

# **Resisting appreciation and accumulating reserves in Asia: examining the domestic financial consequences**

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## **Abstract**

Since 2002, official reserves in Asia have grown at an unprecedented scale, mainly as a by-product of official efforts to resist currency appreciation. Apart from the external adjustment and international political repercussions, critics have also warned of the “perils”, or unintended domestic consequences, of countering capital inflows with sterilised intervention. These warnings in the Calvo (1991) tradition are well known and frequently invoked, but to what extent have the risks cited actually materialised in Asia? This paper examines the domestic consequences in three main areas: monetary control, financial stability and central bank profitability and balance sheet risk. We find that, so far, the evidence has not been as strong or widespread as often presumed. With the exception of India, where a number of archetypal symptoms have emerged, other large reserve accumulators have not exhibited conclusive signs of difficulties. We argue that many of the assumptions underlying the Calvo-type warnings did not apply broadly to Asia. Indeed, rather than being an independent policy with consequences, we find that the large-scale reserve accumulation in Asia might be better seen as a consequence of the weakness of investment relative to savings in this decade.

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## 1. Introduction

Since 2002, the already high levels of official reserves in Asia have grown rapidly, as the authorities in the region have sought to resist or to slow down currency appreciation. This is not the first time that Asian authorities' effort to counter large capital inflows by accumulating reserves has come under international scrutiny. There were earlier bouts of rapid reserve growth in Asia in the late 1980s and in the early 1990s. The episode in the early 1990s has particular resonance with the situation since 2002: at the time, international capital returned full force to emerging markets after the crises of the 1980s against the backdrop of low US dollar interest rates.



The apparent similarities with past episodes of large inflows, coupled with the much larger magnitude of reserve growth this time around, prompted many prophecies that Asia's resistance to currency appreciation could not be sustained. Although the *technical* capacity to accumulate reserves is in principle unlimited, critics warn that prolonged periods of large reserve accumulation risk running up against *economic* limits, which in turn would force an abandonment of the policies driving the accumulation. Indeed, at least since Calvo (1991), many have warned of the "perils" (ie unintended adverse domestic consequences) of handling capital inflows with sterilised intervention, quite apart from any concerns over external adjustment or international political repercussions.

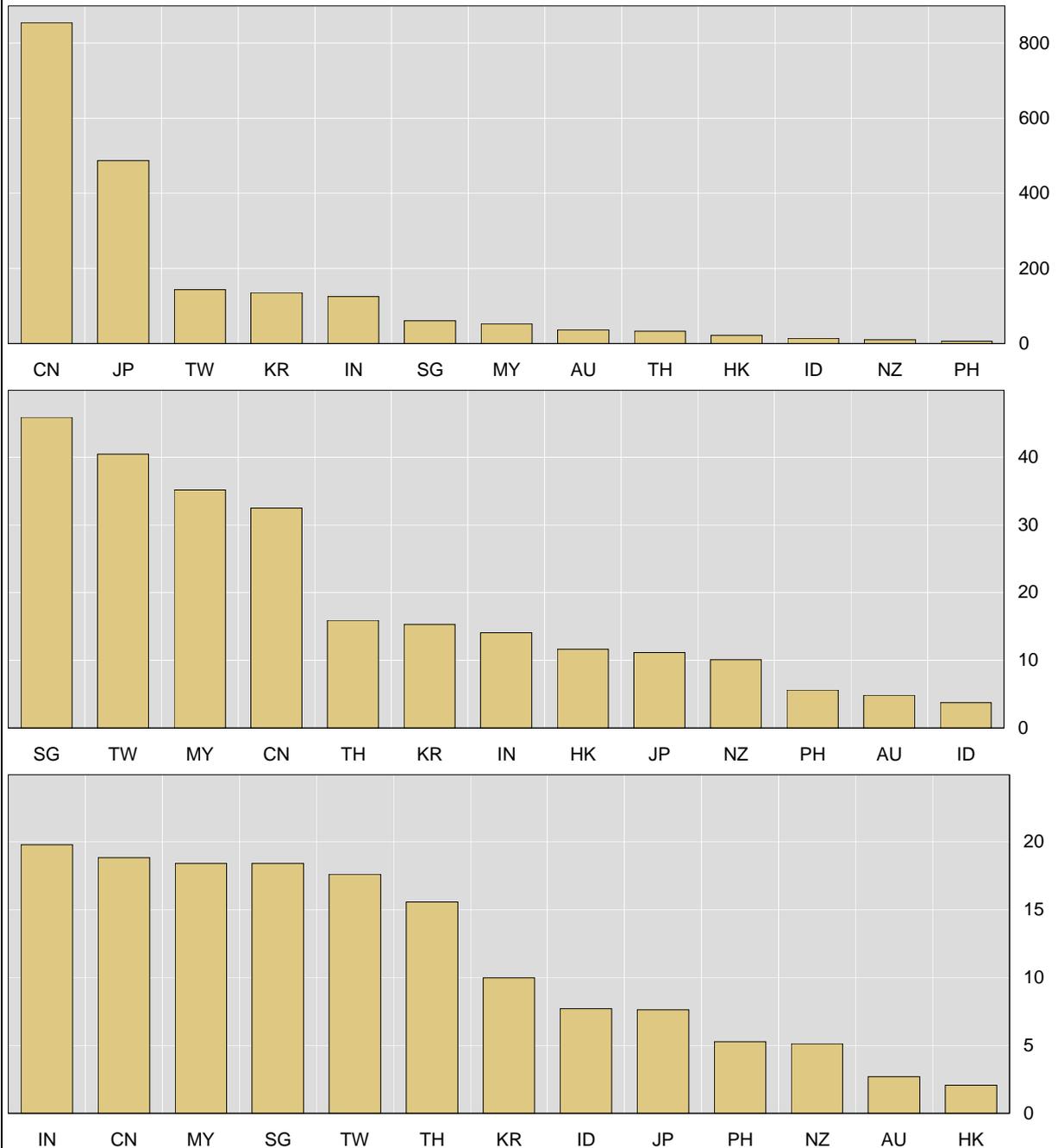
So, which economies in Asia would be the most in peril? Judging by the headline reserve size and growth, China and Japan, followed at the distance by Taiwan (China),<sup>2</sup> Korea and India, would appear to be the prime candidates (Graph 2).<sup>3</sup>

<sup>2</sup> Hereafter, Taiwan.

<sup>3</sup> These comparisons are distorted to the extent that the currency allocation of reserves differs across economies. In particular, given the trend US dollar depreciation since 2002, reserve portfolios with considerable euro or sterling investments would show stronger growth in dollar terms. Of the economies that have disclosed their currency compositions, Hong Kong's non-dollar share is low, and those of Australia and New Zealand are high, relative to the (partial) global average reported by the IMF. However, the effect of the low non-dollar share of Hong Kong's reserves is offset by its unusual weight on equities, which performed very well in the sample period.

Foreign reserve growth (top panel), relative to GDP (middle panel) and relative to size of banking system (bottom panel)<sup>1</sup>

In billions of US dollars and in per cent



<sup>1</sup> Changes in foreign exchange reserves between December 2001 and December 2006, in billions of US dollars, as a percentage of GDP and as a percentage of total assets in the banking system, respectively.

Sources: CEIC; IMF; WEO; national data.

Graph 2

However, the exposure to economic or financial consequences is perhaps better gauged in relation to the size of the economy or of the banking system.<sup>4</sup> Relative to GDP, China's

<sup>4</sup> The comparisons of reserve growth relative to GDP or to the size of the domestic banking system, for its part, are distorted by the different extent of the appreciations of the sample economy currencies against the US

reserve growth in 2002-06 in fact only ranked fourth in Asia, behind that of Singapore, Taiwan and Malaysia. Relative to the size of the domestic banking system, India's reserve growth bulks larger than that of China and stands on par with that of Malaysia, Singapore and Taiwan. The reserve growth in Japan and Korea, so sizeable in dollar terms, falls only in the second rank among its Asian neighbours in relative economic terms. On the opposite end of the reserve accumulation spectrum are Australia and New Zealand, which have not actively resisted currency appreciation, and Indonesia and the Philippines, which experienced depreciation pressure on their currencies through the third quarter of 2005. These economies can be considered to be the control group in this study.

