



## **ADB Working Paper Series**

### **Evaluating Asian Swap Arrangements**

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**Abstract**

Motivated by the unprecedented rise of swap agreements between the central banks of developed economies and their developing economy counterparts, this paper evaluates Asian swap arrangements and their association with the build-up of foreign reserves prior to the 2008–2009 global financial crisis. The evidence suggests that there is a limited scope for swaps to substitute for reserves. Furthermore, the selectivity of the swap lines indicates that only countries with significant trade and financial linkages can expect access to such ad hoc arrangements, on a case by case basis. Moral hazard concerns suggest that the applicability of these arrangements will remain limited. However, deepening swap agreements and regional reserve pooling arrangements may weaken the precautionary motive for reserve accumulation.

**JEL Classification:** F15, F31, F32

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## 1. INTRODUCTION

By any measure, developing Asia (hereafter Asia) has experienced an unprecedented build-up of foreign exchange (FX) reserves since the Asian financial crisis of 1997–1998. Asia's reserves have surged from US\$202 billion in 1990 to US\$3,371 billion in 2008. The growth rate has accelerated since 2000, with reserves growing on average by more than 20% per year.

The People's Republic of China (PRC) has played a significant role in the build-up, accounting for more than 50% of the growth between 1990 and 2008. However, the build-up is a region-wide phenomenon. The pattern is similar even if we account for the region's rapid economic growth—the region's reserves-to-GDP ratio tripled from 13.1% in 1990 to 40.2% in 2008.

The explosive growth of Asia's reserves is part of a broader trend of reserve build-up in developing countries. Developing countries' share of global reserves has risen from 28% to 65% between 1990 and 2008. In Asia's case, the reserve build-up has been largely driven by a sharp reversal of the current account position since the Asian financial crisis. While the region as a whole ran a small current account deficit prior to the crisis, it has run a sizable and persistent current account surplus thereafter. In some countries such as the PRC and the Republic of Korea (hereafter Korea), an important additional source of reserve growth has been net capital inflows. As of December 2009, no fewer than six Asian developing countries were among the world's ten largest holders of FX reserves: PRC; India; Taipei,China; Korea; Singapore; and Hong Kong, China. In addition, Malaysia, Thailand, Indonesia, the Philippines, Viet Nam, and Kazakhstan also have large and growing amounts of FX reserves.

Broadly speaking, there are two main explanations for the extraordinary growth of Asia's FX reserves in the post-crisis period: (i) precautionary self-insurance against financial crisis, and (ii) mercantilist export promotion. The Asian financial crisis had a devastating economic and social impact on Asia. Although five countries—Indonesia, Korea, Malaysia, Philippines, and Thailand—bore the brunt of the impact, the psychological impact of the crisis extended to the entire region. While there is a great deal of controversy about the causes of the crisis, what directly precipitated it was a shortage of international liquidity. Therefore, one plausible interpretation of Asia's reserve hoarding is that it is an attempt to build up an ample war chest of international liquidity to protect itself against a repeat of the Asian crisis. This type of demand for reserves is known as the precautionary or self-insurance demand for reserves.

The other main benefit of accumulating reserves is that it can improve external competitiveness and thus promote exports. This type of demand for reserves is known as the mercantilist demand for reserves. Aizenman and Lee (2007) provide a comprehensive discussion of both precautionary and mercantilist demand for reserves. Their study found that both motives were at play in the region's reserve build-up.

There is yet a third motive for holding reserves, which is related to the first two but somewhat different—exchange rate stability, as outlined by Calvo and Reinhart (2002). Exchange rate stability is often a key macroeconomic policy objective. In this case, rapid reserve growth may be the result of systematic foreign market interventions aimed at stabilizing the exchange rate.

The different motives behind Asia's reserve accumulation are not mutually exclusive from a theoretical point of view, and hence are very difficult to distinguish empirically. Indeed, efforts to empirically distinguish between the precautionary and mercantilist motives may ultimately be unproductive. It is precisely because a more competitive exchange rate allows a country to improve its current account position that it is able to build up the reserves required for precautionary purposes. From the perspective of the global reserve currency system, regardless of the relative importance of the different motives, the massive purchase of United States (US)

dollar-denominated reserve assets—i.e., US government and government sponsored enterprise securities—by Asian countries bolsters the status of the dollar as the world's dominant reserve currency.

The dollar standard or Bretton Woods II view of global imbalances (see Dooley, Folkerts-Landau, and Garber 2009) is closely tied to the mercantilist demand for reserves. According to this view, much of Asia has in effect reverted to tightly-managed, dollar-based exchange rate regimes. This came after a brief experimentation with more flexibility during the Asian crisis. The term Bretton Woods II draws an analogy between the exchange rate behavior of Asian countries since the Asian crisis and the Bretton Woods system of pegged but adjustable exchange rates in place between 1945 and the early 1970s.

The desirability of the fast accumulation of FX reserves in Asia remains debatable (see Cheung and Xingwang 2009). As noted above, holding reserves entails a number of potential benefits—precautionary self-insurance, export promotion, and exchange rate stability. At the same time, countries also incur substantial costs when they accumulate large amounts of reserves. These include inflationary pressures due to the expansion of the monetary base, fiscal costs which arise if the interest rate on sterilization bonds exceeds the interest rate earned on reserve assets, and potentially higher interest rates required to induce the public to hold ever-larger amounts of sterilization bonds. The presence of both costs and benefits implies an optimal reserve level, above which more reserves subtract from, rather than add to, national welfare. According to most conventional measures of reserve adequacy, the region now has reserves far in excess of all plausible estimates of what it needs. One such measure, the Greenspan-Guidotti rule, puts forward that a country has adequate reserves if its reserves exceed its short-term debt.<sup>1</sup> The underlying notion here is that a country which has reserves exceeding all external debt falling within one year should be able to service its most urgent external obligations, even during a financial crisis. At the end of 2008, all of Asia's top 10 reserve holders passed the Greenspan-Guidotti rule, some by a wide margin. Most other reserve adequacy measures also point to an abundance of reserves.<sup>2</sup>

The growing consensus that the region now has substantial amounts of surplus reserves has led to calls for managing such reserves more actively. In the period immediately preceding the global financial crisis, parking surplus reserves in safe and liquid but low-yielding US government securities was increasingly seen as a waste of valuable national resources. The creation of sovereign wealth funds (SWFs) such as the China Investment Corporation (CIC) and the Korea Investment Corporation (KIC) represents a policy response to growing popular

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<sup>1</sup> The focus on short term total external debt/international reserves makes sense if sudden crises have durations shorter than a year. However, severe cases like the global financial crisis of 2008–2009 may have lingering effects well beyond a year. Hence, prudent regulators may pay attention to the external debt maturity structure of a country, looking beyond the short-term debt/International reserve ratio. In the same vein, the regulator may pay attention to both the private and the public external debt maturity structure.

<sup>2</sup> Park and Estrada (2009) provide a comprehensive analysis of whether Asia's reserves have reached excessive levels. Obstfeld, Shambaugh, and Taylor (2009) find empirical support for a broader self-insurance view, where reserves provide a buffer against both deleveraging initiated by foreign parties and sudden demand of domestic residents for external assets, i.e., “sudden capital flight.” The high positive co-movement of international reserves and M2 is consistent with the view that the greatest capital-flight risks are posed by the most liquid assets, i.e., by the liquid liabilities of the banking system captured by M2.

pressure for using surplus reserves for active profit-seeking investment rather than passive liquidity management.<sup>3</sup>

In addition to the opportunity costs of foregoing more productive and profitable investment opportunities, the global financial crisis has exposed the risks of investing in industrialized countries. More specifically, the crisis, which originated in industrialized countries, tarnished their long-standing reputation for safe and efficient financial markets as well as sound financial regulation and macroeconomic policies. The upshot for Asia's reserve management is that holding massive amounts of reserves in the form of US government securities is not without risks, especially in light of the deterioration of public finances due to the current fiscal stimulus. A sustained depreciation of the US dollar and consequent valuation losses is another large potential cost confronting Asia's biggest reserve holders in the post-crisis period.

We have just seen that holding large amounts of reserves entails significant costs and risks for Asian countries. One way to reduce such costs is to use reserves more productively via sovereign funds and, more generally, by active reserve management. Although the global financial crisis has inflicted heavy losses on Asian sovereign funds and temporarily dampened their risk appetite, active reserve management provides an important channel for more productive use of reserves in the medium- and long-term. There are signs that the funds are returning to the financial markets, and there are indications that the PRC may inject up to US\$250 billion of fresh capital into CIC. Furthermore, if we view reserves as insurance against an unexpected shortage of international liquidity and financial crisis, pooling risks is more efficient than individual risk-bearing. That is, collective insurance is always less costly than self-insurance.

