditworthiness of the whole euro area, giving borrowers access to finance at rates significantly lower than they could

(1) esm.europa.eu/about/index.htm. The ESM is also able to grant precautionary credit lines which do not have a link to the IMF. These have yet to be used.

access independently. For example, the ESM charges its own borrowing costs, a charge to cover the cost of holding liquid assets, a (~50 basis points) service fee, plus a (10–35 basis points) margin that varies by type instrument.⁽¹⁾ For example, this meant that Spain and Cyprus were charged lending rates between 0.6% and 1.1% during 2014 for their ESM programme loans.⁽²⁾

Global considerations: RFAs can be a valuable source of additional financing in the case of idiosyncratic shocks and are a more efficient way of accessing insurance than relying heavily on FX reserve accumulation. But RFAs may be less suitable for dealing with region-wide or global economic shocks. There is a risk that the continued evolution of RFAs could be seen to undermine the case for a strong global financial backstop like the IMF. In reality, only a global institution has broad enough membership to effectively backstop countries in region-wide or global crises.

2.4 Multilateral insurance: IMF

The IMF has a mandate to ensure the effective operation of the international monetary system, encourage monetary cooperation and attempt to prevent economic crises through a system of surveillance and to resolve economic crises through lending to stricken countries. IMF resources play a vital backstop role to the GFSN, serving as the last line of defence when a country has a BoP or sovereign debt crisis. IMF resources are made up of four types of funds:

- **Quotas:** Quotas are the IMF's permanent resource base. Each IMF member contributes according to a formula based on their shares of GDP, FX reserves, economic openness and the variability of capital flows. Quota is fully paid-up, with 25% being paid in SDR or an SDR currency and the rest paid in the member's domestic currency.⁽³⁾ The total value of IMF quotas has recently doubled from SDR238 billion (US\$334 billion) to SDR477 billion (US\$671 billion) with the ratification of the 14th General Review of Quotas (GRQ).
- **GAB:** The General Arrangements to Borrow are a set of credit arrangements between eleven IMF members (plus Saudi Arabia who has an associated arrangement) that was established in 1962. In 1983, it was expanded to its current size of SDR17 billion (US\$24 billion).
- **NAB:** The New Arrangements to Borrow are a set of credit arrangements between 38 member countries which allows the IMF to temporarily increase its lending capacity without going through a full quota review. The NAB was originally set up in 1995, and was expanded to SDR370 billion (US\$520 billion) in 2009.⁽⁴⁾ These resources will fall to SDR182 billion (US\$256 billion) once the 14th GRQ quota increases are fully paid-in. The NAB is currently due to expire in 2017.

- **Bilateral loans:** Since October 2012, 35 IMF members have entered into bilateral lending arrangements with the IMF. 33 of these agreements are effective and currently provide the IMF with US\$380 billion.⁽⁵⁾ They were initially intended as temporary arrangements designed to give the Fund additional lending capacity during a period of heightened volatility. These arrangements are due to start expiring in late 2016.

Permanent IMF quotas have historically made up the vast majority of IMF resources, but the situation has significantly changed since the 2007–08 financial crisis. Until the ratification of the 14th GRQ, borrowed resources accounted for three quarters of total IMF resources, an unprecedented break from the IMF being an institution funded primarily by quotas. The 14th GRQ has delivered some rebalancing, with permanent resources rising to just over half of total resources. But even after this rebalancing the IMF will still be exceptionally reliant on temporary borrowing which may not be reliably available over the medium term. NAB activation can be blocked by members with only 15% of votes. And without renewal, the scheduled expiry of the NAB and bilateral loan agreements over the next two years would significantly reduce the IMF's lending capability (**Charts 15 and 16**).

Since 1980, IMF resources have fluctuated around 1% of global GDP. The sharp increase in temporary borrowing has taken Fund resources to about 1.7% of global GDP. A better indicator of the adequacy of IMF resources is the IMF's size relative to global external liabilities. These cross-border capital positions are a proxy for the risk that the IMF is designed to protect countries against. On this measure, despite a rise in recent years, the IMF has been on a downward trend since 1980. IMF resources are now equivalent to 1% of global external liabilities, down from 2.5% in 1980.

Key features of IMF lending

There are three broad types of IMF lending: *ex ante* precautionary lending facilities, *ex post* crisis lending and concessionary lending to low income countries. In this paper we focus on the first two.

Ex ante precautionary lending facilities, the Flexible Credit Line (FCL) and the Precautionary and Liquidity Line (PLL), are arrangements that provide qualifying countries access to a guaranteed credit line for a fixed commitment fee. The FCL, aimed at countries with very strong fundamentals, comes with no *ex post* conditions. The PLL, aimed at slightly weaker countries, comes with some *ex post* conditionality.

(1) See 'FAQ on the ESM'. www.esm.europa.eu/publications/index.htm.

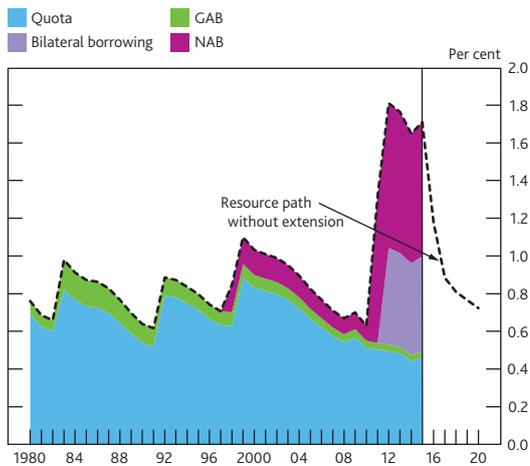
(2) ESM (2014).

(3) www.imf.org/external/np/exr/facts/quotas.htm.

(4) Although it didn't become effective until 2011. www.imf.org/external/np/exr/facts/gabnab.htm.

(5) www.imf.org/external/np/exr/facts/pdf/finfac.pdf.

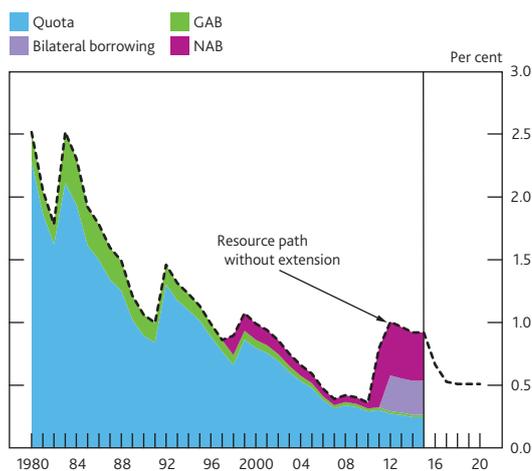
Chart 15 IMF resources as percentage of global GDP, 1980–2020^(a)



Sources: IMF *International Financial Statistics*, IMF *World Economic Outlook* and Bank calculations.

(a) Resource path without extension assumes all temporary resources roll-off at current expiry dates, with no further extension. The path includes the quota increase as a result of the ratification of the 14th GRQ.

Chart 16 IMF resources as percentage of global external liabilities, 1980–2020^(a)



Sources: IMF *International Financial Statistics*, updated and extended version of dataset constructed by Lane and Milesi-Ferretti (2007) and Bank calculations.

(a) Resource path without extension assumes all temporary resources roll-off at current expiry dates, with no further extension. Assumes constant global external liabilities. The path includes the quota increase as a result of the ratification of the 14th GRQ.

Ex post crisis lending is focussed on providing finance to countries who have lost market access, or who can only borrow on prohibitive terms. There are a range of instruments available. The most common type is a Stand-By Arrangement (SBA) which lends over 12–24 months with a repayment period of 3¼ to 5 years and comes with conditionality to address weaknesses in the borrowing economies fundamentals. Other facilities include the Extended Fund Facility, for longer-term funding difficulties and the Rapid Financing Instrument for very short-term emergency liquidity.

Versatility of use: The IMF lends directly to governments and is primarily used to finance external borrowing needs and debt repayments. IMF lending has a relatively long maturity, with

repayment over a 3¼ to 5 year time horizon, suggesting it is targeted at medium to long term financing needs.

Ex ante precautionary lending has limited conditionality so can be used much more freely by the borrower. Once a country has qualified and has paid its commitment fee, the funds are available to be drawn at any time. At this point they are certain, available at very short notice and can be used for any purpose.

Ex post crisis lending is less versatile due to the nature of the programme conditionality. Funding availability depends upon the borrower and the IMF coming to an agreement over lending terms. Monitoring by IMF country experts limits the freedom to use the funds. There can be delays both in countries approaching the IMF, due to stigma concerns, and then in programme negotiations.

Effectiveness: The IMF has played a key role in providing financing during many crisis events. The Fund's enduring role since its creation in 1945 suggests that it provides an important service to members. However, IMF programmes have not always been successful in balancing economic adjustments after a crisis with supporting a country resuming growth. As a result, some countries are very reluctant to borrow from it, limiting the Fund's effectiveness. For example, there are only three countries that have taken an FCL and two a PLL, despite many more potential qualifiers and evidence that access to an IMF precautionary facility promotes capital inflows and reduces sovereign spreads.⁽¹⁾ Moreover, many potential qualifiers have continued to increase their FX reserves, suggesting that there is demand for *ex ante* liquidity insurance, although not that provided by the IMF.

Cost to the borrower: For precautionary lending, the commitment fee is on a sliding scale up to 60 basis points. For IMF crisis lending the spreads above the weekly SDR rate are generally between 100 basis points and 300 basis points, depending upon the programme size and duration.