Being at risk is one thing, whether the risks have materialised is quite another. Have the large reserve accumulators in Asia actually suffered the adverse consequences? In this paper, we examine to what extent the potential perils of resisting appreciation via reserve accumulation have become manifest in Asia in the 2000s. We consider the potential consequences in three main areas: monetary control (section 2), financial stability (section 3) and central bank profitability and balance sheet risk (section 4). We find that evidence in support of the typical warnings has so far been not as strong or widespread in Asia as often presumed. Perhaps with the exception of India, where a number of archetypal symptoms began to emerge from late 2004 on, other large reserve accumulators – even China – have not exhibited consistent or conclusive signs of difficulties.

Some recent cross-country studies, such as Mohanty and Turner (2006) and BIS (2007), have come to less benign conclusions about the link between reserve accumulation and the various domestic perils. Since these other studies cover a much wider sample of emerging market economies, while our paper focuses on only 13 Asia-Pacific economies, the difference in findings may suggest that something is different about Asia. Indeed, while the warnings in the Calvo tradition may have had firm foundations in the 1980s and 1990s (especially in Latin America), many of the underlying assumptions did not apply well to Asia in the 2000s.

Economic slack and consequently low domestic interest rates in Asia contributed much to the weak manifestation of the conventionally argued side-effects. Rather than speaking of reserve accumulation as if it were an exogenous policy with consequences, we suggest that reserve accumulation might be better seen as a consequence of particular economic circumstances. The strong efforts to resist currency appreciation in Asia can be seen as a response to the weak post-crisis recovery of real investment.<sup>5</sup> In China the growth of corporate savings outpaced that of corporate investment, in the early 2000s, with much the same result.<sup>6</sup>

An alternative account of the Asian exception could be that capital controls and undeveloped (or even repressed) financial markets allowed large reserve acquisitions to be financed in the banking system. While this account has particular appeal in the case of China, where it can be argued that capital controls were effective by some measures (Ma and McCauley (2007)), we are not persuaded. On the one hand, the cases of Malaysia, Singapore and Taiwan show that even relatively larger reserve acquisitions than that of China could be managed in a setting of financial openness and development, as long as domestic investment fell well short of domestic savings. On the other hand, India has had difficulty managing its reserve

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dollar. Thus, the growth of Korean and Thai reserves in won and baht terms was held down by the strength of these two currencies.

<sup>5</sup> The reasons for the persistent weakness of investment in post-crisis Asia are not well understood. See Harrigan (2007).

<sup>6</sup> In a closed economy, a 5-10% of GDP drop-off of corporate investment would induce not only a monetary easing but also fiscal stimulus, as was seen in Japan after the bursting of the bubble. In either the case of sterilised intervention in the open economy or fiscal stimulus in the closed economy, government paper fills the gap between deposit and loan growth in the banking system.

acquisition notwithstanding capital controls. The strength of India's corporate investment relative to domestic savings in recent years left little slack (and indeed left India in current account deficit over most the period in contrast to the East Asian economies). Hence, we put more weight on the strength of corporate investment relative to savings than on capital controls as leaving the large reserve acquisitions more manageable than might have been anticipated.

This paper, which was developed out of a note originally written in November 2003, has undergone several updates over the years. While the basic findings have so far stood the test of time, we are mindful that there could remain as yet unseen effects of reserve accumulation.<sup>7</sup> Like wise investors, policy-makers should not over-interpret recent performance.

Finally, the limits of this paper's scope deserve emphasis. It covers only the recent episode of reserve accumulation (2002–2006) in Asia. It is interested in reserve accumulation only in the sense of being a by-product of countering appreciation pressure, not an end in itself (eg post-crisis rebuilding of reserves). And it examines only the main (mostly adverse) domestic financial consequences thereof for which we can present tangible evidence.<sup>8</sup> Since the external and political consequences<sup>9</sup> as well as the benefits of holding reserves and of exchange rate management are not discussed here, this paper should not be read as a full cost-benefit analysis of the policy course of the Asian authorities.

## 2. Monetary control

A classic potential adverse consequence of central bank foreign exchange purchases is that the associated expansion of base money could prove inflationary. Indeed, some critics argue that even if *nominal* exchange rate appreciation is successfully resisted, the *real* exchange rate would still appreciate as a result of rising inflation. This argument follows from the classic adjustment mechanism under a fixed nominal exchange rate: external surpluses expand the domestic money supply, increase spending and drive up prices until the surpluses disappear. However, this mechanism's inflationary consequences may not manifest themselves in situations of chronic demand deficiency – and in any case the mechanism only operates over the long term.

This classic mechanism may also be short-circuited if the central bank offsets the money supply effects of intervention by undoing (“sterilising”) the injection of base money via domestic liquidity management operations. But even so, some critics contend that the authorities could find their ability to sterilise impaired in the face of large-scale and prolonged foreign reserve accumulation, like that in Asia, thereby foiling the implementation of the desired monetary policy. This might be called the “technical” sterilisation problem. A more

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<sup>7</sup> For instance, as recently as 2005, one would have had to resort to using high-end real estate to argue that asset prices in China might be responding to the liquidity entailed by reserve accumulation. However, in 2006 and the first half of 2007, the Shanghai stock index doubled twice. While the surge in the once-feeble Chinese stock market may well be a direct result of the reassuring effect of the share reform, it may also be read as an indication of the broadening of the asset price response to excess liquidity.

<sup>8</sup> More macroeconomic effects, such as potential misallocations between domestic capital stock and foreign assets, or between capital stock in the traded versus non-traded sectors, are not considered in this paper.

<sup>9</sup> Political consequences may result at home if large holdings of reserves create the appearance of a “wealthy” government, enabling it to finance certain “worthy” projects (eg bank recapitalisation in China, infrastructure in India or investment in Taiwan) without resorting to the ordinary budgetary procedures or checks and balances. International political consequences can include pressure to reverse what are regarded as mercantilist policies of exporting unemployment. Such pressures could be accentuated in the event of weak growth abroad or even job losses in particular sectors, which might also nurture protectionist sentiment.

subtle problem could arise if the adverse consequences of foreign reserve accumulation induce the authorities to adopt a more accommodative monetary policy stance than that required by their inflation objective. This might be called the “compromise of goals” problem.

This section first considers in turn whether Asian central banks have met the technical sterilisation challenge and whether they have evidently compromised their inflation goals in response to the adverse effects of sterilisation. It then addresses two broader aspects of monetary control. First, even if the effect of intervention on the monetary base is neutralised, it is possible that a financial system flooded with sterilisation debt might extend credit at a rate well in excess of GDP growth. Thus, the question, regardless of the interest rate or monetary aggregate outcome, is whether credit growth has been evidently excessive against the backdrop of foreign exchange reserve build-up. Second, again even if the sterilisation is in some sense complete, exchange rate expectations might still lead to a loosening of monetary conditions through uncovered interest parity. Thus the question is whether there is evidence that expectations of appreciation may have lowered long-term interest rates, possibly over-stimulating those sectors responsive to them.

## **2.1 Sterilisation, operating target and policy goals**

One aspect of losing monetary control is when a central bank has technical difficulties achieving its day-to-day operating target owing to injections of liquidity associated with foreign exchange purchases. Another is when the adverse consequences of sterilisation lead policy-makers to take their eye off the stated goals of monetary policy.