The seemingly irrational behavior of reserve hoarding can partly be explained by the region's loss of confidence in the International Monetary Fund (IMF) during the Asian financial crisis. In principle, the IMF pools the risks of all countries and thus offers the most efficient collective insurance. In practice, a region-wide perception that the IMF had mishandled the crisis, compounded by a broader region-wide perception that the IMF does not serve the interests of Asian countries, has eroded the region's confidence in the IMF. Regardless of validity, these perceptions have contributed to a marked preference for self-insurance over collective insurance.

The central objective of this paper is to explore one alternative mechanism for reducing the need for precautionary reserves, namely swap agreements or swap lines between central banks of developed economies and their developing economy counterparts. The global financial crisis has witnessed a proliferation of such agreements. Perhaps the most well-known example is the US\$30 billion swap lines between the US Federal Reserve (US Fed) and the central banks of Brazil, Korea, Mexico, and Singapore. These swap lines were opened in October 2008 during

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<sup>3</sup> Park (2007) provides a comprehensive analysis of the emergence of Asian SWFs.

the peak of the crisis.<sup>4</sup> In principle, swaps can either substitute for or complement reserves. To the extent that swaps provide the international liquidity needed during emergencies, central banks can cut back on their reserve holdings. On the other hand, only countries with large reserves may be able to secure swap agreements, and this may encourage countries to accumulate more reserves. In addition, large reserves and swap lines can jointly restore the confidence of financial markets in a country's liquidity and solvency. The broader issue of interest is whether swap lines can be a perceptible deterrent to the speed and scale of Asia's reserve accumulation.

An important integral part of Asia's swap agreements is the Chiang Mai Initiative (CMI), which encompasses a network of bilateral agreements between ASEAN+3 (consisting of the 10 ASEAN member countries, the PRC, Japan, and Korea). The unprecedented provision of US\$120 billion in swap lines to the four emerging markets<sup>5</sup> by the US Fed in October 2008 provided welcome relief and an important signal to the financial markets. Yet the exposure of US banks was the single most important criterion for extending swap-lines to the four countries (see Aizenman and Pasricha 2010). These ad hoc facilities would not suffice in protecting exposed countries from a crisis similar to Asia's in the absence of self-insurance. Furthermore, the selectivity of the swap lines suggests that only countries with a solid record of governance and significant trade and financial linkages can expect access to such ad hoc arrangements, on a case by case basis. Moral hazard concerns suggest that the applicability of these arrangements will remain limited.

Mitigating moral hazard should be the prime responsibility of international financial institutions, in particular the IMF. Due to the "cherry picking" nature of the swap lines between central banks, access to IMF lines of credit would remain a valuable option for many developing countries. However, this is an option that countries may choose to avoid by means of alternative insurance arrangements. Specifically, regions characterized by deepening trade and financial integration may consider cooperative regional arrangements, including regional swap lines and international reserves pooling agreements.

Asia is a good example of a region that stands to gain substantially from collective regional insurance. Intra-Asian trade has grown rapidly in recent years and this trend is likely to gather speed in light of the general weakness of industrialized countries and their consequent diminished appetite for imports. The prospective rebalancing of Asian countries toward domestic demand should also strengthen intra-regional trade, especially in final goods. The resulting shift of intra-Asian trade from parts and components to final goods will make trade among Asian economies less dependent upon final demand from outside the region. While intra-Asian financial integration lags far behind intra-Asian trade integration, we can expect financial links to

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<sup>4</sup> A swap line is a transaction where the supplying central bank (e.g., the US Fed), offers a credit line to a foreign central bank, say the Bank of Korea (BOK), for a pre-set duration. The US Fed- BOK swap provides the BOK with the option of borrowing up to US\$30 billion, at pre-set interest rate, for a pre-set time. The swap line augments the initial international reserves position of the BOK with the option to borrow international reserves. By exercising the swap line, the BOK may mitigate in the short-run dollar shortage propagated by delivering pressure induced by the global crisis. The swap line outsources the US Fed's dollar printing press capacity to the BOK, exposing the US Fed to the sovereign risk associated with lending dollar to foreign central banks. This exposure implies that the US Fed provides such swap lines on a case by case basis, for a pre-set duration.

<sup>5</sup> Brazil, Mexico, Singapore, and the Republic of Korea.



grow as the regional economies become financially more developed. A further impetus for intra-regional financial integration may come from heightened reluctance to invest in industrialized countries in the wake of the global crisis. Other characteristics of Asian countries which work in favor of swap arrangements and regional reserve pooling include high reserve-GDP ratios, high saving rates, and a lingering mistrust of the IMF.

## 2. SWAP LINES AND INTERNATIONAL RESERVES

Swap lines may act to stabilize market concerns about the risk of losing control due to deleveraging pressures, thereby preventing downward pressure on international reserves and the exchange rate, and substituting the need to hoard reserves. This possibly was the case of Korea, where the introduction of the US Fed swap line prevented a replay of the crisis dynamics of 1997 (see Park 2009). Access to swap lines would mitigate the need for Korea to hoard reserves to replace the US\$60 billion reserves it had used during the first phase of the crisis.

In the future, however, Korea may further accumulate reserves given the uncertainty regarding the duration of these swap lines, and lingering concerns that without them, reserves would be insufficient to prevent crisis dynamics. Therefore, perceptions about the duration of swap lines play a key role in determining the future path of reserves.

To the degree that regional arrangements like the CMI offer pooling schemes of indefinite duration, they may mitigate the urge to hoard reserves. Greater use of regional swap lines may also reduce excessive hoarding precipitated by the wish to signal that that country's reserves are above the average of its neighbors (the "keeping with the Joneses" motive, as discussed in Cheung and Qian 2009).

A related issue is the currency composition of swap lines. There is no reason why swap lines have to be denominated solely in US dollars. Just as countries typically hold reserves in different currencies, they could agree to help each other by providing a basket of currencies rather than a single currency. The denomination of swap lines in non-dollar currencies will speed up the diversification of reserves away from dollars. For example, euro-denominated swap lines will raise the demand for euro reserves for two reasons: first, swap lines are ultimately a mutual promise to provide liquidity support in case of emergencies, and second, that promise will not be credible in the absence of reserves.

For Asian countries, a more realistic scenario is the denomination of swap lines in the currency of a dominant regional economy such as the PRC, or even a real or notional Asian currency. Such development would further speed up the shift from dollar reserves and the emergence of an Asia-specific hard currency, much like the Europe-specific euro. In fact, the PRC's central bank has already entered into yuan-denominated swap agreements with its counterparts in Korea; Hong Kong, China; Malaysia; Belarus; Indonesia; and Argentina.<sup>6</sup> A number of other central banks have also expressed a willingness to enter into swap agreements with the PRC. The growing popularity of yuan swaps reflects the rapid emergence of the PRC as a globally

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<sup>6</sup> More specifically, the central banks of PRC and Korea signed a CNY180 billion currency swap framework agreement on 12 December 2008. In 2009, the People's Bank of China entered into a CNY200 billion swap with the Hong Kong Monetary Authority on 20 January; a CNY80 billion agreement with Malaysia's central bank on 8 February; a CNY20 billion deal with the National Bank of Belarus on 11 March; a CNY100 billion swap with the central bank of Indonesia on 24 March; and a CNY80 billion swap with the central bank of Argentina on 29 March. These swaps will allow the parties to avoid using dollars in trade.

significant trading power. Despite the PRC's financial underdevelopment and the yuan's restricted convertibility, growing trade with the PRC gives the yuan some intrinsic value.

There is also an intriguing possibility that broadening and deepening the CMI could result in a more permanent and institutionalized form of regional precautionary insurance against financial crisis. The CMI was announced by the finance ministers of ASEAN+3 in May 2000. In the wake of the Asian financial crisis of 1997–1998, the CMI was designed to address short-term liquidity problems and to supplement existing international financial arrangements in the event of a crisis. The initiative consisted of an expanded ASEAN Swap Arrangement (ASA) involving all ASEAN members, a network of bilateral swap agreements (BSAs) and repurchase facilities among ASEAN+3. By December 2008, the size of the BSA had increased to US\$84 billion (Table 1).