Global considerations: In theory, the IMF is the most effective risk sharing mechanism as it distributes the costs of crisis financing across all 188 member countries. However, stigma associated with IMF borrowing has limited the effectiveness of the Fund.

A too generous safety net provided by the IMF could create moral hazard for both private and public sectors, but the ability of the Fund to apply conditionality (either *ex ante* or *ex post*) significantly reduces this risk.

(1) www.imf.org/external/np/pp/eng/2014/012714.pdf.

Table C Summary of the key features of instruments in the global financial safety net

		FX reserves	Bilateral swap lines	RFAs	IMF
Features	Shock type	All types of shocks.	Short-term systemic banking sector liquidity shock.	Medium to long-term sovereign, balance of payments or banking shocks.	<i>Ex ante</i> precautionary lending: all types of shocks. <i>Ex post</i> crisis lending: all types except short-term banking liquidity shocks
	Size and distribution	Global FX reserves are US\$13.3 trillion (end-2014). Very unevenly distributed.	Potentially uncapped. Current swap lines are estimated to be worth about US\$2.4 trillion. Fixed-limit swap lines are worth US\$1.2 trillion. A rough estimate of the value of the AE network is also about US\$1.2 trillion. Limited countries.	RFAs have combined resources of US\$1 trillion. Resources are concentrated in certain regions.	Total IMF resources are US\$1.3 trillion, which (once the 14th GRQ is fully implemented) will consist of US\$668 billion of quota and US\$660 billion are temporary borrowed resources. Funds available to lend are lower due to precautionary balances and committed resources. Near universal coverage.
Borrower perspective	Speed	Immediately available.	Can be agreed and deployed quickly.	May get delayed due to regional politics.	<i>Ex ante</i> precautionary lending is immediate. <i>Ex post</i> crisis lending requires conditionality negotiation so can be slower. Stigma may delay borrowers from approaching the Fund.
	Duration of lending	No limit.	Short-term (normally up to 88 days).	Medium term.	Medium term (3¼–5 years).
	Certainty	Certain.	Uncertain.	Fairly certain, although resources may be constrained in a region-wide crisis.	<i>Ex ante</i> precautionary lending: fulfilment of criteria uncertain. <i>Ex post</i> crisis lending: almost certain.
	Stigma	None in accumulation. Some concerns about signals of large usage.	Minimal.	If using RFA sends a negative signal it may be stigmatised. May be stigma if the IMF is involved.	Yes.
	Cost	~200 basis points (EME average).	Some past examples: 50 basis points above reference rate.	Benchmark interest rate plus spread.	<i>Ex ante</i> precautionary lending: commitment fee of up to 60 basis points. <i>Ex post</i> crisis lending: 100 basis points above the weekly SDR interest rate plus a surcharge of 200 basis points on amounts above 300% of quota. Additional 100 basis points when outstanding credit is above 300% of quota for more than three years.
Lender/global perspective	Surveillance	None.	Central banks do not have comparative advantage in country risk assessment.	Increasing regional surveillance.	IMF carries out systematic surveillance, which is comparable across countries.
	Conditionality	None.	None, although there may be restrictions on use of currency.	Conditionality varies across RFAs. Risk that IMF and RFA disagree about appropriate conditions.	<i>Ex ante</i> precautionary lending has <i>ex ante</i> conditionality. <i>Ex post</i> crisis lending comes with strong, monitored set of conditions.
	Risk-sharing	No cross-country risk-sharing.	Bilateral risk-sharing.	Some cross-country risk-sharing.	Global risk-sharing.
	Global spillovers	FX accumulation may contribute to global imbalances.	Moral hazard risk limited due to limited availability.	Moral hazard risk limited due to limited availability and programme conditionality.	Moral hazard risk, although limited by programme conditionality.

3 Combining the elements of the global financial safety net

As Section 2 has shown, the global financial safety net is made of a range of different instruments with different features that are not fully substitutable. These features are summarised in **Table C**. For example, central bank swap lines are only appropriate to cover short-term foreign currency liquidity needs in the banking system, while IMF crisis financing tends to be used during balance of payments or sovereign debt crises.

FX reserves are an important first line of defence, but unless countries have very large buffers of FX reserves they may not be able to run them down too far without undermining market confidence. And the continual accumulation of FX reserves may have negative spillovers for the global economy. So, at some point, it may be optimal for countries to switch to relying on the multilateral elements of the GFSN.

For countries where gross capital inflows are a significant source of financing for the government or corporate sector, they may want access to an RFA or IMF precautionary facility. This would give assurance that the country has access to sufficient liquidity, at lower costs and with less global

spillovers than through additional accumulation of FX reserves. IMF and RFA precautionary facilities can substitute excess reserve accumulation.

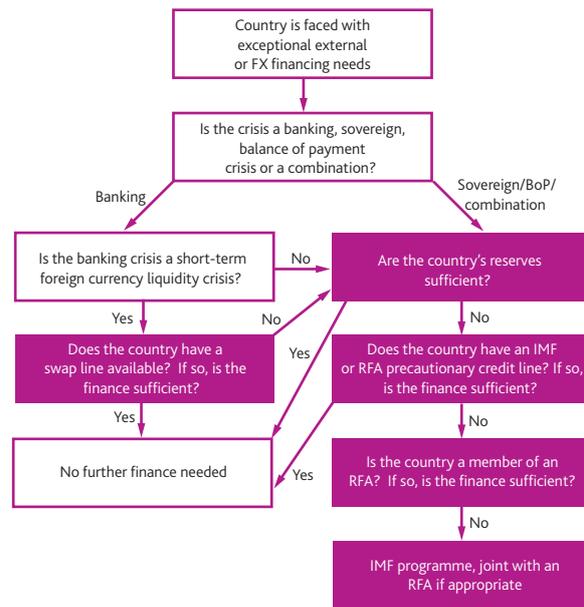
As a backstop behind precautionary facilities sit RFA and/or IMF financing programmes which come with appropriate conditionality. RFAs, however, may not be good substitutes for IMF resources. Economic shocks are often correlated within a region (eg the East Asian, Latin American, and euro-area crises). Were an RFA to substitute for the IMF it would need to ensure it had sufficient resources to be able to deal with a tail event affecting many of its members simultaneously. The IMF can effectively pool resources across regions and this means it needs fewer resources than an equivalent set of regional arrangements.

In general, multilateral facilities, such as RFAs and the IMF, pool risks and so enable a smaller pool of resources to serve as global insurance for a given amount of liquidity risk. This makes them more cost-effective for borrowers and reduces the potential impact of excessive domestic savings.

Where domestic banking systems have large foreign currency liabilities, authorities will want to ensure sufficient holdings of liquid foreign currency denominated assets by the banking system. If official sector FX liquidity is needed, swap lines can substitute for reserve accumulation by giving potential borrowers direct access to the desired currency from the issuing central bank. However, swap lines are less versatile than other forms of borrowing as they: (i) rely upon approval from the liquidity-providing central bank; and (ii) will generally only be available for market wide liquidity shocks and not idiosyncratic ones. This suggests it is important for countries with swap lines to consider a mix of liquidity insurance which would also include FX reserves. Pre-arranged precautionary facilities could also provide rapid liquidity. The use of RFA resources will depend on the nature of the RFA in question, with those being built on central bank swap lines likely to be better suited than others. Due to the time it takes to negotiate a conventional IMF programme, it is unlikely that this form of financing will be useful unless a short-term liquidity shock develops into a full blown banking sector crisis.

Figure 1 presents a stylised decision tree for the order in which elements of the GFSN could be used, depending upon the type of shock the country faces and the resources which are available. Our decision tree includes a scenario where a banking system foreign currency liquidity crisis is managed by central bank swap lines and FX reserves, and then by RFAs and the IMF. And a broader BoP and/or sovereign debt crisis is managed by FX reserves, RFA resources and the IMF.

Figure 1 Decision tree for use of GFSN instruments



4 The size of the global financial safety net

4.1 Scenarios for estimating calls on the GFSN

This section provides an assessment of the capacity of the current GFSN to deal with adverse tail risk events. It considers the scale of potential liquidity shocks, how many resources individual countries have access to and how those resources are distributed.

As shown earlier in **Chart 5**, the GFSN has evolved from one predominately made up of FX reserves with the IMF playing the role of the global backstop, to a more complicated mix of domestic FX reserves and various sources of external financing — bilateral swap facilities, RFAs and the IMF. The following analysis seeks to estimate whether these resources are likely to be sufficient and are distributed in line with the greatest potential liquidity needs.

We run a series of stresses to national balance sheets to calibrate indicative potential draws on the GFSN. We then consider the resources available to countries to fund these liquidity needs before aggregating to make an assessment of the GFSN as a whole. A summary of these stresses is shown in **Table D**. Box 1 outlines the methodology and results for calculating liquidity needs from an EME balance of payments shock. Box 2 outlines the methodology and results for calculating liquidity needs from AE banking sector foreign currency liquidity and sovereign debt shocks.