### **2.1.1 The technical sterilisation problem**

Foreign exchange intervention causes a technical problem when it interferes with a central bank’s ability to achieve its operating target in day-to-day liquidity management. Operating targets can be framed in terms of quantity or price. Many central banks used to target some measure of money over which they had direct control, typically base money or bank reserves. In this case, a technical problem arises if the injection of liquidity associated with foreign exchange purchases is not adequately sterilised via domestic operations, resulting in an expansion of base money that exceeds its targeted path.<sup>10</sup> In current practice, however, many central banks define their operating targets in terms of a short-term interest rate, leaving quantities endogenous. In this case, a technical problem arises if sterilisation is

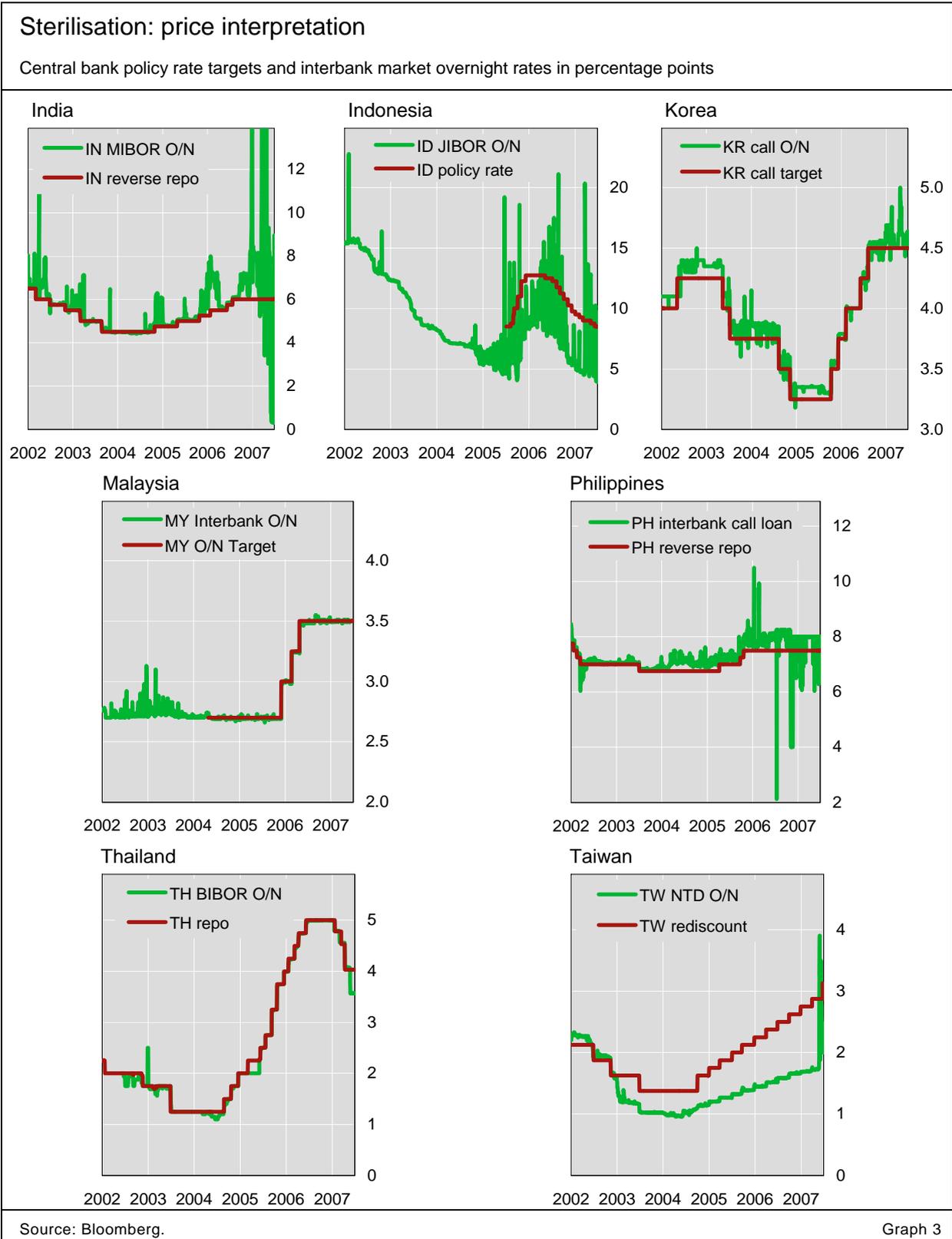
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<sup>10</sup> The typical textbook portrayal of sterilised intervention suggests an intentional, simultaneous, one-for-one offset (so as to keep “money” constant). In practice, however, the mapping between foreign exchange and domestic liquidity operations is not so mechanically precise. The two types of operations are typically implemented in separate departments, each operating according to its own mandate. The domestic operations department would contend with the injection of domestic currency liquidity during foreign exchange intervention as only one out of several autonomous factors it faces. How much liquidity it would eventually withdraw would depend on (1) the net liquidity position of the system after taking into account all autonomous factors and (2) its operating objective. Thus, “sterilisation” is in practice more an interpretation rather than a separate policy: sterilised intervention can be said to have occurred if the surplus liquidity that is being mopped up comes predominantly from foreign exchange purchases.

That monetary control at the operational level does not require “fully” sterilising each unit of foreign exchange purchase is illustrated by the Federal Reserve’s operations in 1991. That year, the Federal Reserve acquired \$12.6 billion in foreign currency assets while its net liabilities rose by \$11.1 billion. It would therefore appear that very little of the foreign exchange acquisition was sterilised. In fact, it just happened that the liquidity drain from additional demand for cash (which varies from year to year but is always positive) nearly matched the injection from foreign exchange purchases, while other factors nearly netted to zero. In the market for overnight bank deposits, federal funds traded normally in relation to the Federal Reserve’s targets. Operationally, there was full sterilisation, but a naïve juxtaposition of the rise in foreign exchange holdings and the rise in liabilities would conclude the contrary. We are indebted to Dino Kos for pointing out this case.

inadequate, allowing the relevant market interest rate to fall and stay below the targeted level. Much of the discussion of sterilised intervention in Asia suffers from anachronism, since it applies measures consistent with quantity targeting to assess the behaviour of central banks with interest-rate operating targets.

The evidence on interest rates and central bank balance sheets suggest that technically successful sterilisation was the norm in most of Asia during the recent period of active foreign exchange purchases. Central banks with explicit short-term interest rate operating targets or official rate corridors (for example, in India, Indonesia, Korea, Malaysia, the Philippines and Thailand) were able to manage money market liquidity such that the relevant interest rates did not fall and stay below their announced targets, notwithstanding bouts of foreign exchange purchases (Graph 3). Taiwan's case is less clear, since the policy rate in principle only provides a ceiling for the overnight rate. Nonetheless, the only sizeable deviation from the de facto operating target for the overnight rate occurred in June 2007, when the authorities *sold* US dollars and allowed the overnight rate to rise in order to squeeze short-positions in the domestic currency. Similarly, albeit more frequently, the



overnight rate in Indonesia at times traded well above the SBI target rate, especially during the period of rupiah weakness in 2005. Only in late 2006 and in the first half of 2007 in the Philippines and in May-July 2007 in India did overnight rates trade well below the reverse repo rate that would ordinarily be expected to provide a floor for short-term rates. On this

showing, there have been at most only recent and exceptional evidence of technical difficulties in sterilisation.<sup>11</sup>

It is also notable that even though quantities are in principle endogenous in interest rate targeting economies such as Korea, Malaysia, Taiwan and Thailand, liquidity draining operations managed to constrain base money growth. This is evident in clear gaps between central bank net foreign asset growth and base money growth (Graph 4)<sup>12</sup>. Thus in both price and quantity terms, sterilisation was technically effective in these economies and monetary control remained intact.

There have been four notable exceptions to the prevalence of interest rate targeting in the region. Under a currency board regime, Hong Kong does not have an active monetary policy. The equivalent of the operating target would be the spot exchange rate. As a rule, foreign exchange operations to maintain the spot rate link to the US dollar are not sterilised. Base money, driven mainly by the aggregate balance of the banking system, clearly expanded in tandem with foreign reserve acquisition during the bout of US dollar-buying that started in September 2003, before reversing in the second half of 2004 (Graph 4).<sup>13</sup> Hong Kong dollar interbank interest rates, being entirely endogenous, fell below their US counterparts before gradually reconverging in early 2005, after official US dollar sales in response to market demand had deflated the bloated aggregate balance back to more normal levels.

Given its effective exchange rate based monetary policy framework, Singapore's domestic interbank interest rates are also in principle endogenous.<sup>14</sup> However, foreign exchange intervention appears to be generally sterilised at the operating horizon. In fact, the wedge between the monetary authority's net foreign asset growth and the remarkably stable base money growth has been a feature in Singapore even long before the period under investigation (Graph 4).