**Table 1:**  
**Swap Arrangements under the Chiang Mai Initiative (as of December 2008)**

<b>From</b>	<b>To</b>	<b>PRC</b>	<b>Japan</b>	<b>Republic of Korea</b>	<b>Indonesia</b>	<b>Malaysia</b>	<b>Philippines</b>	<b>Singapore</b>	<b>Thailand</b>	<b>Total</b>
PRC			3.0	4.0	4.0	1.5	2.0		2.0	16.5
Japan		3.0		13.0	6.0	1.0	6.0	3.0	6.0	38.0
Republic of Korea		4.0	8.0		2.0	1.5	2.0		1.0	18.5
Indonesia				2.0						2.0
Malaysia				1.5						1.5
Philippines			0.5	2.0						2.5
Singapore			1.0							1.0
Thailand			3.0	1.0					..	4.0
Cambodia										0.0
Lao PDR										0.0
Myanmar										0.0
Viet Nam										0.0
<b>Sub-total</b>		<b>7.0</b>	<b>15.5</b>	<b>23.5</b>	<b>12.0</b>	<b>4.0</b>	<b>10.0</b>	<b>3.0</b>	<b>9.0</b>	<b>84.0</b>
<b>ASEAN Swap Agreement (among the 10 ASEAN countries)</b>										<b>2.0</b>
<b>TOTAL</b>										<b>86.0</b>

Source: Elaborations based on Japan's Ministry of Finance website.

Available from: <http://www.mof.go.jp/english/index.htm>. Accessed: February 2009.

The leaders of ASEAN+3 decided to push for the multilateralization of the CMI in October 2008. Multilateralization means that funds available under the CMI would be under a self-managed reserve pooling arrangement, governed by a single contract, reducing waste and inefficiency. At the time, the countries also agreed that ASEAN's share of contribution in the total reserve pool would be 20%, while the combined share of the PRC, Korea, and Japan would be 80%. In February 2009, ASEAN+3 finance ministers agreed to expand the pool of foreign-currency reserves from US\$80 billion to US\$120 billion. The most substantive progress toward multilateralization took place in May 2009, when the finance ministers agreed upon the governing mechanisms and implementation plan for the CMI multilateralization (CMIM). The politically tricky issue of relative contributions among the big three powers was resolved, with

Japan and the PRC each contributing 32% and Korea contributing 16%. Other details such as voting rights, decision making rules, and operational issues such as activation of short-term liquidity in case of a sovereign financial emergency were also agreed upon.<sup>7</sup>

Especially significant was the agreement to establish an independent regional surveillance unit. This unit will monitor the region's economies and support CMIM decision-making. While the formal unit is being set up, the ASEAN Secretariat and ADB are working out an interim surveillance arrangement based on existing surveillance processes. The ASEAN+3 independent regional surveillance unit is intended to supplement rather than replace the IMF. It is primarily a mechanism for objective economic monitoring. Under the CMIM, a country can draw up to 20% of its quota without being subject to IMF conditionality, although the duration is restricted to a maximum of six months. Should a country avail itself of its full quota, 80% of the total amount disbursed would be tied to an IMF program. Once the regional surveillance unit becomes fully operational, the amount that member countries can withdraw without IMF conditionality could be increased. The collective CMIM agreement on the process of managing a regional pool of international reserves marks a major milestone in institutionalizing Asian regionalism.

### **3. THE IMPLICATIONS OF THE GLOBAL FINANCIAL CRISIS FOR THE DOLLAR STANDARD'S SUSTAINABILITY, AND ALTERNATIVE OPTIONS**

The global financial crisis, which originated in market failures in US housing and financial markets, brings into question the desirability and feasibility of pegging Asian currencies to the dollar as the keystone for the regional stability and future growth. The alleged gains from pegging to the dollar are debatable, and there is a scarcity of studies that test this hypothesis carefully against others. The instability of the dollar against the euro and other key currencies implies that pegging to the dollar would increase domestic currency volatility against the euro, pound, and other currencies. This effect may be sub-optimal for countries that trade heavily with the euro bloc and experience an increase in such trade over time. One way to deal with this issue is to evaluate what would have been the optimal weight of achieving real exchange stability against a basket of currencies that reflect the actual trading patterns of the region.

Recent studies dealing with the Trilemma (Aizenman, Chinn, and Ito 2010) are consistent with the notion that emerging market countries have moved towards the Trilemma middle ground, associated with greater exchange rate flexibility and limited but growing financial integration, buffered by sizable reserve holdings.<sup>8</sup> This has enabled them to retain a degree of monetary autonomy, even as financial integration has continued. Take the case of India and the PRC before the crisis, when both countries grew rapidly while maintaining controlled financial openness and limited exchange rate flexibility. During that time, the Chinese yuan appreciated significantly, without obvious downside effects. The onset of the crisis led to the renewed pegging of the yuan to the dollar, but it is not self-evident that returning to a rigid peg to the dollar is desirable and sustainable in the post-crisis period.

Applying data predating the crisis, Aizenman, Chinn, and Ito (2010) failed to find evidence that countries which pegged their currency to the dollar performed on average better than those that allowed controlled flexibility. During crises, many developing countries found that allowing the

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<sup>7</sup> For the full text of the agreement, please visit <http://www.asean.org/22536.htm>.

<sup>8</sup> Both trends are more pronounced for the emerging markets than for the non-emerging developing countries.

real exchange rate and monetary policy to initially take the brunt of the required adjustment facilitated the adjustment process. We will look at the recent history of the region to assess the potential gains from prolonging the dollar standard.

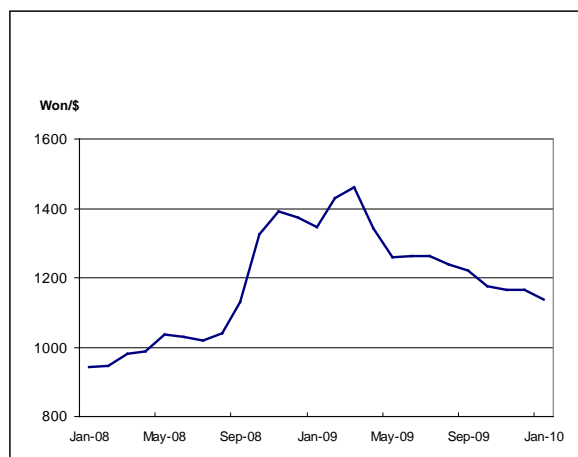
#### 4. THE REPUBLIC OF KOREA'S FINANCIAL TURMOIL IN THE SECOND HALF OF 2008: THE USE OF BOTH RESERVES AND SWAPS

During the second half of 2008, Korea used both FX reserves and swap lines to cope with turbulence in its FX and financial markets. The primary transmission channel which spread the global financial crisis to Asia was the collapse of trade and exports. By and large, Asian financial systems were relatively immune from the turbulence which afflicted their counterparts in the US and EU. However, in the case of Korea, the global crisis also had adverse effects on both the real economy and the financial system. During the course of 2008, Korea suffered an unusually high degree of financial instability relative to other countries in the region. This instability peaked in October 2008, when the Korean won teetered on the verge of collapse (Figure 1) and the stock market plunged by one third (Figure 2). There was even speculation of a repeat of the Asian financial crisis which had wrought havoc on the Korean economy.

The financial stress was puzzling in light of Korea's relatively strong macroeconomic fundamentals (e.g., GDP growth, current account balance and fiscal balance) and microeconomic fundamentals (e.g., balance sheets of financial institutions and corporations). Equally puzzling was the fact that the country's fundamentals were at least as strong as, and certainly not visibly worse than those of comparable countries such as the newly industrialized economies (NIEs)<sup>9</sup> or the ASEAN-4,<sup>10</sup> which were spared such financial turbulence. Furthermore, Korea was the world's sixth largest holder of FX reserves when it entered the crisis, and its reserve level comfortably passed conventional tests of reserve adequacy.

**Figure 1:**

**Korean Won per US dollar, January 2008–January 2010**

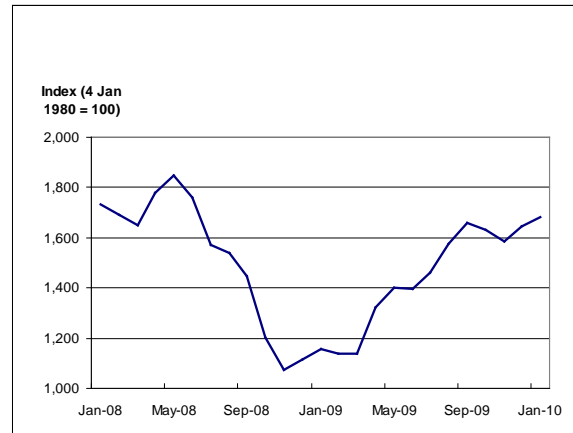


Source: International Financial Statistics (IMF) and authors' calculations.