This type of exercise is only a partial equilibrium simulation. We do not take into account the reaction of other key variables such as country GDP and the feedback that this could have onto some of the variables of interest. Moreover, we treat countries independently and do not consider

Table D Summary of shock scenarios

	Balance of payments shock	Banking sector FX liquidity shock	Sovereign debt shock
Countries included in stress	48 EMEs.	25 BIS reporting AEs.	25 BIS reporting AEs, excluding AAA-rated and reserve currency issuing countries.
Nature of shock	Sudden stop in capital inflows partially offset by reaction of domestic investors: <ul style="list-style-type: none"> – Reduction of foreign capital inflows. – Reduction of current account deficit. – Reduction in domestic capital outflows. 	Market dysfunction in FX markets creating funding difficulty for resident banks.	Loss of market access combined with increased financing requirements. <ul style="list-style-type: none"> – Foreign investors unwilling to refinance maturing sovereign debt. – Increasing fiscal deficit.
Calibration and calculation of financing needs	Historical reaction of BoP variables during sudden stops. <ul style="list-style-type: none"> – Identify sudden stops based on Korinek and Mendoza (2013). – Take distribution of the two-year change of BoP flows during the sudden stop. – Use distribution to define baseline and severe shock. Apply to current balance sheet using BoP identity to calculate funding needs. 	Historical usage of swap lines in global financial crisis. <ul style="list-style-type: none"> – Calculate usage of Fed swap line in relation to the size of resident banking sectors' US dollar assets. – Use distribution to define baseline and severe shock. Apply to current foreign currency assets of resident banking sectors. 	Historical increases in fiscal deficits. <ul style="list-style-type: none"> – Use Laeven and Valencia (2012) database to identify sovereign debt crises. – Take distribution of changes to fiscal deficit during sovereign debt crises. – Use distribution to define baseline and severe shock. Apply to current fiscal deficits.
Sources of available financing	FX reserves. RFAs. IMF precautionary lending. IMF crisis programme.	Central bank swap lines. FX reserves. RFAs. IMF crisis programme.	FX reserves. RFAs. IMF crisis programme.
Range of financing needs	US\$432 billion — US\$1.3 trillion.	US\$569 billion — US\$1.5 trillion.	US\$1.4 trillion — US\$1.7 trillion.
Range of IMF funding needs	US\$255 billion — US\$878 billion.	US\$16 billion — US\$154 billion.	US\$886 billion — US\$1.1 trillion.

feedback loops and the impact which the announcement of a policy initiative (eg an IMF programme in response to a sudden stop crisis) could have on the financing needs of a country under stress. It is easy to imagine more complex scenarios where, for example, a balance of payments crisis evolves into a banking sector or a public debt crisis. Finally, we treat the three types of stress scenario as independent. While it is possible that each could occur independently, it is likely that there would be some connection between the different scenarios. For example, a major liquidity crisis in advanced economy banking sectors is likely to spillover to EME balance of payments through the impact of international capital flows. Thus, the findings from this paper should be treated as indicative rather than a fully comprehensive assessment of the official sector liquidity needs of potential borrowers.

4.2 Emerging market balance of payments shock

We simulate a balance of payments shock applied to 48 EMEs. Box 1 outlines the details of the methodology, the calibration of the shocks, the scenario and the results.

EME balance of payments shock

The EME stress consists of a reversal in portfolio and other investment gross capital inflows. Different scenarios consider the severity of that reversal and the potential offsetting reactions of domestic resident investors and the current account balance. Box 1 outlines the details of the calibration of that exercise, the scenarios and the results.

We undertake six stress scenarios calibrated on the distribution of changes in portfolio and other investment gross capital inflows during 40 historical sudden stop episodes. Three scenarios are based upon the median reversal in portfolio and other investment gross capital inflows and three are based upon the, more severe, 25th percentile.

For each stress severity, we consider three reactions by other types of capital flows: (i) no reaction; (ii) the current account deficit decreases while FDI inflows increase (which is consistent with historical experience); and (iii) as (ii) but in addition domestic residents reduce their gross capital outflows.

Faced with a potential financing need, we assume a country can first use a portion of its FX reserves. We allow a country to use any FX reserves it has in excess of 100% of the IMF reserve adequacy metric, subject to the stock not falling by more than 25%. If this is insufficient then the country can access the resources of an IMF precautionary facility, if it has one, and then of any RFA of which it is a member. If there is still a financing need the IMF can provide funds.

Below we summarise the key findings which are reported in Box 1, **Table 4**.

Baseline shock results: The baseline balance of payments shock sees foreign portfolio and other investment gross capital inflows reverse in the year of the shock and being close to zero the following year.

Box 1 Methodology for calculating EME liquidity needs from a balance of payment crisis

To calculate potential EME liquidity needs, our strategy involves three main steps:

- (i) First, we identify EME sudden stops between 1990–2012 and calculate the behaviour of the balance of payments variables during these episodes.
- (ii) Second, we apply a stress to EMEs' current external balance sheets. This uses the results of Step 1 to calibrate the reaction of balance of payments variables during a sudden stop scenario. From this we calculate a potential financing need.
- (iii) Finally, we consider the resources available to a country to meet this financing need and the potential impact on IMF and RFA resources.

Step 1: Calibration of balance of payments crisis

We build upon the methodology of Korinek and Mendoza (2013) to identify 40 sudden stop episodes over the period 1990–2012. In these episodes: (i) a country has a variation in portfolio and other investment gross inflows (as a percent of GDP) which is less than the country's full-period average variation minus 1.5 standard deviations; and (ii) the portfolio and other investment gross inflows turn negative either in that year, or the following one.

We then calculate the percentage changes in flows of each of the balance of payments components in the year of the stress (time, t) and the following year (time, $t+1$). For each variable we compute:

$$\left(\frac{X_t - X_{t-1}}{\text{abs}(X_{t-1})}\right) \text{ and } \left(\frac{X_{t+1} - X_t}{\text{abs}(X_t)}\right)$$

where X_t is the balance of payment flow in year t .

The median and the 25th percentile of these statistics are reported in the **Table 1**. These results show that in the median historical balance of payment crisis, portfolio and other gross inflows reduced by 139% in the year of the stress — there was both a sudden stop and foreign investors repatriate some of their assets. In the same year, the median current account deficit reduces by 23.8%.⁽¹⁾

Step 2: Calculating potential financing needs

We simulate a two year long sudden stop crisis for the 48 EMEs for which sufficient BoP data exists. We exclude any

Table 1 Percentage change in gross capital flows and the current account

	Median		25th percentile	
	$t-1$ to t	$t-1$ to $t+1$	$t-1$ to t	$t-1$ to $t+1$
FDI inflows	7.9	10.2	-17.6	-14.5
Portfolio and other inflows	-139.2	-97.6	-183.0	-143.1
FDI outflows	-23.8	-5.7	-64.0	-61.0
Portfolio outflows	37.2	-30.3	-63.6	-91.4
Other outflows	-54.7	-19.4	-154.0	-113.5
Current account balance	23.8	27.3	-22.8	-59.0

country which was undergoing a sudden stop in 2014, as their baseline flows are already stressed.⁽²⁾ We run a range of scenarios by progressively adding in assumptions about the reaction of other type of capital flows to the sudden stop in portfolio and other investment inflows.

The plausibility of combining different shock scenarios can be inferred from the (rank) correlation of the percentage changes of the sum of portfolio and other investment gross inflows with the percentage changes of the other components of the balance of payments identity. These correlations are shown in **Table 2**. The strongest (rank) correlation is with the current account balance.

Table 2 Correlation of changes in other balance of payments flows with changes in gross portfolio and other investment inflows

Correlation type	FDI inflows	FDI outflows	Portfolio investment outflows	Other investment outflows	Current account balance
Pearson (year t)	0.08	0.06	0.04	0.03	-0.01
Pearson (year $t+1$)	0.09	0.12	0.04	0.02	-0.29
Rank (year t)	-0.02	0.12	0.13	0.42	0.07
Rank (year $t+1$)	0.17	0.28	-0.05	0.04	-0.51

We run three shock scenarios calibrated using the variables in rows of **Table 1**, with two different shock severities.

- Scenario 1: Our baseline shock assumes there is a median sudden stop in portfolio and other capital inflows, but there is no reaction from other investors.
- Scenario 2: As scenario 1, but we assume that FDI inflows increase, consistent with the intuition that FDI investors tend to take a longer view of EME growth potential, and the current account deficit (surplus) reduces (increases).

(1) We use percentage change rather than percentage point change in the value as a percentage of GDP in order that our subsequent stress can vary with the size of inflows. Scaling everything by GDP results in a stress which depends upon a country's GDP but not on the type of capital inflows.

(2) In some simulations we lose a few countries because some data are still missing. Our simulations generally include 38 countries.

- Scenario 3: As scenario 2, but domestic residents reduce their gross investments abroad to offset some of the reduction in gross capital inflows.⁽¹⁾
- Scenarios 4, 5 and 6 are as above but with a more severe initial shock, calibrated on the 25th percentile of historical experience.

We use the April 2015 IMF *World Economic Outlook* figures for the 2014 balance of payments flows as our baseline. The exact calibration of the stress scenarios is outlined in **Table 3**.

Table 3 Shock scenario parameters, percentage change relative to flows in year $t-1$

	Year	Baseline shock			Severe shock		
		1	2	3	4	5	6
FDI inflows	t		7.9	7.9		7.9	7.9
	$t+1$		10.2	10.2		10.2	10.2
Portfolio inflows	t	-139.2	-139.2	-139.2	-183.0	-183.0	-183.0
	$t+1$	-97.6	-97.6	-97.6	-143.1	-143.1	-143.1
Other inflows	t	-139.2	-139.2	-139.2	-183.0	-183.0	-183.0
	$t+1$	-97.6	-97.6	-97.6	-143.1	-143.1	-143.1
Current account	t		23.8	23.8		23.8	23.8
	$t+1$		27.3	27.3		27.3	27.3
FDI outflows	t			-23.8			-23.8
	$t+1$			-5.7			-5.7
Portfolio outflows	t			37.2			37.2
	$t+1$			-30.3			-30.3
Other outflows	t			-54.7			-54.7
	$t+1$			-19.4			-19.4

Combining the reduction in gross portfolio and other investment gross inflows, with the adjustment of the other components of the balance of payment identity, we compute the implied variation of the country's FX reserves; in other words, the total financing need.