### Sterilisation: quantity interpretation

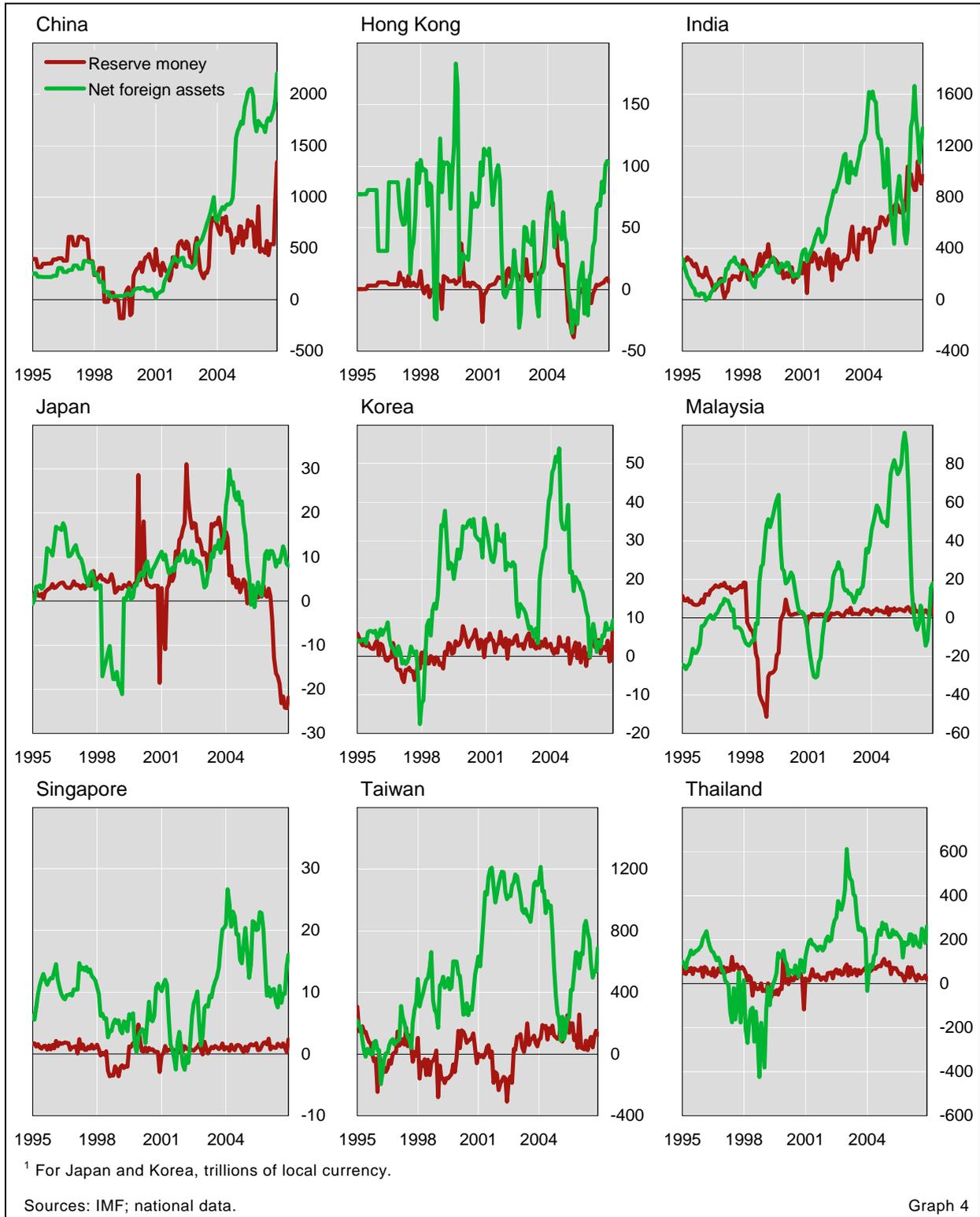
Annual changes, in billions of local currency<sup>1</sup>

<sup>11</sup> However, neither the Indian nor the Philippine case is a clear-cut one of technical difficulty in sterilisation: each has some suggestion of the central bank choosing to let market rates fall relative to stated policy rates. In India, previous technical problems had been evident in the *injection* of liquidity, as Indian overnight rates traded well above the official corridor in 2006 and more so in early 2007, owing to the distribution of collateral for central bank repos. In March 2007, the central bank decided to limit the daily absorption of funds through its reverse repo facility, stating its intention to rely more on sales of government bills and bonds to absorb "structural" excess liquidity under the Monetary Stabilisation Scheme (RBI (2007, Chapter 3)). In the event, as the central bank bought dollars in May-July 2007, its sales of government paper lagged and overnight call interest rates fell towards zero. One interpretation is that the central bank chose for a time not to enforce its interest rate corridor as the rupee strengthened toward 40 to the dollar. In the case of the Philippines, the central bank allowed money-market interest rates, especially the benchmark 91-day Treasury bill yield, to fall below its policy rate corridor by putting in place in November 2006 a tiering system that rationed access to its deposit facility. The stated purpose was to catalyse domestic bank lending, and the decline of the benchmark lending rate to about 3% would have increased the attractiveness of borrowing from banks. In mid-2007, the two central banks took removed their respective limits on the enforcement of their corridors for overnight rates and the unusual configurations of interest rates ceased.

<sup>12</sup> Since base money growth has not been adjusted for the effects of changes in reserve requirements, cuts in reserve requirements can show up as large drops in base money growth, as in Malaysia in late 1998 or Taiwan in 2002-03.

<sup>13</sup> Prior to this episode, base money was generally very stable relative to the swings in foreign reserves. However, this is not a result of "sterilisation". The institutional peculiarity is that the Exchange Fund's liabilities to the Hong Kong Government and its own accumulated surplus (net worth) have been important counterparts to changes in foreign reserves. Banks and other market participants generally stood ready to offset the effect of changes in Government-held foreign assets on the monetary base, on the basis of the signals of smallish foreign exchange operations.

<sup>14</sup> Over a longer horizon, domestic interest rates should be ultimately constrained by open interest rate parity, via the interaction of the targeted path of the exchange rate and the interest rate levels of trading partners.



Japan also presents a special case that has inspired conflicting interpretations. With the adoption of “quantitative easing” in March 2001, the Bank of Japan switched from targeting the overnight call rate to targeting the current account balances of the financial system held at the central bank. This quantity target was raised in multiple steps between March 2001 and January 2004, driving a rapid expansion of base money, while short-term rates remained close to zero. The very rough parallel between base money growth and foreign exchange reserve accumulation over this period prompted some observers to describe the Japanese authorities’ intervention as “de facto unsterilised” (Higgins and Klitgaard (2004)). However, one should recall the unique institutional separation in Japan. The Ministry of Finance, not the central bank, is the buyer of foreign exchange at the margin and finances its purchases

by issuing bills. Thus, intervention is essentially always sterilised. Moreover, at near-zero interest rates, there is little practical difference between sterilised and unsterilised intervention: private holdings of short-term government paper that in effect paid no interest and holdings of non-interest bearing central bank current balances are basically perfect substitutes in private portfolios (McCauley (2004)).