<sup>9</sup> NIEs = Hong Kong, China; Republic of Korea; Singapore; and Taipei, China.

<sup>10</sup> ASEAN-4 = Indonesia, Malaysia, Philippines, and Thailand.

**Figure 2:**  
**KOSPI Monthly Average, January 2008–January 2010**

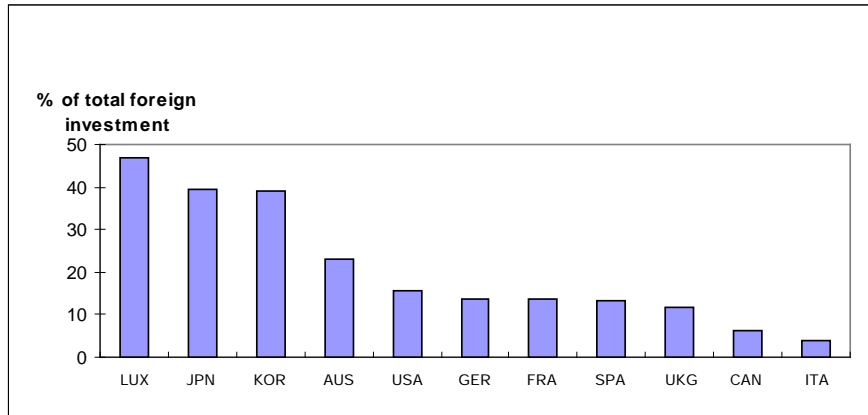


Source: International Financial Statistics (IMF) and authors' calculations.

The most likely answer to the puzzle lies in Korea's exceptionally high degree of capital account liberalization. For example, there are almost no restrictions on foreign residents' purchase and sale of domestic equities or domestic financial institutions' foreign borrowing. Growing financial integration kicked off by liberalization since the Asian financial crisis led to rapid increase in the share of foreign investments in the country's stock market capitalization, from less than 5% in 1992 to more than 35% by 2005. In addition, the share of equity investment in total foreign investment is third highest among 30 OECD economies, at 39.0% (Figure 3). The large exposure of Korean banks to short-term foreign loans arose from their taking counterparty positions to the purchases of forward exchange contracts by shipbuilders keen to hedge themselves against exchange rate risk. The rollover rate on those loans fell sharply as a result of the global credit crunch, and the resulting repayment pressures precipitated the freefall of the won in October 2008. As the global financial crisis intensified, hedge funds and other foreign residents withdrew from Korean equities in droves to reinforce their balance sheets back home. Total net sales of equities by foreign residents exceeded W43 trillion during 2008. Those sales were the main drivers of the year-long plunge of the equity market and also contributed to the won debacle in October.

The Korean experience should serve as a cautionary tale for other developing Asian countries about the substantial risks of capital account liberalization. Countries which are more open to cross-border capital flows will suffer disproportionately when foreign residents withdraw their funds from the local financial markets.

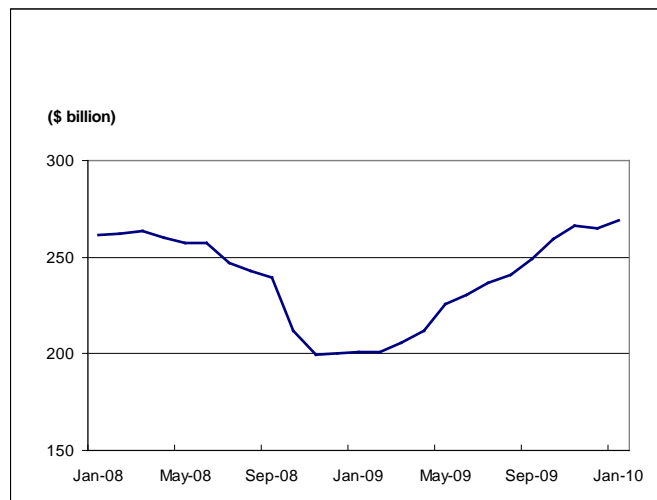
**Figure 3:**  
**Equity Investment as Share of Total Foreign Investment, Selected OECD Countries**



Source: Authors' calculations from national statistics.

The Korean government took a number of decisive policy actions to contain the financial turmoil. The Bank of Korea (BOK) spent around US\$60 billion trying to defend the won but without much success (Figure 4). There were some reservations about how the BOK handled its FX market intervention, especially in terms of clearly communicating its intentions to the financial markets. The upshot, however, is that even sustained and massive intervention failed to restore stability. The centerpiece of a bailout package the government finally unveiled in response to the mounting market pressure was a US\$100 billion, three-year government guarantee for banks' debt raised abroad before July 2009. This sum is more than sufficient to cover Korean banks' foreign debt maturing by June 2009, estimated by the Korean Ministry of Strategy and Finance to be about US\$80 billion. Yet, despite the large stockpile of FX reserves used to finance the bailout package, market pressures did not subside. The limited effectiveness of high reserves-to-GDP ratio in containing market pressures reflects Korea's vulnerability to balance sheet effects, due to its heavy short-term borrowing in foreign currencies as well as its vulnerability to massive deleveraging by foreign portfolio investors during the global crisis (see Aizenman 2009).

**Figure 4:**  
**Republic of Korea's FX reserves, January 2008–January 2010**



Source: Authors' calculations from national statistics.

Korea regained a measure of financial market stability only after the BOK entered into a US\$30 billion swap agreement with the US Fed. The BOK-Fed swap agreement came into effect on 30 October 2008 and was part of a network of US\$30 billion agreements that the US Fed simultaneously signed with the central banks of four emerging markets: Brazil, Korea, Mexico, and Singapore. The initial swap arrangement was in effect until April 2009 but has been twice extended since then, up to February 2010. The facilities were designed to support the provision of US dollar liquidity to fundamentally sound and well-managed emerging markets which faced the risk of US dollar funding shortage due to unfavorable global liquidity conditions. Korea made the swap deal as part of efforts to secure secondary support measures, not because of any shortage of reserves. Further bolstering market confidence were two additional swap agreements reached with the PRC and Japan in mid-December 2008, which expanded Korea's existing swap lines with the two countries to US\$30 billion each.

A simplified overall picture of the Korean experience is as follows: a country with an ample pool of reserves tries to defend its currency with massive but ineffective FX market intervention, and is ultimately rescued by swap agreements.

## **5. EMPIRICAL ANALYSIS OF SWAP LINES**

In this section, we report and discuss the results of our empirical analysis of swap lines. Our analysis is based on cross-country data. The swap lines since December 2007 to date involve 24 countries as shown in Table 2. Collectively, the economic size of the swap providers and recipients is equal to 85% of world GDP. In terms of the initial swap amounts, the US Fed has been the largest provider, extending 14 swap lines worth US\$755 billion in total. The People Bank of China (PBOC) has provided swap lines to six countries (CNY650 billion) and the European Central Bank (ECB) has committed four swap lines (€31.5 billion).

**Table 2:**

Initial swap lines provided by the US Federal Reserve (US\$ billion), the European Central Bank (€ billion), and the People Bank of China (CNY billion).

<u>Central Bank</u>	FED (US\$)	ECB (€)	PBC (CNY)
Argentina			70
Australia	30		
Brazil	30		
Belarus			20
Canada	30		
Denmark	15	15	
ECB	240		
Hong Kong, China			200
Hungary		5	
Iceland		1.5	
Indonesia			100
Japan	120		
Republic of Korea	30		180
Mexico	30		
Malaysia			80
Norway	15		
New Zealand	15		
Poland		10	
Sweden	30		
Singapore	30		
Switzerland	60		
United Kingdom	80		

Source: Federal Reserve Bank of New York and authors' calculations.

While the swap lines provided by the US Fed to the ECB, the Bank of Japan, and the Bank of England are by far the largest, many believe that the swap commitments among these central banks could be even larger. However, the claim that some of the swap lines are infinite or unlimited is probably overstating the evidence. The swap lines involved in the OECD countries are more elastic at the margin, but they are most likely not infinite.