Step 3: Calculating potential financing sources

Once we have calculated the potential financing needs of a country in a sudden stop event, we consider the available resources. The first line of defence is a portion of the country's FX reserves. We calculate the IMF's reserve adequacy metric on the latest available data (2014 or earlier) and assume that usable FX reserves are any in excess of 100% of the metric, subject to the country not allowing their FX reserves to fall by more than a quarter.

If the country has an IMF precautionary facility we then allow it to draw on that. We then consider each country's RFA membership, and their borrowing limits. There are five RFAs which could provide financing to EMEs: the Chiang Mai Initiative Multilateralization, the BRICS Contingency Reserve Arrangement, the FLAR, the Arab Monetary Fund and the EU Balance of Payments facility.⁽²⁾

The final layer of resources in the GFSN is the IMF. We assess what happens if we cap any individual IMF programme to the largest programme seen so far (relative to quota). This was lending to Greece, which was equivalent to 3,212% of

quota.⁽³⁾ The potential financing needs in each of the scenarios and how these needs are met are outlined in **Table 4**.

Table 4 Financing needs and sources

\$US billions	1 2 3 4 5 6					
	Baseline shock			Severe shock		
Total financing need	850.0	583.3	432.2	1304.9	969.4	802.0
(Number of countries)	(35)	(32)	(27)	(36)	(34)	(32)
– Funded by reserves	215.5	160.7	131.9	332.0	225.9	210.0
(Number of countries)	(17)	(16)	(13)	(18)	(17)	(16)
External financing need	634.5	422.6	300.3	972.8	743.4	592.0
(Number of countries)	(30)	(25)	(21)	(32)	(30)	(28)
– Funded by RFAs	76.7	64.1	45.4	94.7	87.5	78.0
(Number of countries)	(18)	(13)	(11)	(20)	(19)	(17)
– Funded by IMF	557.8	358.5	254.9	878.1	655.9	514.0
(Number of countries)	(30)	(25)	(21)	(32)	(30)	(28)
Shortfall if IMF programme capped	46.1	16.9	8.4	102.4	66.1	53.5
(Number of countries)	(3)	(3)	(2)	(6)	(5)	(3)

When a country borrows from an RFA or the IMF it may no longer be in a position to contribute to that institution's resources. We assess the impact of our scenarios upon the IMF's financing in **Table 5**.

Table 5 Available IMF resources

\$US billions	1 2 3 4 5 6					
	Baseline shock			Severe shock		
IMF forward commitment capacity	419.3	419.3	419.3	419.3	419.3	419.3
Bilateral loans ^(a)	396.4	396.4	396.4	396.4	396.4	396.4
Impact on IMF quota	-15.2	-13.5	-7.7	-15.2	-15.2	-14.1
Impact on IMF NAB	-26.2	-25.7	-9.9	-26.2	-26.2	-25.7
Impact on bilateral loans	-20.2	-20.2	-14.6	-20.2	-20.2	-20.2
Already included in FCL/PLL	86.7	74.7	56.5	92.7	86.4	82.1
Total available IMF resources ^(b)	761.5	751.7	760.7	767.5	761.2	758.5
Potential calls on IMF	557.8	358.5	254.9	878.1	655.9	514.0

Sources: IMF (2015a) and Bank calculations.

(a) Only 80% of bilateral loans are available to lend due to IMF precautionary balances.

(b) Total available IMF resources were computed summing up the FCC, 80% of bilateral loans (to take away the prudential balances), the impact on IMF quota, the impact on IMF NAB, the impact on bilateral loans and by adding up resources already included in FCL/PLL.

As a robustness check, we run a simulation based on a reduction in capital flows relative to IMF forecasts for balance of payments variables. The results are largely consistent with these findings. The full results and methodology are reported in Annex A2.

- (1) In the year of the stress, portfolio flows abroad by domestic investors actually increase although this reverses in the following year.
- (2) As no EMEs are members, the ESM is not included. For the EU Balance of Payments facility there is no fixed value that a country can draw upon. We assume that a potential borrower can draw a value equal, as a percentage of GDP, to the average of the drawings to date.
- (3) The Greek programme was an exceptionally large programme relative to quota, so the real limit may be lower. We apply limits based upon the quota values before the ratification of the 14th GRQ. However, the doubling of quotas due to the ratification of the 14th GRQ would suggest that programme limits could double without changes to the exceptional access framework.

In the worst-case baseline scenario (where there is no reaction from other flows) total financing needs are US\$850 billion (Box 1, **Table 4**, column 1). Countries are able to meet about a quarter of this (US\$215 billion) by drawing upon their FX reserves. RFAs contribute a further US\$77 billion, leaving 30 countries which would need to go to the IMF. This overall funding shortfall is US\$558 billion. This could be met by current IMF resources, especially given that some of these potential calls come from countries which already have access to a precautionary line. However, this scenario would see three countries needing IMF programmes larger than that of Greece (relative to IMF quota). Capping the size of an individual programme to this level would result in a funding shortfall across affected countries of US\$46 billion.

Other scenarios imply partially offsetting current and capital account flows and so reduce the potential financing needs and calls on FX reserves, RFAs and the IMF.

Severe shock results: Compared to the baseline shock, the severe balance of payments shock sees a larger reversal in foreign portfolio and other investment gross capital inflows in the year of the shock which continues (albeit at a lower rate) into the following year.

The mildest of the severe shocks (which allows domestic residents to reduce their capital outflows) results in US\$802 billion in financing needs, US\$210 billion of which can be met by FX reserves, US\$78 billion by RFAs and the remaining US\$514 billion by the IMF (Box 1, **Table 4**, column 6). The IMF has sufficient resources to be able to meet these demands. However, this scenario would again see three countries needing IMF programmes larger than that of Greece (relative to IMF quota). Capping the size of an individual programme to this level would result in a funding shortfall across affected countries of US\$54 billion.

The most severe shock, where we assume there is no offsetting reaction by domestic residents or reduction in the current account deficit, results in potential financing needs increasing to over US\$1.3 trillion, with US\$878 billion of this falling upon the IMF (Box 1, **Table D**, column 4). In this scenario the potential calls on IMF resources would be greater than the IMF's total available resources. If we cap the IMF's contribution to any individual programme, the implied funding shortfall in this scenario is US\$102 billion and affects six countries.

Note that in our scenarios the Fund is called upon to make wide use of the exceptional access policy. This allows them to lend to countries beyond their standard access limits of 200% of the borrower's quota annually and 600% cumulatively (IMF (2015a)). If we fix a two-year cap to the IMF lending of 400% of quota and apply this to the 14th GRQ quota values, the funding shortfall increases substantially. In particular, in the worst case baseline scenario we have a funding shortfall of US\$239 billion affecting 15 countries; in

the most severe scenario it rises to US\$486 billion affecting 22 countries.

The assumptions we make about the willingness and ability of countries to use their FX reserves have a large impact on the estimates of external financing needs. If we replaced the condition setting a floor under FX reserve holdings based on the IMF's reserve adequacy metric with the a weaker condition based upon the traditional 100% of short-term external debt metric, this would reduce the demands on the IMF by up to US\$130 billion.

Main messages from the EME balance of payments shock

The scenarios which we have simulated for an EME balance of payment shock result in a wide range of potential financing needs which are met by a mix of FX reserves, RFAs and the IMF.

Despite the huge amount of FX reserves accumulated by EMEs in the past couple of decades, for many countries their reserve holdings would not be sufficient if they were faced with a sudden stop crisis. This comes partly from the distribution of reserves not corresponding precisely to the distribution of external balance sheet risks and partly from the observation that countries are generally unwilling to use all of their reserves for fear about sending negative signals to financial markets. Where self-insurance is insufficient, countries turn to external funding sources.

Regional financing arrangements are likely, at present, to provide a limited contribution to overall external financing needs of EMEs. Even in the worst case scenario, RFAs only provide US\$95 billion, less than 10% of total financing needs. This is because RFA membership is limited to a subset of countries, with some large EMEs not being members of any RFA. Moreover, the availability of RFA resources is largely concentrated in countries which either have no large potential financing needs or have sufficient FX reserves to be able to meet any need without external support.

For countries without access to an RFA, or where RFA financing would only partially meet their potential financing needs, the IMF can provide financing. Our scenarios show that the total resources currently available to the IMF are likely to be adequate to deal with a severe but plausible EME crisis. It is only in a scenario where EMEs simultaneously face a shock which is particularly severe relative to past experiences and domestic residents do not react by reducing domestic outflows that IMF resources look insufficient. However, many of the IMF's current resources are temporary, so this finding relies on the current level of resources being maintained in the future.

Finally, while IMF resources may be sufficient in aggregate for most potential calls upon them, individual countries may have

financing needs which are so large, relative to their IMF quota, that the IMF is unwilling to fully fund them. In such circumstances countries may have difficulty in meeting their balance of payments needs without more severe reductions in current account deficits through domestic economic contraction. This suggests there may be some significant holes in the global financial safety net which impact some large EMEs. In other words, the coverage of the GFSN is, in some places, patchy.

4.3 Advanced economy banking sector FX liquidity and sovereign debt shocks

To calculate the potential liquidity needs of AEs we consider two types of shock — one to the banking sector requiring foreign currency liquidity and one to sovereign debt which increases the size of the fiscal deficit and reduces sovereign access to financial markets. Box 2 outlines the details of the methodology, the calibration of shocks, the scenarios and the results.