China is perhaps the most difficult to interpret of all cases for several reasons. First, the central bank's monetary operation goals, be they de jure or de facto, are not explicitly stated. Behaviour at certain times suggest that excess reserves in the banking system serve as an operating target, but there is also an interest rate corridor defined by the interest rate paid on excess reserves at the bottom and the central bank's refinancing rate on the top (Ma and McCauley (2004)). Second, bank reserves (both required and excess) are remunerated, and thus do not carry the same interpretation as the interest-free ones in most other economies. Remuneration, like a deposit facility, helps to keep idle liquidity from pushing money-market rates toward zero, and thus can be seen as a type of passive, automatic sterilisation, not easily distinguishable from active sterilisation operations. Finally, the Chinese authorities have actively raised reserve requirements to tighten liquidity since 2003, increasing demand for reserves and thereby permitting rapid base money growth at positive interest rates.<sup>15</sup>

All that said, the profiles of China's base money and foreign reserves expansion certainly look different from the typical pattern observed in other economies (Graph 4). Until as recent as early 2003, base money growth had in fact tended to outpace foreign reserve growth. After the first placement of PBC bills in late 2003, base money growth began to lag behind foreign reserve growth, suggestive of a conscious effort to control liquidity associated with foreign exchange purchases. But even so, a clear wedge did not take shape until 2004 and, compared to the typical case, China's base money growth is still a relatively large counterpart to foreign reserve growth, somewhat similar to the case of India (where the central bank has also raised reserve requirements since September 2004). Some observers concluded that China was a case of partial sterilisation (Higgins and Klitgaard (2004)). Yu (2007), however, holds that the foreign exchange reserve growth (a RMB 11 trillion injection over five years) was pretty well sterilised by higher reserve requirements (RMB 3 trillion), the sale of People's Bank bills (RMB 5 trillion) and the (often neglected) natural growth of demand for reserves arising from the double-digit nominal growth of the economy even at low to moderate of inflation (an average RMB 600 billion per year for five years, or RMB 3 trillion).<sup>16</sup>

In summary, with perhaps the very recent and short-lived exceptions of India and the Philippines, it is difficult to argue that Asian central banks have technical difficulties with sterilisation as a result of large-scale foreign exchange purchases. Evidence from interest rate targeting central banks suggests technically effective sterilisation.<sup>17</sup> The juxtaposition of foreign reserve growth and base money growth also does not suggest a loss of control. China may be a borderline case, although institutional peculiarities such as reserve remuneration and, more fundamentally, uncertainty regarding the central bank's operating objectives render a conclusive interpretation difficult.

### **2.1.2 Has sterilisation compromised inflation objectives?**

While the general accuracy of Asian central banks in hitting their interest rate targets is undeniable, a more subtle and important question here is whether the interest rate targets

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<sup>15</sup> The effect of changes in reserve requirements on the size of reserve demand can be considerable. Reserve Bank of India (2007) notes that reserve money grew 23.7% in 2006-07, but only 18.9% if adjusted for the first round effects of the hikes in the reserve requirement.

<sup>16</sup> However, Yu does not draw a sanguine conclusion from this view. See below under Section 3.1.

<sup>17</sup> The question of the running cost of sterilisation operations is discussed in section 4.2.

themselves have been set lower than would have been otherwise, in light of heavy intervention, leaving monetary policy looser than warranted. It was tempting for critics to point to, for example, Korea's policy rate cuts in 2004 – a year of heavy intervention on the one hand and upward-creeping core inflation on the other – as evidence of slippage towards pure exchange rate management at the expense of the professed commitment to inflation targeting. However, since core inflation remained within the Bank of Korea's stated target of 2.5–3.5% in 2004 and even undershot the target in 2005 and 2006, it was hard to argue that heavy intervention and snowballing sterilisation debt had led the Korean authorities to adopt an overly accommodative policy stance. The rate cuts in 2004 were arguably more consistent with the need to stimulate weak domestic spending than with any desire to resist currency appreciation.<sup>18</sup>

Although Japan is not an inflation targeter, its monetary policy goal during the period of heavy intervention (up until March 2004) was clearly to bring inflation back into positive territory. Accordingly, active efforts to resist yen appreciation and the heavy issuance of highly liquid Ministry of Finance debt to finance the intervention were in fact consistent with the easy monetary policy stance adopted at the time. A similar story generally applies to other large reserve accumulators such as Taiwan, Malaysia and Singapore, even in the absence of explicit, quantified inflation targets. The low or even at times negative inflation outcomes in these economies during most of the period under review implies that any efforts to resist currency appreciation were unlikely to have stood in the way of the warranted policy stance.

As for China and India, the situation was less unambiguously benign. CPI inflation in China breached the officially flagged 5% threshold in the third quarter of 2004, while wholesale price index inflation in India rose to over 8% in August 2004. One may infer from both countries' entering into policy rate hiking mode in October 2004 that there was some official discomfort with the price increases.<sup>19</sup> Inflation in both economies retreated subsequently. China's inflation ended up averaging less than 2% per year over 2002-2006, but India's averaged over 4%, ranking relatively high by regional standards. In early 2007, moreover, inflation in China climbed again and more so in India, prompting more tightening measures. That said, the absence of explicit inflation targets and the practice of using multiple policy levers<sup>20</sup> in these two economies make it difficult to judge conclusively whether efforts to resist currency appreciation had constrained their monetary policy to be too loose.

All in all, Asia during the period under consideration did not provide evidence for the well-known argument that large-scale reserve accumulation would be inflationary. The top reserve accumulators, be it in absolute terms (China and Japan) or in relative to GDP terms (Singapore, Malaysia, Taiwan and China), did not experience notably larger rises in inflation over the period 2002-2006 compared to economies that accumulated little reserves (Graph 5).<sup>21</sup>

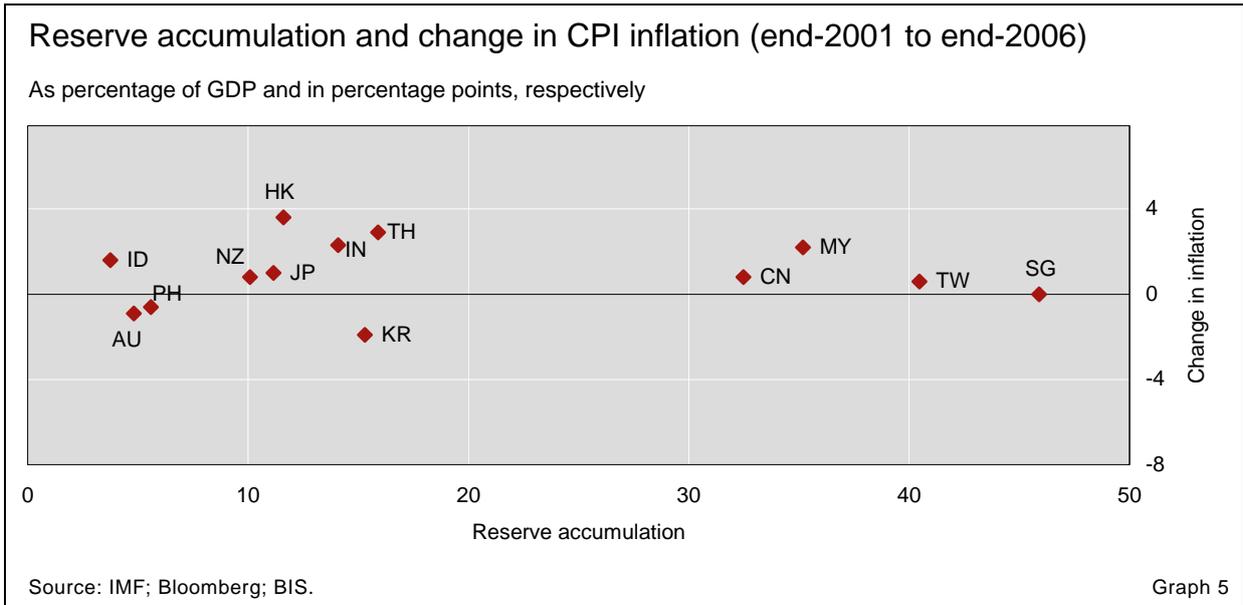
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<sup>18</sup> In addition, given the predominance of equity flows (as opposed to fixed-income flows) in Korea's balance of payments, interest rate cuts do not necessarily have the conventional effect of depressing the currency value. By boosting the stock market, rate cuts may in fact encourage portfolio inflows, which in turn exert further upward pressure on the local currency. See Chai-anant and Ho (2007) on the effect of stock market rises on portfolio capital inflows and the exchange rate.