To illustrate, the global swap size is constrained by a multiple of global GDP, but practicality suggests that they are elastic at the range that OECD countries will use them. Better institutional



quality means lower moral hazard, which should imply more elastic access to larger swap lines. This seems to be the case for the swap lines between the OECD countries.<sup>11</sup>

Figure 5 plots the extent and use of swap lines in the last two years. The earliest columns measure the size of the swap lines. The remaining columns correspond to the actual use of the swap lines (subject to data availability). The figure reveals that the usage of the US Fed's dollar swaps has been limited. Since the announcements of dollar swap liquidity,<sup>12</sup> the amounts outstanding have declined across the swap receivers. Canada, Brazil, Singapore, and New Zealand have never used the dollar swaps, and the total dollar swap liquidity extended had dropped to US\$57 billion as of 30 September 2009. These swap lines were originally authorized through 1 February 2010, but have recently been re-scheduled to 30 October 2010.

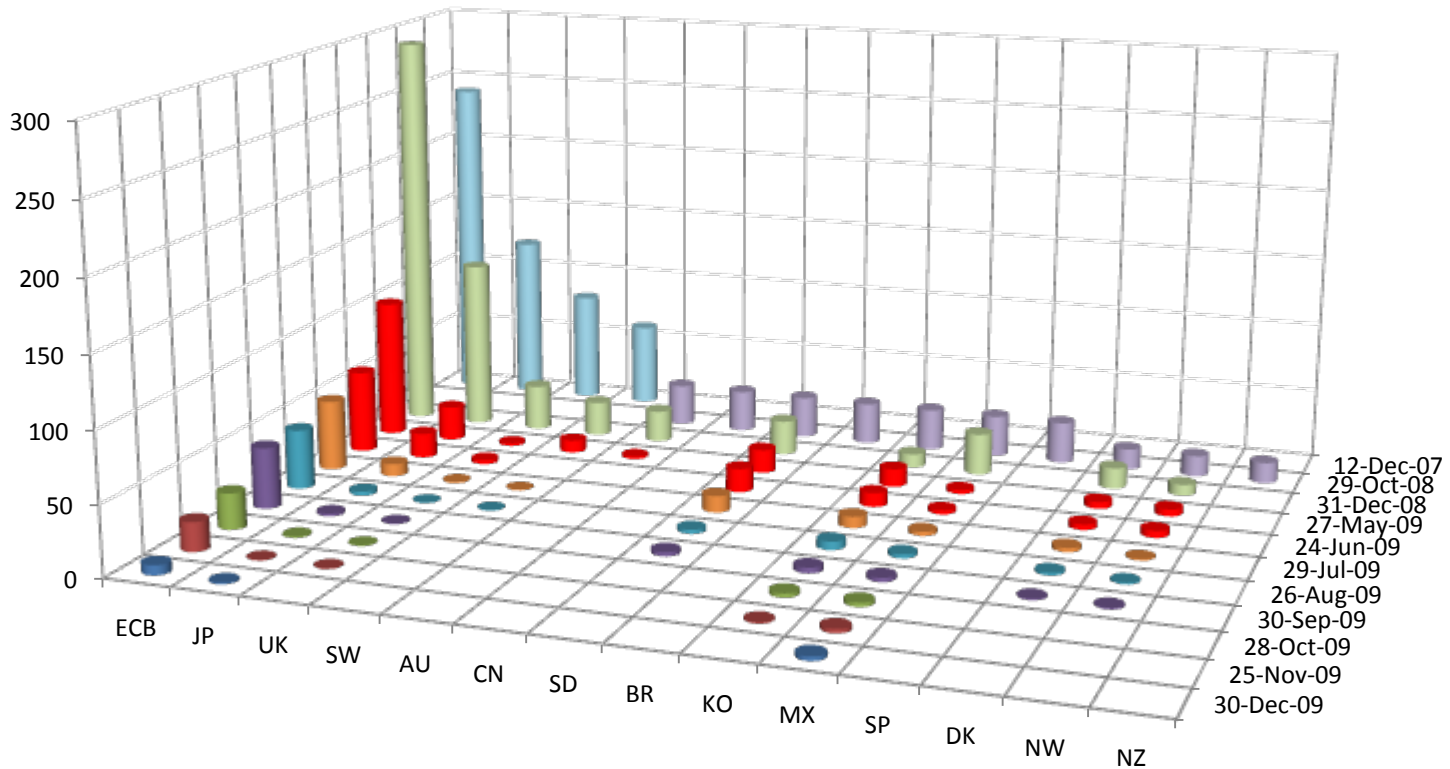
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<sup>11</sup> Swap lines resemble unsecured sovereign debt, and may be constrained by similar considerations. Hence, factors that explain better access to sovereign borrowing may also explain easier access to larger swap lines. These factors include low volatility, higher trade openness, credibility associated with history of low incidence of default and good growth prospects, quality of institutions, etc. All these factors play a role in explaining the differential patterns of access and the use of swap lines.

<sup>12</sup> Announced on 12 December 2007 for the ECB and the Swiss National Bank, and 29 October 2008 for the other central banks, except the Bank of England and the Bank of Japan, where the dollar swaps are implicitly always in place. The figure provides the amount of outstanding swap lines (in US\$ billions) between the US Fed and foreign central banks as reported in the Federal Reserve System Monthly Report on Credit and Liquidity Programs and the Balance Sheet.

**Figure 5:**

The amount of outstanding swap lines (US\$ billion) between the US Federal Reserve and foreign central banks as reported in the Federal Reserve System Monthly Report on Credit and Liquidity Programs and the Balance Sheet.



Notes: ECB: European Central Bank; JP: Japan; UK: United Kingdom; SW: Sweden; AU: Australia; CN: Canada; SD: Sweden; BR: Brazil; KO: Republic of Korea; MX: Mexico; SP: Singapore; DK: Denmark; NW: Norway; NZ: New Zealand.

The authorized dates of these dollar swap liquidity are 12 December 2007 for the ECB and the Swiss National Bank, and 29 October 2008 for the other central banks (except the Bank of England and the Bank of Japan, where the dollar swaps are implicitly always in place). The earliest columns measure the size of the swap lines.

Source: Federal Reserve Bank of New York and authors' calculation.

We first look at the percentage changes (%) of key variables from December 2007 to October 2009 between receivers and non-receivers of swap lines. Table 3 reports for 86 developing economies (of which eight are swap receivers),<sup>13</sup> the changes in foreign exchange reserves, nominal depreciation, short-term external debt, and export credits (standard errors in brackets). The data are taken from the Economist Intelligent Unit (EIU) database. Since the end of 2007, in percentage terms, the swap receivers on average accumulated larger foreign reserves, experienced more nominal depreciation, deleveraged bigger amounts of short-term debt, and witnessed more decline in export credits. The evidence of short-term debt and export credits

<sup>13</sup> The eight economies are Argentina; Brazil; Hong Kong, China; Hungary; Indonesia; Korea; Mexico; and Poland.

seems to suggest that the swap receivers are more exposed to the (lagged) effects of a general deterioration of conditions in global short-term funding markets.

**Table 3:**

Percentage changes of key variables from December 2007 to October 2009 between receivers and non-receivers of swap lines.

	<b>Swap Line(s)?</b>		
	<u>No</u>	<u>Yes</u>	<u>Difference</u>
<b><u>% Change: December 2007–October 2009</u></b>			
Foreign Reserves	5.620 [3.875]	14.846 [8.550]	-9.226 [9.387]
Nominal Depreciation	8.685 [2.044]	18.463 [4.083]	-9.778 [4.566]
Short-Term Debts	-7.768 [3.966]	-26.130 [6.269]	18.363 [7.418]
Export Credits	-2.711 [2.173]	-14.132 [7.688]	11.421 [7.989]

Notes: Standard deviations are in brackets. The sample includes 86 developing economies (of which 8 are swap receivers: Argentina; Brazil; Hong Kong, China; Hungary; Indonesia; Republic of Korea; Mexico; and Poland). The data are derived from the Economist Intelligent Unit (EIU)

Source: Authors' calculations.

Obstfeld, Shambaugh, and Taylor (2009) found that currencies of countries holding more reserves relative to M2 have tended to appreciate during the crisis, whereas those with smaller foreign reserves have tended to depreciate. They also argued that the dollar swaps to the emerging markets have been largely symbolic since Brazil, Korea, and Singapore already had foreign reserves more than predicted.<sup>14</sup> Our evidence in Table 3 suggests that, as a group, the emerging market swap recipients have experienced significantly larger nominal currency depreciation and reduction of short-term debt stocks. Given that most of the emerging markets' short-term external debt are foreign currency denominated, the swap liquidity might have been in place to backstop these emerging markets, substituting for a large hoarding of foreign exchange reserves in a short period of time.