Banking sector FX liquidity shock

The banking sector foreign currency liquidity shock is based upon disruption to AE banking sectors' funding of their foreign currency denominated assets. We calibrate the stress based upon the drawings of US dollars from central bank swap lines observed during the global financial crisis, relative to the borrowers' resident banking sectors' US dollar denominated liabilities. We assess four scenarios: a baseline and a severe shock applied to both US dollar assets only and all foreign currency assets. This gives us a range of potential foreign currency liquidity needs for advanced economy banking sectors.

The baseline shock applied only to the funding of US dollar assets results in US\$570 billion of liquidity needs, of which US\$414 billion could be met with existing swap lines, US\$139 billion by FX reserves with a small residual (US\$16 billion) falling on the IMF. Relaxing the FX reserve constraint would allow that funding need to be met domestically.

The severe shock applied to all foreign currency assets results in a total financing need of US\$1.5 trillion, of which about two thirds could be met by central bank swap lines, US\$386 billion by reserves and the remaining US\$154 billion by the IMF. In this hypothetical scenario, the majority of swap resources would be provided by the Fed, the ECB and, to a lesser degree, the Bank of England.

Even in the most severe case, no country would need to borrow more from the IMF than the Greek programme, relative to quota. However, the three implied IMF programmes would require use of the Fund's exceptional access policy. In the event that the Fund applied its standard access limits, but based on the increased quota values of the

14th GRQ, would see a shortfalls for three borrowers, totalling up to US\$77 billion, in the most severe case.

These results suggest swap line drawings which are of a similar order of magnitude as those in 2008/09. The US dollar assets scenarios result in lower US dollar swap drawings, despite the shock being applied to more countries. This reflects reductions in the size of US dollar balance sheets of non-US banking sectors. Application of the shock to all foreign currency denominated assets increases the potential swap drawings. The total size of swap drawings under all of our scenarios is below our estimates of the size of the AE swap network.

Sovereign debt shock

The sovereign debt shock is based on a global risk sentiment shock which has two impacts: (i) reduced willingness of foreign investors to rollover maturing debt and fund fiscal deficits; and (ii) a widening of the fiscal deficit, calibrated on historical experience. We assume that foreign investors are unwilling to continue to fund the borrowing government, that domestic investors are willing to rollover the maturing sovereign debt that they own and fund a portion of the fiscal deficit, but that domestic investors do not increase their share of sovereign debt holdings by substituting for foreign investors. We then assess two scenarios based on a baseline and severe widening of the fiscal deficit.

These scenarios result in very large potential financing needs. The baseline shock scenario creates a US\$1.4 trillion financing need for 14 sovereigns (US\$1.7 trillion in the severe stress). In four countries this financing need can be met entirely by running down some of their FX reserves. In the other ten countries, the FX reserves reduce the need for official sector finance but do not eliminate it.

All ten countries are a member of an RFA, so the remaining financing need is split between the RFA and the IMF. Many of the potential borrowers are members of the ESM. The current Forward Commitment Capacity of the ESM is US\$414 billion, well below the implied calls in this sovereign debt stress.⁽¹⁾ This puts additional burden on the IMF. Potential calls on the IMF are US\$886 billion in the median case (US\$1.1 trillion in the severe case).

In one case, the implied size of IMF programme would be larger than the Greek programme, relative to quota. This would require use of the Fund's exceptional access policy. In the event that the Fund applied its standard access limits, but based on the increased quota values of the 14th GRQ, there would be a shortfall for one borrower of US\$102 billion in the median stress case and US\$128 billion in the severe stress case.

(1) As of 19th August 2015. www.esm.europa.eu/assistance/FCC/index.htm.

Box 2

Methodology for calculating AE liquidity needs from banking sector and sovereign debt crises

To calculate the potential liquidity needs of AEs we consider two types of shock — one to the banking sector requiring foreign currency liquidity and one to sovereign debt which increases the size of the fiscal deficit and reduces sovereign access to financial markets.

Banking sector FX liquidity shock

As shown in **Chart 2**, international banks have rapidly increased their activity in foreign currencies over the past 20 years. When faced with foreign currency liquidity shortages during the global financial crisis, many central banks turned to FX swap lines to provide financing.

Since 2008 there has been an extensive programme of financial sector regulation. This has included increases in the amount and quality of banks' capital and the introduction of liquidity regulations which should make the banks' balance sheets less vulnerable to liquidity shocks, including in foreign currency.

Step 1: Calibration of banking sector FX liquidity shock

To calibrate the size of liquidity shocks we compared the amount of drawing on the Fed swap lines with the total US dollar assets of the borrowing country's resident banking sector from the BIS International Banking Statistics.⁽¹⁾ The choice of assets as opposed to liabilities reflects McGuire and Von Peter (2009) who show how banks fund foreign currency assets with a mix of direct foreign currency liabilities from deposits or interbank money markets and domestic currency liabilities which they covert in the cross-currency swap markets. Both of these funding sources are vulnerable to liquidity shocks so to gauge the overall scale of foreign currency liquidity needs you need to look at the assets which need funding, rather than exclusively at the foreign currency liabilities.

Table 1 shows the maximum drawings on Fed swap lines. The 25th percentile usage of US dollar swap lines was equivalent to 6.8% of US dollar assets of the borrowing central bank's resident banking sector. The median was equivalent to 9.3% of US dollar assets.

Step 2: Calculating potential financing needs

We apply the stress to the 25 BIS reporting AEs. We use the resident banking sector gross foreign currency assets in 2015 Q1 as our baseline and multiply this by the historical usage of swap lines relative to US dollar assets of the resident banking sector. This is a proxy for the amount of foreign currency

Table 1 Maximum usage of Federal Reserve swap facilities

Borrowing central bank	Maximum usage of swap line
Bank of England	95.0
Bank of Japan	127.6
Bank of Korea	16.4
Bank of Mexico	3.2
Danmarks Nationalbank	15.0
ECB	313.8
Norges Bank	9.0
Reserve Bank of Australia	26.7
Sveriges Riksbank	25.0
Swiss National Bank	31.1

Sources: Federal Reserve and Bank calculations.

liquidity a banking sector could need after it has met any liquidity needs out of its own stock of liquid foreign currency denominated liquid assets.

We assess four scenarios: a baseline and severe shock applied to both US dollar assets only and all foreign currency assets. This gives us a range of potential foreign currency liquidity needs for AE banking sectors.

Baseline shock: We calibrate the baseline shock based upon the 25th percentile of historical experience. The choice of 25th percentile as opposed median reflects the improvements to bank regulation that have occurred since 2008. For countries which drew on their US dollar swap line during the global financial crisis we apply a shock equal to their actual usage, relative to US dollar assets, scaled down by the ratio of the 25th percentile to the median.

Severe shock: We calibrate the severe shock based upon the median of historical experience. For countries which drew on their US dollar swap line during the global financial crisis we apply a shock equal to their actual usage, relative to US dollar assets.

Step 3: Calculating potential financing sources

Once we have calculated the potential FX liquidity needs of AE banking sectors we consider what tools authorities have to deal with them.

If a country has access to central bank swap lines, given this is a systemic event, we allow them to be used as the first line of defence to meet the potential foreign currency liquidity needs. Where these lines have no fixed limit we assume that the central bank is able to borrow sufficient funds to meet the rest of their liquidity needs.

(1) www.federalreserve.gov/newsevents/reform_swaplines.htm.

Table 2 Financing needs and sources

\$US billions

	US dollar assets		All FX assets	
	Baseline shock	Severe Shock	Baseline shock	Severe Shock
Total financing need	569.3	776.1	1,100.1	1,499.8
(Number of countries)	(22)	(22)	(25)	(25)
– Funded by swap lines	414.1	564.5	713.4	960.5
(Number of countries)	(17)	(17)	(21)	(21)
– Funded by reserves	139.3	171.3	302.4	385.6
(Number of countries)	(5)	(5)	(7)	(7)
– Funded by RFAs	0	0	0	0
(Number of countries)	(0)	(0)	(0)	(0)
– Funded by IMF	15.9	40.3	84.6	153.7
(Number of countries)	(1)	(2)	(3)	(3)
Shortfall if IMF programme capped	0	0	0	0
(Number of countries)	(0)	(0)	(0)	(0)

If a country doesn't currently have any swap arrangements, or the size of the line is insufficient, we allow countries to use 50% of their FX reserves as the next line of defence. This is higher than in the EME stress as markets do not typically judge the external stability of AEs with reference to their FX reserve stocks. Governments may want to keep some of their FX reserves to use in the event of another type of shock so we limit usage to 50% of its total reserve stock. If the country is a member of an RFA based on swap lines then we assume they will provide financing, up to stipulated limits. If there remains a financing need we assume that this is met by the IMF.

Sovereign debt shock

Advanced economies may also be vulnerable to a sovereign financing shock. We apply a global risk sentiment shock which has two impacts: (i) reduced willingness of foreign investors to rollover maturing debt and fund fiscal deficits; and (ii) a widening of the fiscal deficit, calibrated on historical experience. Sovereign debt stresses are more difficult to calibrate and, as such, this should be seen as more tentative than the other stress results.

Step 1: Calibration of sovereign debt shock

We identify historical events of sovereign debt crises and calculate the impact of these events on countries' fiscal positions. We use the Laeven and Valencia (2012) crisis database to date fiscal and sovereign debt restructuring events.⁽¹⁾ We calculate the percentage change in fiscal deficit in the year following the crisis date (time, t) and the following year, $t+1$. We then produce a distribution of the changes in fiscal deficits as a percentage of the initial fiscal deficit and calculate relevant percentiles which are shown in **Table 3**.