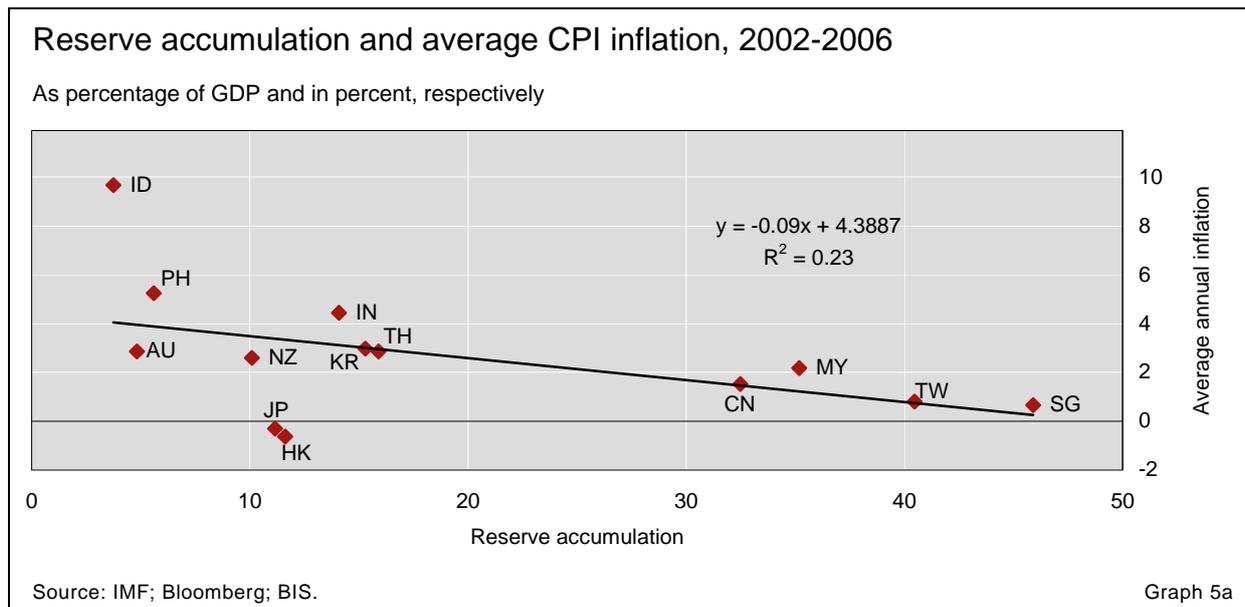
<sup>19</sup> China's 5% inflation in 2004 was per se not very high. However, considering the fact that China just emerged from deflation in 2003, the acceleration was remarkable.

<sup>20</sup> While Chinese policy rate hikes were relatively rare (once in 2004 and twice in 2006), reserve requirements were raised multiple times between 2003 and 2006. The Reserve Bank of India hiked the cash reserve ratio in September 2004 and again in October 2004 but relied more on policy rate hikes subsequently to tighten (once in 2004, twice in 2005 and four times in 2006).

<sup>21</sup> If one considers a broader sample that includes non-Asian emerging markets, a mildly positive relationship emerges. What holds for emerging markets in general does not apply to Asia in particular in this case.



More strikingly, there is in fact an inverse relationship between reserve accumulation and average inflation performance in Asia over the same period (Graph 5a). The top reserve accumulators all had relatively low inflation or even deflation. In contrast, two economies that saw the least reserve accumulation (Indonesia and the Philippines), given currency weakness through 2005, were the ones that over-shot inflation targets and experienced the highest inflation in the region. This inverse relationship is even more evident if one juxtaposes the inflation rate in 2001 (ie the initial condition) with the subsequent degree of reserve accumulation.



Thus, rather than being an independent policy with supposed inflationary consequences, the heavy intervention in Asia in the early 2000s might be better seen as itself a consequence of the economic circumstances of the time. Macroeconomic slack – related to weak investment expenditure outside of China and rising enterprise savings in China – was pervasive among Asian economies during the period under review. Even if policy efforts to contain nominal appreciation were successful in supporting external demand, there was still sufficient excess labour and capacity to meet this demand without exerting great upward pressure on prices. Under different circumstances, resisting appreciation could carry more inflationary risk. But then, with less economic slack, policymakers would be less drawn to resisting appreciation as a means to support growth.

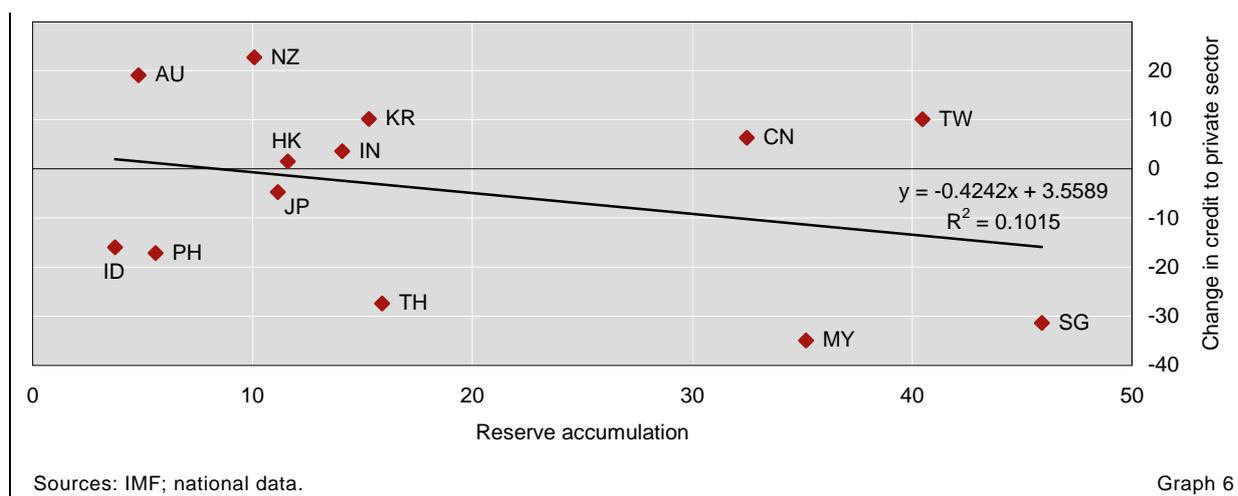
## 2.2 Credit growth

Beyond monetary operations, money growth and goods price inflation, monetary control can also be assessed in a broader sense by examining the growth of credit to the private sector. Some critics would contend that absence of goods price inflation does not necessarily mean that the economy is safe from overheating (White (2006)). If intervention, even if sterilised, created looser-than-otherwise conditions that encouraged excessive credit growth, a kind of overheating in disguise would result.

Just as there was no strong relationship between foreign reserve accumulation and base money growth in Asia during the period under review, there was also no tight link between reserve accumulation and domestic private credit growth (Graph 6). Among the top reserve accumulators, China's and Taiwan's credit growth in 2002-2006 relative to GDP did rank high by regional standards, similar to that of Korea and, to a lesser extent, India. However, other large reserve accumulators such as Japan had essentially no credit growth in excess of GDP growth, while Malaysia and Singapore even saw credit growth being outpaced by GDP growth during this period. In contrast, Australia and New Zealand, two countries that boast freely floating and appreciating currencies, had the strongest credit growth relative to GDP in the region. In fact, a negative cross-sectional relationship prevailed.