Also noticeable is a decline in the export credits of developing countries. This probably reflects the effects of adverse global short-term credit market conditions on the real side of global economy, namely international trade in goods and services. The finance literature consistently highlights the importance of trade credits as a financing vehicle between the buyers and sellers, as well as a source of external finance along with bank loans.<sup>15</sup> For all the emerging markets, export credits account for 10% of the short-term external debt.<sup>16</sup>

We explore further the relationship between swap agreements and international trade for all possible countries. Table 4 reports a seemingly unrelated regression of swap amount (dependent variable) on the size of bilateral trade between the country of swap providers (the US Fed, the ECB, and the PBOC) and swap recipients (22 countries in Table 2) and non recipients (191 countries). The size of bilateral trade is the total sum from 2004 to 2008. The swap amount is in the currency of providers. The estimating equation is given by:

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<sup>14</sup> They predict the foreign reserves/GDP ratio as a function of financial openness, the exchange rate regime, monetary depth (M2/GDP ratio), a dummy for the advanced countries, and the ability to issue debt in one's own currency. From their estimates, however, Mexico and Hungary had fewer foreign reserves than predicted and their swap lines may have had a more substantive impact beyond mere signaling.

<sup>15</sup> See for example, Love, Preve, and Sarria-Allende (2007). In the context of international transactions, Jinjarak (2007) provided some evidence that lagged trade credits forecast import, but not vice versa.

<sup>16</sup> This ratio dropped from 26% in 1997, presumably due to the Asian financial crisis.

From USA to country  $i$

$$SWAP_{USA \rightarrow i} = a_{USA} \frac{EXPORTS_{USA \rightarrow i}}{\sum_i^{213} EXPORTS_{USA \rightarrow i}} + b_{USA} \frac{IMPORTS_{USA \leftarrow i}}{\sum_i^{213} IMPORTS_{USA \leftarrow i}} + \varepsilon_{USA,i}$$

From European Central Bank to country  $i$

$$SWAP_{EUR \rightarrow i} = a_{EUR} \frac{EXPORTS_{EUR \rightarrow i}}{\sum_i^{213} EXPORTS_{EUR \rightarrow i}} + b_{EUR} \frac{IMPORTS_{EUR \leftarrow i}}{\sum_i^{213} IMPORTS_{EUR \leftarrow i}} + \varepsilon_{EUR,i}$$

From People Bank of China to country  $i$

$$SWAP_{CHN \rightarrow i} = a_{CHN} \frac{EXPORTS_{CHN \rightarrow i}}{\sum_i^{213} EXPORTS_{CHN \rightarrow i}} + b_{CHN} \frac{IMPORTS_{CHN \leftarrow i}}{\sum_i^{213} IMPORTS_{CHN \leftarrow i}} + \varepsilon_{CHN,i}$$

In using the above specification, we focus on the role of swap lines extended during the latest financial crisis. This approach can be considered as a version of the gravity model of international lending (e.g., Rose and Spiegel 2004; and Aizenman and Pasricha 2010) in which conditions that lead two countries to be more integrated are likely to lead to more financial activity between them. The key variable for swap liquidity provision is a trade link, as measured by the trade shares of swap recipients in the provider's total trade.<sup>17</sup>

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<sup>17</sup> Aizenman and Pasricha (2010) found that for the US, both the trade and financial exposure to developing countries explains the recipients of the US Fed's swap lines. Unfortunately, data limitations prevent us from controlling for the financial exposure of the country supplying the swap lines to the recipient country.

**Table 4-a:**

Seemingly unrelated regression of swap amount (dependent variable) on the size of bilateral trade between the country of swap providers (the Federal Reserve, the European Central Bank, and the People Bank of China) and the receivers (22 countries in Table 2) and non-receivers (191 countries).

The estimating equation is given by

$$SWAP_{USA \rightarrow i} = a_{USA} \frac{EXPORTS_{USA \rightarrow i}}{\sum_i^{213} EXPORTS_{USA \rightarrow i}} + b_{USA} \frac{IMPORTS_{USA \leftarrow i}}{\sum_i^{213} IMPORTS_{USA \leftarrow i}} + \varepsilon_{USA,i}$$

$$SWAP_{EUR \rightarrow i} = a_{EUR} \frac{EXPORTS_{EUR \rightarrow i}}{\sum_i^{213} EXPORTS_{EUR \rightarrow i}} + b_{EUR} \frac{IMPORTS_{EUR \leftarrow i}}{\sum_i^{213} IMPORTS_{EUR \leftarrow i}} + \varepsilon_{EUR,i}$$

$$SWAP_{CHN \rightarrow i} = a_{CHN} \frac{EXPORTS_{CHN \rightarrow i}}{\sum_i^{213} EXPORTS_{CHN \rightarrow i}} + b_{CHN} \frac{IMPORTS_{CHN \leftarrow i}}{\sum_i^{213} IMPORTS_{CHN \leftarrow i}} + \varepsilon_{CHN,i}$$

	<i>Trade Share (% of Total), SUR Estimation</i>		
Bilateral Trade Shares	USA	EUR	PRC
<i>Exports</i>	1.927** (0.839)	0.052 (0.122)	2.922*** (1.037)
<i>Imports</i>	-1.422* (0.752)	-0.056 (0.128)	-2.067*** (0.781)
R-squared	0.041	0.001	0.038
Countries	213	213	213
Swap lines	11	4	6

Notes: The size of bilateral trade is the total sum from 2004 to 2008. The swap amount is in the currency of providers. Standard errors are in parentheses (\*, \*\*, \*\*\* denotes statistical significance at 10%, 5%, 1%, respectively).

Source: Authors' calculation.

**Table 4-b:**

Probit and tobit estimation of swap lines (dependent variable) on the size of bilateral trade between the country of swap providers (the Federal Reserve, the European Central Bank, and the People Bank of China) and the receivers (22 countries in Table 2) and non receivers (191 countries).

Specification	Probit Estimation			Tobit Estimation		
	USA	eurozone	PRC	USA	eurozone	PRC
Bilateral Trade Shares						
% of Total Exports	0.220** (0.109)	0.281 (0.505)	0.050 (0.072)	25.479* (13.600)	5.966 (10.669)	14.920 (17.884)
% of Total Imports	-0.197* (0.110)	-0.308 (0.553)	-0.031 (0.056)	-22.028* (13.176)	-6.521 (11.682)	-9.475 (13.845)
Pseudo R-squared	0.0705	0.0114	0.0107	0.0315	0.0075	0.0071
Countries	213	213	213	213	213	213
Swap lines	11	4	6	11	4	6

Notes: The size of bilateral trade is the total sum from 2004 to 2008. The swap amount is in the currency of providers. Standard errors are in parentheses (\*, \*\* denotes statistical significance at 10% and 5%, respectively).

Source: Authors' calculation.

The estimation results in Table 4-a show that the importance of swap recipients as an export destination is associated with a larger amount of swap liquidity extended from the US Fed and the PBOC. In the case of the dollar swap lines, the results seem to be driven by the presence of Japan and the euro area, which account for 7% and 20% of US exports, respectively. For the swap liquidity extended by the PBOC, the association between the swap size and export share is quite systematic: Hong Kong, China; Korea; Indonesia; Malaysia; and Argentina account for 12%, 4%, 0.9%, 1.1% and 0.2% of the PRC's total exports, respectively. An issue in Table 4-a is that most of the dependent variables are zero, with the exceptions of about a dozen countries, the few recipients of swap lines. Therefore, we redo and report in Table 4-b the regression results using the Probit and Tobit estimations, confirming that bilateral trade ties are strongly associated with the dollar swap lines.