Step 2: Calculating potential financing needs

We consider the same set of 25 AEs as in the banking sector shock. However, we reduce this sample by excluding three reserve issuer countries (apart from the euro area) and

Table 3 Summary of percentage change in nominal fiscal balance during a sovereign debt crisis

	Median		25th percentile	
	$t-1$ to t	$t-1$ to $t+1$	$t-1$ to t	$t-1$ to $t+1$
Fiscal balance	30.1	10.6	-54.2	-93.4

Note: Positive number indicates an improvement in the fiscal balance.

countries which are currently AAA rated by all three major credit rating agencies. This leaves 14 AEs.

We apply a shock whereby countries lose access to *external* markets to finance their sovereign debt. This applies to both refinancing maturing debt and to the issuance of new debt to finance fiscal deficits. In effect we assume a rollover rate of 0% of external borrowing and of 100% on domestic borrowing and that domestic residents are willing to finance a proportion of the fiscal deficit, but foreign investors are not. We assume that domestic residents are not willing to fund the rollover of maturing sovereign debt previously held by foreign residents. We also assume no intervention by the domestic central bank to purchase the country's sovereign debt. We use the IMF's April 2015 Fiscal Monitor (IMF (2015b)) forecast for financing needs as our baseline and Arslanalp and Tsuda (2014, May 2015 data update) on the external share of countries' government financing at Q4 2014.⁽²⁾

For each of the 14 stressed countries we calculate the sovereign financing needs as the sum of the maturing sovereign debt in 2015 and 2016 and the fiscal deficit. The median historical impact of a sovereign shock was a reduction in the fiscal deficit (an increase in the fiscal balance) (**Table 3**). We make our median stress slightly more severe by assuming no change in the fiscal deficit from the year prior to the crisis. The severe stress sees an increase in the fiscal deficit, calibrated using the 25th percentile. We then multiply the total financing needs by the share of the outstanding debt stock held by foreign investors.

Step 3: Calculating potential financing sources

Faced with this financing gap, countries then have a range of resources which they can draw upon. Countries can draw first upon their stocks of FX reserves. As in the banking sector shock we assume that a country can draw reserves down by 50%. We do not assume that sovereign debts are necessarily denominated in foreign currency, but that the government could liquidate some of their foreign currency assets and use

(1) The majority of the crises in the Laeven and Valencia (2012) database occur in EME, so given the small sample size of AE specific sovereign debt shocks, we use all countries in the database to calibrate the size of the shock.

(2) Where data are not provided we use the WEO database for fiscal deficits and countries' debt management office statistics for the maturing sovereign debt in 2015 and 2016. Where data are not available we assume the country's external share of debt is equal to the average of all the countries in the Arslanalp and Tsuda (2014) sample.

the revenue to fund temporary government financing shortfalls.

If this is not sufficient and the country is a member of an RFA, then we assume the RFA and the IMF funds the remaining financing need by $\frac{2}{3}$ and $\frac{1}{3}$ respectively. Where the total call on the RFA exceeds its current financing capacity we cap the total RFA financing distributing across countries in proportion to their share of total financing needs.

An important caveat to this analysis is that under this type of scenario it is questionable whether the RFA would be able to raise sufficient private sector financing if a large number of its members were simultaneously seeking financing from it. Such a scenario, although very extreme, does show the limits of regional arrangements if faced with a region wide shock.

Given the severity of a sovereign debt shock impacting 14 AEs simultaneously, the IMF would have sufficient resources to be able to fund only the needs of the three largest countries simultaneously.

While we include FX reserves as a financing source, some countries may not consider using them to fund stressed government financing. In this case, either domestic investors (in particular banking sectors) would need to expand their lending to the government, or the additional financing gap would need to be met by the GFSN. In this case, the RFAs and the IMF would be even less likely to be able to meet the financing needs. Assuming no FX reserve usage would add a further US\$122 billion potential call on the IMF.

Main messages

The potential financing needs implied by the shocks to AEs are potentially large. The nature of AE balance sheets means that they are exposed to different types of risks than EMEs, and so may need a different composition of financial safety net.

Banking sector shocks can create very large financing needs. In these circumstances the network of AE central bank swap lines plays a very important role with the values of potential drawings implied by this analysis of the same order of magnitude as the actual drawings in 2008/09. The provision of liquidity is spread across central banks within the AE network. Were there to be tighter limits on the usage of the swap lines between AE central banks the potential financing shortfall could be large.

The programme of financial sector reform since 2009 has reduced the liquidity risk on banks' balance sheets, thus

Table 4 Financing needs and sources

US\$ billions	Median shock	Severe Shock
Total financing need	1,422.8	1,652.1
<i>(Number of countries)</i>	<i>(14)</i>	<i>(14)</i>
– Funded by reserves	122.4	122.4
<i>(Number of countries)</i>	<i>(14)</i>	<i>(14)</i>
– Funded by RFAs	414.0	414.0
<i>(Number of countries)</i>	<i>(10)</i>	<i>(10)</i>
– Funded by IMF	886.4	1,115.8
<i>(Number of countries)</i>	<i>(10)</i>	<i>(10)</i>
Shortfall if IMF programme capped	0.0	19.0
<i>(Number of countries)</i>	<i>(0)</i>	<i>(1)</i>

reducing the potential calls for FX liquidity insurance.

Comprehensive implementation of the Basel III agreements, including applying liquidity standards to foreign currency mismatches where appropriate should be the first line of defence for countries with banking systems which have large FX exposures.

For countries facing potential banking sector FX liquidity shocks but without access to central bank swap lines there may be a need to increase their access to liquidity either by increasing FX reserves, entering into an RFA which allows access to short-term liquidity or accessing an IMF precautionary programme which would allow rapid drawing of funds.

IMF resources would likely be sufficient to deal with most plausible residual banking sector liquidity needs. However, given the time necessary to negotiate an IMF programme, IMF programme lending may not be suitable for a very short-term banking liquidity shock.

AEs are also vulnerable to sovereign debt crises which have the potential to generate very large liquidity needs. As central bank swap lines would not be available to fund governments during a sovereign debt crisis, there is likely to be less external funding available. RFAs would likely be called on to play a much larger role than in other types of crises, particular within a currency union. But the risk of regionally correlated shocks is significant and could overwhelm the RFA's resources.

The IMF would have sufficient resources to deal with three large sovereign debt events. But were there to be a simultaneous shock in 14 AEs, the IMF would be unlikely to have sufficient resources.

However, these simulations are undertaken independently of the EME scenarios. In reality, a very severe AE stress would likely spillover to EMEs through both financial and trade channels. This could put further strain on the GFSN.

5 Conclusions and policy implications

The adequacy of the GFSN depends upon the size and coverage of resources, and also the features of the instruments and their reliability. We have shown that the four tools of the global financial safety net are not necessarily substitutes. They have very different characteristics regarding their versatility, effectiveness, cost and broader role in the international monetary and financial system. We have argued that while swap lines and RFAs can play an important role in the global financial safety net they are not a substitute for having a strong, well resourced, IMF at the centre of it.

We have also assessed the size and distribution of GFSN resources. Our main message is that, with the current temporary IMF resources in place, the GFSN appears capable of dealing with most severe, but plausible, crisis scenarios which could pose a threat to the international financial system. In particular, our simulations, which are based on parameters calibrated from a large set of sudden stop episodes, sovereign debt crises and the US dollar banking liquidity shortage recorded in 2008/09 suggest that the current GFSN could deal with systemic sudden stops affecting EMEs and liquidity shortages affecting AE banking systems. Only in very extreme and highly unlikely events (an extremely severe BoP shock hitting 36 EMEs simultaneously and including no offsetting domestic reaction and a sovereign debt crisis hitting a large number of AEs simultaneously), would the global financial safety be insufficient overall.

The one caveat to these results is that we have assessed the financing needs under each of these stress scenarios independently. It is likely that were one of the scenarios to materialise, there would be spillovers between advanced and emerging economies, or between banking and government sectors which could result in an outcome which has elements of each of the scenarios. In this case, financing needs could be larger than those simulated.

Our analysis has, however, also highlighted that the aggregation of global resources can mask vulnerabilities at the country, and even regional, level. In other words, while the current safety net might be big enough in aggregate, it may have some significant holes. Moreover, these holes appear across a range of emerging and advanced economies and across a number of regions around the world.

The scenarios described here suggest that the potential need for resources depends heavily upon the structure of a country's external balance sheet, the type and size of capital flows, the amount of foreign currency assets in the banking sector and the reliance of cross-border funding of the government. It is likely that other factors, which we don't consider, such as monetary policy regime, the exchange rate regime, the capital account openness and in particular the

quality of domestic institutional arrangements, including for prudential supervision, are also likely to affect the behaviour of the main components of the balance of payments during a sudden stop scenario.⁽¹⁾

However, our analysis is performed on the *current* size of countries' external balance sheets and cross-border capital flows. It is likely that the global economy will become more financially integrated over time and potential calls on the GFSN will rise commensurately. Therefore, forward-looking policymakers should consider policy measures which (i) reduce vulnerabilities in external balance sheets which leave countries exposed to volatility in cross-border capital flows and increase potential demands on the safety net; (ii) secure the availability of appropriate GFSN resources, including the IMF's resource base; and (iii) make more efficient use of GFSN resources by ensuring the elements of the GFSN more effectively complement one another.