### Reserve accumulation and credit growth (end-2001 to end-2006)

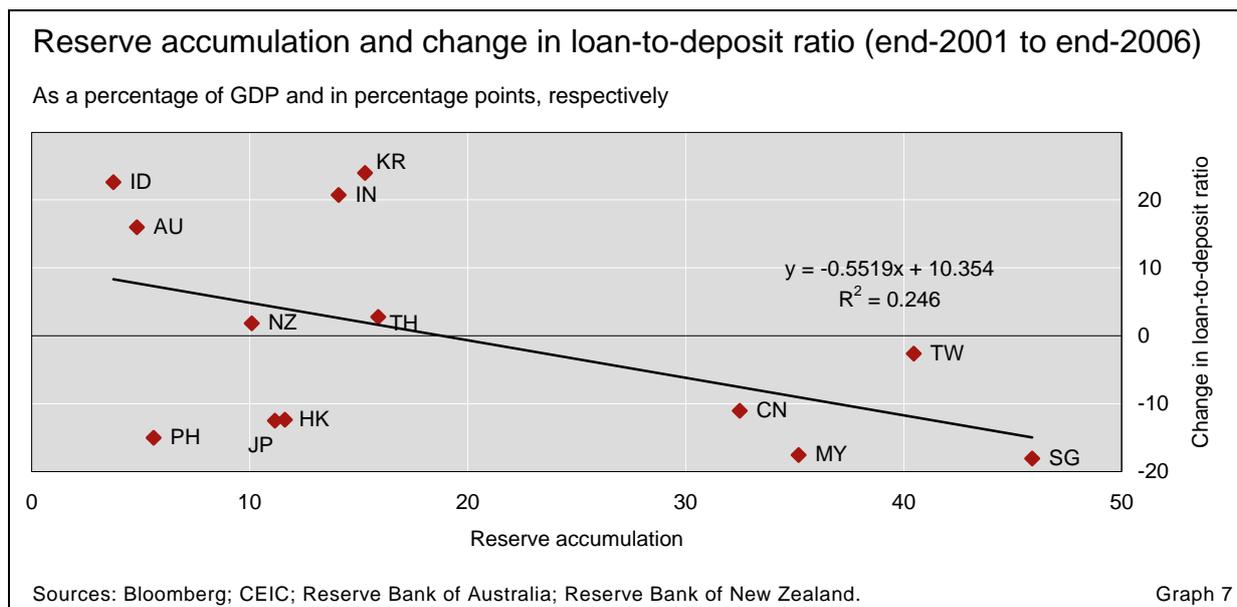
As a percentage of GDP



Feeble credit growth was a common phenomenon in post-crisis Asia, in light of weak corporate loan demand. (It is noteworthy that most of the economies most affected by the Asian financial crisis, Indonesia, Malaysia, the Philippines and Thailand, experienced shallower credit in relation to GDP in 2006 than they had in 2001, or 1996, for that matter.) Loan-to-deposit ratios declined – most notably in Hong Kong, Indonesia, Singapore and Thailand – in the wake of the Asian crisis and in most cases remained low through at least 2005. Although China and Taiwan registered relatively strong credit growth in 2002-2006, their loan-to-deposit ratios did not show any increase during this period (Graph 7). The only two large reserve accumulators that saw both notable credit growth and a rise in the loan-to-deposit ratio are Korea and India. In these cases, the question remains as to the relationship of any observed rise in credit growth and/or loan-to-deposit ratio to foreign exchange intervention.<sup>22</sup> In any case, as with inflation and credit growth, the change in loan-to-deposit ratio also exhibits a negative relationship vis-à-vis the extent of reserve accumulation among the economies in our sample. Such a relationship is consistent with the interpretation that, rather than being an independent policy that has a side-effect of fuelling loan growth, the heavy intervention observed in Asia might have responded to the lack of loan growth.<sup>23</sup>

<sup>22</sup> In China, for instance, the acceleration in credit growth in 2002 was arguably induced by policy then to spur growth. Credit growth decelerated substantially between mid-2003 and end-2005 in response to a series of restrictive administrative measures to check investment, even as foreign exchange intervention became heavier. Bank lending in Korea recovered relatively quickly after the Asian crisis thanks in part to active policy to encourage lending to households in order to boost consumption. The credit card boom in 2001/2002 was illustrative of this policy-induced lending boom. See Kang and Ma (2007).

<sup>23</sup> The low and falling loan-to-deposit ratios among the top reserve accumulators could also be interpreted as a sign of sterilisation debt “crowding out” the extension of loans by the banking sector (see section 3.1).



### 2.3 Currency expectations and long-term interest rates

A third channel through which rapid growth of foreign exchange reserves might affect monetary conditions is the effect on long-term interest rates. Some critics have warned that if market participants believe that heavy intervention could only be sustained for a limited time, then they would expect sharp currency appreciation in the future when the authorities retreat from further intervention.<sup>24</sup> Such expectations, in turn, could lead to a decline in long-term interest rates through uncovered interest rate parity. The fall in long-term rates could in principle constitute an unintended easing of credit conditions, encouraging more leverage among borrowers, especially in economies with substantial corporate bond markets and investments in long-lived assets like real estate.<sup>25</sup>

Hong Kong provides an illustration of this channel. After the inception of the US dollar link in 1983, long-term Hong Kong dollar interest rates had tended to be higher than US dollar interest rates,<sup>26</sup> suggestive of the prospects for depreciation outweighing those for appreciation. In effect, the exchange rate link had spent most of the first two decades of its existence being challenged by investors' scepticism. All this changed in September 2003, when appreciation pressure on Asian currencies intensified. Forward rates on USD/HKD traded well below the linked rate of 7.8, or, equivalently, short-term Hong Kong dollar money market interest rates declined, as expected under a currency board mechanism in a capital inflow scenario (Graph 8).<sup>27</sup> As appreciation pressure mounted again in late 2004, 10-year

<sup>24</sup> More generally, expectations of further currency appreciation may also obtain if market participants see intervention merely as slowing, not necessarily preventing, appreciation.

<sup>25</sup> In emerging Asia, Hong Kong, Korea, Malaysia and Thailand have relatively developed corporate bond markets (see Jiang and McCauley (2004) and BIS Paper no 26). However, in most of Asia, housing finance tends to be priced based on short-term rather than long-term rates.

<sup>26</sup> Even on the occasions, as in early 2001, when heavy capital inflows pushed short-term Hong Kong dollar interest rates below their US dollar counterparts, longer-term interest rates remained above.

<sup>27</sup> Effectively zero short-term interbank interest rates led Hong Kong banks to cut their best lending rates, notwithstanding the rising trend of US interest rates.

Hong Kong dollar yields fell below the US dollar counterpart. As appreciation pressure subsided in 2005, the interest rate gap also narrowed.<sup>28</sup> But both reversed again in 2006.

Elsewhere in Asia, however, it is less straightforward to juxtapose currency expectations and long-term yield differentials. While Hong Kong's fixed exchange rate and endogenous short-term rates mean that currency expectations can be cleanly proxied by interest rate differentials (or, equivalently, Hong Kong dollar forward premia), the same is not true for most other Asian economies where the central bank targets short-term interest rates. Under capital mobility, the differences between domestic and US dollar short-term interest rates (both exogenously influenced by monetary policy) are reflected with law-like accuracy in the short-term forward exchange rates. Thus, any observed co-movement between the forward premia and long-term interest rates could reflect the influence of the short-end of the yield curve on the long-end, not only currency expectations. In general, the influence of currency expectations and that of the yield curve cannot be easily untangled.

The existence of non-deliverable forwards (NDFs) for several Asian currencies, however, offers a measure of currency expectations that is independent of monetary policy settings. Since NDF markets are typically not accessible by onshore participants, NDF premia are not tightly constrained by domestic interest rates. Thus, NDFs can in principle serve as cleaner proxies for exchange rate expectations. A notable exception in this regard is the Korean won NDF market, which admits onshore participation and thus generally reflects short-term interest rate differentials.