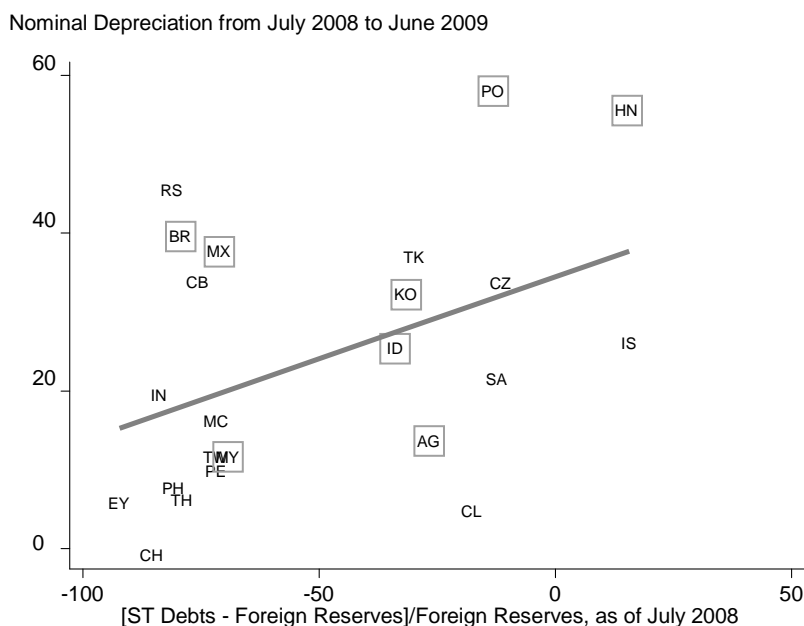
It is useful to check whether the marginal increase in bilateral trade (i.e., the % increase in bilateral trade in the previous five years, as a measure of the swap provider's propensity to trade) is associated with the presence of swap agreements and their size. Using the SUR specification in Table 4-a, we address this issue first by using OLS estimation and separating trade shares below and above 1%. The estimation results continue to show that larger export destinations tend to receive larger swap lines from the US and the PRC. Next, we replace the bilateral trade shares with the marginal increases in bilateral trade. Specifically, we check whether an increase in the PRC's exports to Argentina relative to an increase in the PRC's total exports from 2004 to 2008

increase the size of swap lines extended from the PRC. The results suggest that the marginal increase of bilateral trade over the past five years is associated with the swap liquidity extensions by both the US and the PRC.

During the global financial crisis, the frequent concern voiced toward the emerging markets has been the possibility that their foreign exchange reserves might have been too low relative to GDP and outstanding short-term external debt. Indeed, history has never been short on evidence of concurrent external liquidity and currency runs. Figure 6 plots the nominal depreciation (%) from July 2008 to June 2009 against  $(ST\ Debts - FX\ Reserves) / FX\ Reserves$  (%) as of July 2008 for 23 emerging markets.<sup>18</sup> The figure also provides a linear prediction (quarterly data) specification (III) of Table 5.

**Figure 6:**

Nominal depreciation (%) from July 2008 to June 2009 against the  $\frac{ST\ Debts - Foreign\ Reserves}{Foreign\ Reserves}$  (%) as of July 2008. The 23 countries below make up the S&P and MSCI emerging bond and equity indices. The linear prediction (using quarterly data) is given by specification (III) in Table 5.



Source: Authors' calculations.

<sup>18</sup> We focus on these 23 countries as they make up the widely-followed S&P and MSCI emerging-market bond and equity indices.



**Table 5**

Test whether  $\frac{\text{ST Debts-Foreign Reserves}}{\text{Foreign Reserves}}$  and  $\frac{\text{Foreign Reserves}}{\text{GDP}}$  of July 2008 (explanatory variables) are associated with the nominal depreciation during June 2008 to June 2009 (dependent variable). The sample includes 23 emerging markets (with quarterly data and included in MSCI).

	(I)	(II)	(III)
(SE-IR)/IR	.21 (.09)**		.16 (.10)
IR/GDP		-.37 (.19)*	-.24 (.20)
R-Squared	.19	.15	.24
Countries	23	23	23

Notes: Standard errors are in parentheses (\* and \*\* denotes statistical significance at 10% and 5%, respectively).

Source: Authors' calculations.

As noted earlier, Obstfeld, Shambaugh, and Taylor (2009) found that currencies of countries holding more reserves have tended to appreciate in the crisis. The estimation results in Table 5 show that, as expected, larger nominal depreciation is associated with larger (ST Debts – FX Reserves)/FX Reserves and lower FX Reserves/GDP ratios. Both coefficient estimates are, however, statistically weak. If we run the regression with only one of these two variables, each variable becomes highly significant. As of July 2008, the correlation between (ST Debts – FX Reserves)/FX Reserves and FX Reserves/GDP is -0.43, which is rather high. Emerging markets with larger external financing gaps tended to hold smaller amounts of foreign reserves at the onset of the 2008 crisis.

The swap recipients in Figure 6 seem to be indistinguishable from the non-recipients in terms of their nominal depreciation and short-term financing gap. Focusing on the recipient group, however, shows some difference between the recipients of the PRC's swaps (Argentina, Indonesia, and Malaysia) and the other swap recipients. In relation to the prediction line, the recipients of the PRC's swap have experienced smaller actual nominal depreciation than predicted. On the other hand, the recipients of swaps with the US (Brazil, Korea, and Mexico) and swaps with the ECB (Hungary and Poland) have had larger actual depreciation than the predicted ones. One interpretation of this evidence is that PRC's swap liquidity has been complementary to international reserves as an effective insurance against the instability of its recipient's currency. On the other hand, swaps from the US Fed and the ECB have played a substitute role to foreign reserves accumulation in the emerging markets.<sup>19</sup>

<sup>19</sup> An alternative interpretation is that Argentina, Indonesia, and Malaysia are less integrated with the global financial system than Brazil, Korea, and Mexico, and therefore faced smaller effective deleveraging pressure. This suggests that controlling financial integration, balance sheet exposure, and deleveraging would provide a more satisfactory explanation of cross-country variations in exchange rate depreciation and international reserves losses during the global financial crisis.

A limitation of our analysis is that, at this stage, we are unable to control for the factors accounting for foreign currency pressure—for example, deleveraging pressures and declines in net exports, as well as country-specific balance sheet exposures. Ideally, one needs to control for these variables in order to understand the marginal contribution of swap lines.<sup>20</sup> Figure 5 and our estimation results are consistent with the possibility that the introduction of swap lines is more important than the actual use of these lines. This would be the case if countries value flexibility granted by the swap line, providing the option of using it if the crisis deepens. Yet, the actual use of a swap line may be associated with a stigma, implying that countries would prefer to use swap lines as a last resort (or at least as a secondary resort).<sup>21</sup> Hence, somewhat paradoxically, countries that are eager to have access to swap lines in a crisis may refrain from using it.

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<sup>20</sup> To illustrate this point, take the case of Korea and Brazil. A bigger drop in net exports, greater deleveraging, and exposure to short term foreign currency debt may have induced Korea to deplete its FX reserves by US\$60 billion, as well as allow the won to depreciate. In contrast, Brazil's adjustment was mostly via the depreciation of the real.

<sup>21</sup> The crisis suggests a lingering stigma associated with accessing IMF credit lines, with some countries preferring to use ad hoc swap lines before using IMF credit lines.

## 6. CONCLUDING OBSERVATIONS

One key stylized fact of global FX reserve management during the global financial crisis has been the proliferation of swap agreements between large central banks such as the US Fed, PBOC and ECB on one hand, and the central banks of emerging markets on the other. The most well-known of such agreements is the US\$30 billion agreements between the US Fed and the central banks of four systematically important emerging markets with strong fundamentals —Brazil, the Republic of Korea, Mexico, and Singapore—which came into effect in October 2008. An important issue which arises in connection with the swap deals is the extent to which they can mitigate the precautionary or self-insurance motive, which underpinned the unprecedented reserve accumulation in developing countries immediately prior to the global crisis. At a broader level, swap lines can substitute for reserves since the two serve the same basic purpose—they are both international liquidity which can be called upon in case of unexpected shortages of the same. Upon closer inspection, there are clear limits to substitutability between swaps and reserves. Above all, the credibility of reserves in the eyes of financial markets is ultimately determined by the credibility of the central bank holding the reserves, while the credibility of swap lines is determined by the credibility of the central bank providing the liquidity support. Of course, one may question the credibility of the US Fed in light of the fact that the global crisis originated in the US. However, the somewhat paradoxical appreciation of the dollar at the slightest sign of global financial distress, as in the Dubai crisis, attests to the enduring safe-haven status of the dollar.

Before we can meaningfully assess the prospective impact of swap agreements on reserve accumulation, it is necessary to look at the nature of those agreements as well as their determinants. This has motivated the empirical analysis of this paper. Overall, the evidence indicates that by and large, swap lines are extended only to fundamentally sound and well-managed emerging markets. Crucially, sound fundamentals include healthy levels of FX reserves.

The highly selective nature of swap recipients means that a majority of developing countries will not have access to swap facilities. For those countries, swap lines cannot possibly be a substitute for reserve accumulation, for the simple reason that the central banks of large countries will be unwilling to provide them with swap lines. Of course, there are other substitutes for individual reserve accumulation, such as regional reserve pooling arrangements or access to IMF credit lines.