5.1 Strengthening external balance sheets to reduce the link between cross-border flows and the GFSN

The scenario analysis developed in this paper suggests a strong link between cross-border capital flows and potential calls upon the GFSN. There are many potential benefits from increased cross-border financial activity so the aim of risk reduction should be to promote safe types of finance and to put in place policies that prevent an excessive build-up of risk rather than aim at blanket reductions in cross-border flows. The financial reform programme that has been in train since 2008 has taken significant steps towards increasing the resilience of financial sectors, and so reducing the riskiness of cross border banking flows. But there are still areas where further improvements can be made.

Safer capital flows: Our analysis of the capital flow volatility during balance of payment crises has shown some types of flow to be less volatile than others. For example, FDI investors tend to take a longer term view of a country's growth potential than shorter term portfolio and banking investors. And within portfolio flows, there is a large literature on the advantages of equity flows rather than debt flows. Countries should particularly encourage FDI and portfolio equity flows since they are associated with lower probability of crises than debt flows (for a summary see Bank of England (2015)).

Develop local currency bond markets: Further promotion of local currency bond markets — a policy action which has frequently been mentioned in G20 communiqués — would serve to reduce the FX risk on national balance sheets.

(1) IMF (2013c) provided tentative evidence on this issue by partitioning 38 EMEs into 'resilient' and 'non-resilient' economies — where resilient economies are those that absorb swings in gross inflows more through changes in gross outflows and reserves than through the current account — and by trying to relate the resilience to variables such as the monetary policy regime, the exchange rate regime, the capital account openness, the institutional quality.

Although much progress has been made in developing local currency sovereign debt markets, corporate sectors in EMEs still issue significant amounts of debt in foreign currencies. A related policy action would be to support the development of derivative markets which allow firms to access instruments to hedge FX risk.

Macroprudential measures, capital flows and capital flow management: Macroprudential policies are typically applied to enhance the resilience of domestic banking sectors or to lean against the wind of the domestic credit cycle. Some financial stability risks come from financial flows which have cross-border implications, for example some foreign currency borrowing. Domestic authorities aim to reduce such vulnerabilities in national balance sheets through sound domestic prudential arrangements so as to reduce exposure to capital flow volatility and their reliance on the global financial safety net. In such cases the line between macroprudential measures and capital flow management measures can be blurred (Bruno *et al* (2015)).

Capital flow management measures (CFMs) have been the subject of international debate in recent years with the G20 agreeing 'Coherent Conclusions for the Management of the Capital Flows' and the IMF publishing its institutional view on the liberalisation and management of capital flows (IMF (2012)). But the interaction of macroprudential actions and CFMs has not been given sufficient attention. Clear guidance of what actions constitute macroprudential measures and what are, more contentious, measures aimed at affecting capital flows would enhance the clarity of national policy frameworks.

GDP-linked bonds for sovereigns: GDP-linked bonds have the feature that the principle and interest payments vary with a country's GDP. Countries that issued them would pay a small premium during years of strong GDP growth in order to have the insurance of additional fiscal space, which would help ensure debt sustainability, at times when a country's GDP is falling. The promotion and wider use of GDP-linked bonds could help reduce the probability of sovereign debt crises and the potential size of calls on the GFSN by reducing financing costs when a crisis did occur. Development of a GDP-linked bond market would have to overcome difficulties such as the accurate measurement of GDP, issuers accepting the potentially higher cost of issuance and the lack of liquidity in nascent secondary markets.

Sovereign debt resolution arrangements: The size of potential financing needs can be reduced if some losses are borne by private sector investors. Having arrangements for sovereign debt restructurings which are efficient, effective and designed to reduce delays and distribute losses with minimal risk of spillovers. The introduction of new style 'collective

action clauses' into many sovereign debt contracts is a welcome step.

5.2 Securing the availability of GFSN resources

For a given set of risks, countries need to be assured they have sufficient access to resources in the event of a risk crystallising. Our analysis has shown that for a number of countries this is unlikely to be the case and so policymakers may wish to take steps to increase their access to resources.

Reserve accumulation: There are a number of countries which, our analysis suggests, have inadequate stocks of self-insurance. EMEs and AEs may need access to FX reserves to smooth macroeconomic adjustment and excess market volatility in the event of balance of payments crises or sovereign debt crisis or to provide banking sectors with foreign currency denominated lender of last resort facilities. If bilateral or multilateral GFSN instruments do not keep pace with potential calls upon them, FX reserves accumulation might continue over the next years. But limits to their effectiveness mean that other tools will be needed.

Managing banking sector FX liquidity risk: Where banking sectors have substantial foreign currency liabilities, central banks should consider whether domestic regulation adequately mitigates FX liquidity risk and whether they have sufficient access to foreign currency liquidity to be able to provide lender of last resort facilities. If not, AEs should seek to strengthen their regulatory and supervisory frameworks and consider increasing their access to foreign currency liquidity.

IMF resources: Our analysis suggests that the overall size of IMF financing is likely to be broadly appropriate at present. But this relies upon the continued activation of the NAB and the bilateral borrowing. Both of these temporary facilities are due to expire in the coming years, reducing the IMF's resources below that which we assess necessary. The ratification of the 14th GRQ — and the increase in quota resources that results — is a significant step in the right direction. But the IMF is still reliant on temporary resources to be fully equipped with sufficient funds in the event of a very severe crisis. A short-term proposal would see IMF members committing to maintain the current resource levels. However, if bilateral loans are going to be extended and to represent a more permanent second line of defence, it may be appropriate to consider linking their provision more closely to IMF governance.

An alternative option would see the IMF borrowing funds on capital markets during periods of crisis, when there is heightened demand for IMF lending. This would allow the IMF's balance sheet to react flexibly to demands put upon it and result in an increase in the supply of safe assets at a time when there was increased demand from investors. The IMF's articles of agreement already allow this to happen with the

consent of the member whose currency the IMF wants to borrow. In practice this provision has never been used.

Looking forward, IMF resources may need to increase further to fill the increased need for insurance from larger financial flows.

5.3 More efficient use of the current GFSN resources: stitching together the GFSN

There may be limited scope for increasing resources in the GFSN so policymakers may consider how to make more efficient use of the current resources.

RFAs: RFAs which are built on pooling FX reserves and redistributing them through central bank swap lines or other mechanisms are a good example of elements of the GFSN working together to use the current stock of resources more efficiently. RFAs have the potential to grow, especially in regions that are net over-insured and could play an important part in keeping the GFSN adequate as cross-border financial flows grow. But for the benefits of this risk pooling to be fully realised, RFAs need to be usable and free of stigma. Where RFAs have yet to be drawn upon it would be sensible for members to consider ways to make them more attractive.

Interactions between the IMF and RFAs: In order to ensure complementarity of different elements of the GFSN, the RFAs and the IMF need to ensure that they are operating in ways which are compatible with one another. The G20's 2011 'Principles for Cooperation between the IMF and Regional Financing Arrangements' are a good start. The IMF and RFAs could take this co-operation further and consider arranging joint facilities to reduce the stigma associated with IMF lending and to reduce the risks to regional arrangements. They could also consider *ex ante* agreements on the order of financing and respective roles in surveillance and programme design.

IMF precautionary facilities: Precautionary lending is a more efficient way of providing liquidity support than *ex post* crisis lending. The existence of a precautionary line may reduce the probability of a crisis event. The arrangement signals to market participants that the IMF judges the country to have sound fundamentals and a policy track record. And it adds additional resources which could be used to smooth short term volatility. Pre-arranged financing ensures that funds are available immediately in the event of a liquidity stress, reducing the costs of programme delay. Immediate access means that precautionary lending can straddle the gap between central bank provision of short-term liquidity through swap lines and conventional *ex post* crisis lending by RFAs or the IMF. And a high bar for qualification acts as a form of *ex ante* conditionality, ensuring access is only given to countries with strong policy frameworks and so reducing the potential for moral hazard.

The IMF's FCL and PLL provide guaranteed access to foreign currency with no or very limited *ex post* conditionality. However, they have not been widely taken up due to stigma concerns. Countries with a shortage of liquidity insurance, or those which have sufficient reserves and were considering additional reserve accumulation, could consider access to IMF precautionary facilities.

There are various proposals for how to make the IMF's precautionary facilities more effective and to remove the stigma associated with requesting IMF support. One proposal is for the IMF to unilaterally offer liquidity lines to all qualifying countries in the event of a global liquidity crisis. It would provide countries with additional liquidity at times where they may face strains on their external balance sheets from sharp adjustments in capital flows. And it would go some way in addressing the issue of IMF stigma as groups of countries would be approached by the IMF rather than having to approach the Fund unilaterally.

Annex A1

Size of selected, currently active bilateral swap and repo lines

Table A1.1 Size of selected bilateral swap and repo lines, US\$ billion (per cent of borrower GDP)^(a)

Borrowing country	Lending central bank				
	Bank of England	Bank of Japan/Japanese Ministry of Finance	ECB	Federal Reserve	People's Bank of China
Australia					31 (2.1)
Brazil					30 (1.3)
Canada	Uncapped and undrawn.	Uncapped and undrawn.	Uncapped and undrawn.	Uncapped and undrawn. Additional US\$2 billion line available under NAFTA, which is undrawn.	
China	53 (0.5)		49 (0.5)		
Denmark			16 (4.4)		
Euro area	Uncapped and undrawn.	Uncapped and undrawn.		Uncapped. Max drawing: 314 (2.3)	55 (0.4)
Hong Kong					62 (21.3)
Hungary					2 (1.5)
India		50 (2.4) ^{(b)(c)(e)}			
Indonesia		23 (2.6) ^{(b)(c)(e)}			16 (1.8)
Japan	Uncapped and undrawn.		Uncapped and undrawn.	Uncapped. Max drawing: 128 (2.8)	
Korea					56 (4.0)
Mexico				3 (0.2)	
Philippines		12 (4.2) ^{(b)(c)(e)}			23 (8.1)
Poland			6 (2.0) ^(d)		
Singapore		3 (1.0) ^(e)			47 (15.3)
Sweden			13 (2.3)		
Switzerland	Uncapped and undrawn.	Uncapped and undrawn.	Uncapped and undrawn.	Uncapped. Max drawing: 31 (4.4)	23 (3.3)
Turkey					2 (0.3)
United Kingdom		Uncapped and undrawn.	Uncapped and undrawn.	Uncapped. Max drawing: 95 (3.2)	55 (1.9)
United States	Uncapped and undrawn.	Uncapped and undrawn.	Uncapped and undrawn.		