More fundamentally, our evidence shows that large central banks tend to extend swap facilities only to those countries with which they have strong financial and trade linkages. In other words, while swaps can contribute to the global public good of global financial stability, in reality, large central banks provide liquidity support only when it is in the self-interest of their respective countries to do so. For example, as noted earlier, exposure of US banks was the single most important explanation for the US Fed entering into swap deals with Brazil, Korea, Mexico and Singapore.

In the context of swap lines motivated by the self-interest of providing countries, a particularly interesting result from our empirical analysis is the strong influence of trade, particularly exports, in the determination of recipient countries. That is, large central banks tend to enter into swap agreements with their counterparts in countries which are important export markets. Although this pattern holds for large central banks in general, what is striking is that it helps to explain the recent rise of the PBOC as a major provider of swap facilities. For all its spectacular growth, the PRC's financial system is still underdeveloped and lags far behind the country's real economy. The depth, breadth, liquidity, and sophistication of its financial markets fall far below that of financial center countries, which explains why the PRC invests so much of its savings in US financial markets. Furthermore, the credibility of the PBOC is not noticeably greater than that of

central banks in other emerging markets, even though it sits atop the world's largest stockpile of reserves.

Nevertheless, the emergence of the PRC as a globally significant trading power gives the yuan some intrinsic value despite the country's financial under-development. In particular, the yuan can be used to pay for imports from the PRC, which is large and growing in many countries given the sustained and rapid growth of the country's exports. The inclusion of countries such as Argentina and Belarus—not known for strong fundamentals or sound management—among PBOC's swap recipient countries points to the overarching dominance of export markets as the key criterion. Be that as it may, the growth of yuan-dominated swap lines may be a precursor to the eventual emergence of the yuan as a new reserve currency.

The Korean experience is highly significant because it is a real-world example of a country simultaneously using both FX reserves and swap deals to deal with financial instability during the global financial crisis. One possible interpretation of the Korean saga is that more is always better when it comes to reserves, since even its ample stockpile of reserves failed to prevent a sharp depreciation in the won. However, such a misinterpretation would be misguided and inappropriate since it is doubtful whether more reserves would have made any difference. When market confidence is shattered, FX market intervention to stabilize the exchange rate becomes ineffective, even if the economy has sound fundamentals. That is, reserves fail to perform their precautionary or self-insurance function when tail-end risks are realized. In fact, as in the case of Korea, declining reserves themselves intensified market fears and concerns. This formed a vicious cycle in which adverse market sentiment drove down reserves via FX market intervention, and the decline in reserves, in turn, further dampened market sentiment. The timing of market movements suggests that BOK's three swap agreements, particularly the agreement with the US Fed, played a pivotal role in calming market hysteria over a possible dollar shortage. Quite clearly, the swap agreement would have been much less effective in the absence of strong fundamentals, including healthy reserve levels. A plausible interpretation of the Korean experience seems to be that swap lines which have important signaling effects, such as the BOK-Fed deal, can restore the precautionary or self-insurance function of reserves. This function can temporarily freeze up during severe shocks, but the Korean experience shows that swap deals can revive the function by restoring market confidence.

One big puzzle in Asia's FX reserve management in the global crisis period is the virtual invisibility of the CMI. It was precisely the type of financial turbulence visited upon Korea in the second half of 2008, precipitated by market jitters about prospective shortage of dollar liquidity, that the architects of the CMI had in mind. However, Korea turned to the US Fed for primary support when push came to shove and the country teetered toward a full-fledged financial crisis. Even CMI partners PBOC and the Bank of Japan played only a secondary role, and outside the CMI framework at that. What are needed for member countries to make greater use of the CMI in the future are more concrete and specific governance structure and implementation details.<sup>22</sup>

Encouragingly, as noted earlier, substantive progress has been made toward the multilateralization of the CMI (CMIM) since October 2008. In fact, the global financial crisis has served as a catalyst for CMIM. The resolution of politically sensitive issues such as the relative share of contributions among member countries, as well as the establishment of clear conditions

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<sup>22</sup> Curiously, BOJ swap lines were available to under CMI, and were not even tied to IMF conditionality. Despite this, Korea did not access the swap lines, and preferred to use the US Fed swap line instead.

for withdrawal of reserves and an independent regional surveillance unit, is expected to significantly boost the attractiveness of CMI as a source of funds during a crisis.

Despite progress with the CMIM, a range of issues relating to its the governance, operations, and technical details still remain unresolved. These include, for example, how withdrawal requests will be evaluated and how funds will be disbursed.

In addition to deepening regional reserve pooling arrangements such as the CMIM, another policy option for mitigating the need for precautionary reserves is to lengthen the duration of swap agreements. The Korean experience shows that swap agreements can help restore market confidence at a time of severe crisis. There is an intriguing possibility that swaps can help maintain market confidence even during non-crisis periods. The evidence of our analysis suggests that swap lines are motivated primarily by the self-interest of provider countries, but in fact they deliver substantial benefits for both provider and recipient countries. For provider countries, swaps help to safeguard the economic interests they have in countries to which they extend swap lines. The interests may take different forms—e.g., the exposure of US banks or a significant export market—but they can be substantial. For recipient countries, swaps help to restore financial stability during episodes of extreme financial distress when even large stockpiles of FX reserves fail to reassure markets. It is entirely possible that swaps are mutually beneficial not only during crises but also during non-crisis periods. Formalizing and institutionalizing swap lines so that they are transformed from temporary anti-crisis measures to more long-term mechanisms for liquidity support may dampen the need for precautionary reserve hoarding.

At a broader level, the desirability of the unprecedented scale and speed of Asia's reserve accumulation in the pre-crisis period is debatable. According to the dollar standard or Bretton Woods II view of global imbalances, Asia seeks to achieve rapid economic growth by adopting macroeconomic and exchange rate policies that keep exchange rates very competitive on a sustained basis. A centerpiece of such policies is systematic intervention in the FX market to purchase US dollars and de facto pegging to the US dollar. The rapid build-up of reserves may be a visible consequence of those policies. According to this interpretation, the global financial crisis has shattered the myth that the dollar standard was sustainable for a long period of time since it benefited both Asia (through rapid growth driven by strong export growth) and the US (which obtained cheap external financing due to massive Asian purchases of low-yielding US government bonds). Arguably, some observers interpret the global crisis as a painful wake-up call that Asian over-production counterbalanced by US over-consumption is ultimately an unsustainable game which harms all countries.

Finally, since volatile capital flows usually results in financial instability in emerging markets, and the fundamental purpose of precautionary reserves is to limit this effect, some emerging markets may opt to dampen the precautionary accumulation of FX reserves by controlling volatile capital flows. According to this argument, controlled financial integration which retains some restrictions on capital flows may limit financial instability; this in turn will limit the need for precautionary FX reserves. One possible solution to sudden stops and deleveraging may be a Pigovian tax scheme, where inflows of portfolio flows and external borrowing above a threshold may be taxed at an increasing rate, reflecting the resultant higher exposure of the central bank to a possible future bailout of the banking system.<sup>23</sup> Such a tax scheme, implemented *before* banks' external

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<sup>23</sup> The design of the US Federal Deposit Insurance Corporation (FDIC) deposit insurance scheme may be viewed as generating outcomes similar to such a Pigovian tax scheme. The FDIC charges insurance premiums on bank deposits at a rate that ideally should reflect the riskiness of banks' investments. The insurance premium is akin to a tax on banks' borrowing, inducing the bank to internalize the impact of its balance sheet on the possibility of future bailouts. As with any insurance scheme, care should be taken when dealing with the possibility of moral hazard.

borrowing takes place, may curtail exposure to the growing hazard facing the recipient country due to possible deleveraging.<sup>24</sup> It may induce the foreign investor to internalize the externality associated with possible costs of deleveraging, and reduce the cost of self-insurance by funding some of it.

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<sup>24</sup> It is noteworthy that this tax should apply only to external borrowing in hard currency, and not to other forms of capital inflows, like equity flows and foreign direct investments (foreign purchase of domestic equities and domestic capital). The differential treatment of the various types of financial inflows follows from the logic of balance sheet exposure and the original sin: the depreciation of the domestic currency induced by deleveraging reduces the foreign currency needed to finance domestic equity deleveraging, but increases the domestic currency needed to fund deleveraging of foreign currency debt.

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