(a) All swap lines are by authorities in exchange for their domestic currency unless otherwise indicated. Figures reported are in US dollar equivalent, using the exchange rate on 7 Dec 2015. The values for the euro area, Japan, Switzerland and the United Kingdom refer to the maximum amount drawn in late 2008. The values for the remaining countries refer to the formal limit of the swap line. The figures include bilateral swaps lines that are separate from but under the framework of the Chiang Mai Initiative Multilateralization.

(b) Only 30% (20% for India and Korea) can be accessed independent of an IMF programme.

(c) Swap lines denominated in US dollars.

(d) Repo agreement (Source: IMF Article IV for Poland (2009)).

(e) Swap line currency is US dollars rather than Japanese Yen.

Annex A2

Robustness assessment of EME balance of payments shock

In this appendix we replicate the EME balance of payments shock outlined in Section 4 and Box 1 using a different calibration methodology. We use the same method based on Korinek and Mendoza (2012) to identify sudden stop episode. In Section 4 we used a calibration strategy focusing on percentage change of each balance of payments variable during the sudden stop episodes, we now shift our attention to percentage deviation from the IMF's *World Economic Outlook* forecasted values for balance of payments variables in the year prior to the shock.

For each country j experiencing a sudden stop at time t , we compute

$$\frac{X_{jt} - \hat{X}_{jt}}{\text{abs}(\hat{X}_{jt})} \text{ and } \frac{X_{j,t+1} - \hat{X}_{j,t+1}}{\text{abs}(\hat{X}_{j,t+1})}$$

where X_{jt} and $X_{j,t+1}$ are the historically recorded value of any balance of payment variable taken out of the *WEO* database published in the Spring of year $t+3$ while \hat{X}_{jt} and $\hat{X}_{j,t+1}$ are the IMF projections published in the Spring of year $t-1$.⁽¹⁾

The data regarding portfolio and other investment gross inflows reported in **Table A2.1** support our identification strategy. In the large majority of sudden stop episodes we identified, the portfolio and other investment gross inflows record a negative deviation from the IMF's forecasted values.

Table A2.1 Percentage difference between forecast and actual gross capital flows and the current account

	Median		25th percentile	
	$t-1$ to t	$t+1$	t	$t+1$
FDI Inflows	62.5	26.7	8.2	-47.9
Portfolio and Other Inflows	-132.3	-92.0	-235.8	-161.8
FDI Outflows	67.1	22.0	-29.5	-43.7
Portfolio Outflows	-22.8	-21.9	-94.1	-92.6
Other Outflows	100.7	-28.2	-40.1	-175.1
Current account balance	58.9	79.0	10.7	10.6

The (rank) correlations reported in **Table A2.2** suggest that it is reasonable to consider scenarios where a sudden stop is coupled with an unexpected improvement of the current account balance. In contrast, this evidence does not support a scenario where a sudden stop is associated with an unexpected decline of FDI gross inflows: the Pearson and rank correlations provide weak evidence that a sudden stop in portfolio and other gross inflows is consistent with a positive

Table A2.2 Correlation of changes in other balance of payments flows with changes in gross portfolio and other investment inflows

Correlation type	FDI inflows	FDI outflows	Portfolio investment outflows	Other investment outflows	Current account balance
Pearson (year t)	-0.11	-0.12	-0.14	0.01	-0.03
Pearson (year $t+1$)	-0.06	-0.44	-0.22	0.39	0.05
Rank (year t)	-0.15	-0.22	-0.16	0.27	0.03
Rank (year $t+1$)	0.01	0.07	0.11	0.14	-0.28

deviation of FDI inflows from projected values. There is some tentative evidence consistent with a retrenchment of other investment gross outflows during a sudden stop episode; but we do not assign a high credibility to these retrenchment scenarios because the number of observations of deviations of gross outflows from baseline projections is much lower.

We run a similar set of scenarios but based on this revised calibration. Our baseline scenario is the forecasted balance of payment variables for 2015 and 2016 from the IMF's Spring 2015 *World Economic Outlook*. **Table A2.3** reports the scenario calibrations we used in our robustness exercise. **Table A2.4** reports the financing needs and sources. **Table A2.5** reports the impact on IMF financing.

Table A2.3 Shock scenario parameters, percentage change relative to flows in year $t-1$

	Year	1	2	3	4	5	6
		Median shock			Severe shock		
FDI inflows	t		62.5	62.5		62.5	62.5
	$t+1$		26.7	26.7		26.7	26.7
Portfolio inflows	t	-132.3	-132.3	-132.3	-235.8	-235.8	-235.8
	$t+1$	-92.0	-92.0	-92.0	-161.8	-161.8	-161.8
Other inflows	t	-132.3	-132.3	-132.3	-235.8	-235.8	-235.8
	$t+1$	-91.2	-92.0	-92.0	-161.8	-161.8	-161.8
Current account	t		58.9	58.9		58.9	58.9
	$t+1$		79.0	79.0		79.0	79.0
FDI outflows	t			67.1			67.1
	$t+1$			22.0			22.0
Portfolio outflows	t			-22.8			-22.8
	$t+1$			-21.9			-21.9
Other outflows	t			100.7			100.7
	$t+1$			-28.2			-28.2

(1) We dropped out those country-year observations where projected and/or actual values are assigned a value equal to zero.

Table A2.4 Financing needs and sources

\$US billions						
	1	2	3	4	5	6
	Median shock			Severe shock		
Total financing need	775.5	263.4	360.8	1,432.9	683.7	845.1
<i>(Number of countries)</i>	<i>(31)</i>	<i>(15)</i>	<i>(15)</i>	<i>(34)</i>	<i>(22)</i>	<i>(26)</i>
– Funded by reserves	276.1	66.0	82.6	380.8	124.3	201.6
<i>(Number of countries)</i>	<i>(17)</i>	<i>(7)</i>	<i>(7)</i>	<i>(19)</i>	<i>(11)</i>	<i>(14)</i>
External financing need	501.4	197.4	278.1	1,052.1	559.4	643.5
<i>(Number of countries)</i>	<i>(25)</i>	<i>(14)</i>	<i>(14)</i>	<i>(29)</i>	<i>(19)</i>	<i>(20)</i>
– Funded by RFAs	60.0	44.2	44.8	114.6	50.5	51.1
<i>(Number of countries)</i>	<i>(14)</i>	<i>(11)</i>	<i>(11)</i>	<i>(19)</i>	<i>(12)</i>	<i>(12)</i>
– Funded by IMF	441.4	153.2	233.3	937.5	508.9	592.4
<i>(Number of countries)</i>	<i>(25)</i>	<i>(14)</i>	<i>(14)</i>	<i>(29)</i>	<i>(19)</i>	<i>(20)</i>
Shortfall if IMF programme capped	31.9	18.3	24	183.9	71.5	110.4
<i>(Number of countries)</i>	<i>(3)</i>	<i>(2)</i>	<i>(2)</i>	<i>(10)</i>	<i>(3)</i>	<i>(4)</i>

Table A2.5 Available IMF resources

\$US billions						
	1	2	3	4	5	6
	Median shock			Severe shock		
IMF forward commitment capacity	419.3	419.3	419.3	419.3	419.3	419.3
Bilateral loans	396.4	396.4	396.4	396.4	396.4	396.4
<i>Impact on IMF quota</i>	<i>-20.2</i>	<i>-8.8</i>	<i>-8.8</i>	<i>-21.2</i>	<i>-8.8</i>	<i>-8.8</i>
<i>Impact on IMF NAB</i>	<i>-13.9</i>	<i>-10.4</i>	<i>-10.4</i>	<i>-38.5</i>	<i>-10.4</i>	<i>-10.4</i>
<i>Impact on bilateral loans</i>	<i>-10.9</i>	<i>-10.6</i>	<i>-10.6</i>	<i>-28.2</i>	<i>-14.6</i>	<i>-14.6</i>
<i>Already included in FCL/PLL</i>	<i>85.5</i>	<i>6.1</i>	<i>17.2</i>	<i>98.2</i>	<i>61.5</i>	<i>66.7</i>
Total available IMF resources	776.9	712.7	723.8	746.7	764.1	769.3
Potential calls on IMF	441.4	153.2	233.3	937.5	508.9	592.4

The results of the simulations confirm most of the results reported in Section 4.

- The estimated total external financing needs are in the same order of magnitude as the estimates in Section 4.
- The total resources available to the IMF at present are likely to be adequate to deal with a severe but plausible EME sudden stop crisis. It is only in the severe shock where there is no offsetting domestic reaction that IMF resources look insufficient.
- Even if the total amount of resources available to the IMF are adequate to deal with sudden stop scenarios, if we fix a cap on the size of an IMF programme a shortfall of external funding arises for a small number of countries.

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