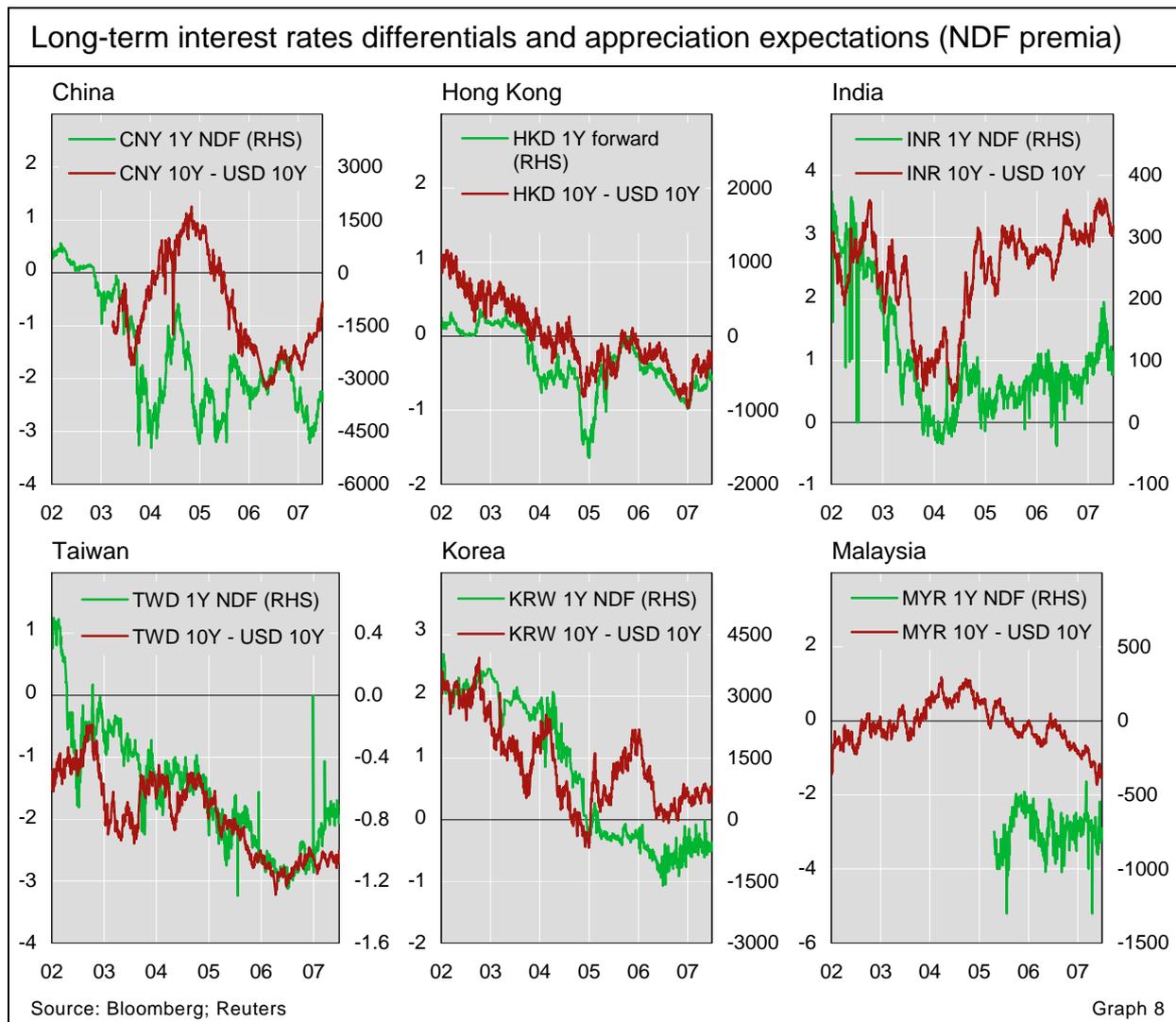
To check for currency expectations effect on long-term interest rate differentials, we plot for Korea, India, Taiwan and China their 1-year NDF premia against the yield spread of their 10-year government bonds over the matching-maturity US Treasury bond (Graph 8). If the expectations channel works, long-term rate differentials should rise and fall with NDF premia.

Overall, evidence from these four economies during the recent period of heavy intervention is not particularly robust. For Korea, the co-movement between NDF premia and long-term rate differentials was quite clear in 2002-2004 and in 2006, but broke down in 2005. However, owing to the onshore-offshore integration permitted in the won NDF market, the NDF premium may reflect short-term interest rate differentials, making it less of an independent indicator of currency expectations than in the cases of the other more segmented markets.<sup>29</sup> Accordingly, the observed co-movement may not be conclusive evidence of uncovered interest parity at work.

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<sup>28</sup> The May 2005 refinements to the currency board, which involved explicitly defining a (hereto informal) strong-side limit of the narrow trading zone for the spot rate, contributed to the cooling of speculative pressure on the Hong Kong dollar. With the benefit of hindsight, the move batted down of the hatches before the imminent unpegging of the Chinese renminbi. The lack of any dramatic developments after the actual unpegging of the renminbi in July 2005 further cooled speculation.

<sup>29</sup> The convergence of Korean bond yields in 2004 to US Treasury yields could just as well reflect continued monetary easing by the Bank of Korea against the backdrop of the Fed's tightening.



Evidence from the other economies is mixed. For India, the currency expectations hypothesis was broadly supported in 2002-2004, but failed quite conspicuously in the fourth quarter of 2004 and broke down more generally in 2005. The long-rate differential in this case remained positive and quite large throughout the sample period. Evidence in the case of Taiwan was, in contrast, generally weak in 2002-2004, but gathered strength in 2005 and 2006. The long-rate differential was negative throughout the sample period. As for China, NDF premia and long-term rate differentials seemed to evolve in opposite directions most of the time. Long-term interest rate differentials rose and fell in a relatively smooth path, but appreciation expectations, as reflected in NDF premia, were quite erratic.

Overall, evidence of the currency expectations channel in Asia has been scant. This finding may be due to the not very internationally integrated nature of bond markets in much of Asia (Takeuchi (2006)). Uncovered interest parity need not hold if foreign investors whose currency expectations drive the pricing of NDFs were not allowed into, or were somehow absent from, domestic bond markets.

The violation of the channel's basic premise – that intervention inevitably ends by force, resulting in accelerated appreciation – may also have contributed to the weak manifestation of this channel. In practice, pauses in intervention often reflect changes in market or economic conditions (eg a halt in capital inflows in April/May 2004, general US dollar appreciation in 2005, capital outflows in May/June 2006). If a pause in intervention does not automatically mean accelerated appreciation, then the observation of heavy intervention per se need not automatically heighten appreciation expectations.

Finally, the argument may not work because low long-term interest rates may reflect factors other than currency expectations. In Asia, weakness in aggregate demand in the early 2000s, restraints on foreign investment by domestic institutional investors (thereby creating a captive investment pool), imbalance between the demand for duration from institutional investors and the supply from the government may have to various extents contributed to low long-term interest rates. Indeed, with investment well short of saving in many Asian economies during the period under review, lower long-term rates might not have been as unwelcome as critics feared.<sup>30</sup>

### 3. Financial stability

The classic financial stability argument contends that rapid foreign exchange reserve accumulation, if not properly sterilised, would result in a strong rise in money and credit that would in turn fuel a financial boom-and-bust cycle. Section 2 already showed that the Asian authorities have generally managed to sterilise base money growth associated with foreign exchange purchases, and that heavier intervention has not so far led to faster private credit growth. Nonetheless, beyond the immediate consequence on money and credit, there could be at least two other potential concerns. One pertains to how banks might react to the build-up of safe and liquid sterilisation debt. Another focuses on the private sector's potential misperception of currency risks, given the authorities' resistance to appreciation, and its choosing to adopt mismatches between the currency of debts and cash flows as a result.

#### 3.1 Sterilisation debt and the riskiness of the financial system

Beyond its consequences for base money, sterilised intervention may also affect the asset composition – and thus the riskiness – of the domestic banking system. As the central bank offers market participants its holdings of government paper or its own liabilities to mop up liquidity, the immediate impact is an expansion of the banking system's holdings of relatively risk-free assets, giving rise to little or no regulatory capital charge.<sup>31</sup> The banking system thus becomes less risky, edging closer to Simon's archetype of a "narrow bank", which backs deposits with low-risk financial assets (Litan (1987), Pierce (1991)).

Subsequent events can take different paths, depending on how much appetite the banking system has for these risk-free securities. If the demand for bank loans is weak or if somehow banks are not keen to make loans, then the banking system would have plenty of room for these safe assets. In this case, banks would be happy to hold these securities and live with the higher ratio of safe assets.

However, if the demand for bank loans is not weak to begin with, then the offering of these public sector debt securities to the banking system would in the first instance siphon off available resources, leaving less available for lending to the private sector – a kind of crowding-out.<sup>32</sup>

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<sup>30</sup> In any case, this argument that intervention could inspire expectations that would in turn depress long-term rates is in contradiction to another popular argument that prolonged sterilised intervention could drive up the yield on sterilisation debt (see section 4.2). Both arguments cannot reasonably hold at the same time.

<sup>31</sup> In the case of sterilisation through foreign exchange swap transactions, the banking system is sold a US dollar deposit with a matching forward purchase of US dollars. As a result, the banking system acquires a foreign asset hedged back into the domestic currency. The risk weight on the asset depends on the foreign currency asset acquired (government paper vs interbank deposit vs full-weight claim on the private sector).

<sup>32</sup> A main difference here is while government debt is typically associated with the financing of fiscal deficit, sterilisation debt does not carry this connotation.

However, the story may not end there. The ultimate effect on credit extension to the private sector could range from crowding-out to an expansion, depending on the banking system's portfolio response to the safe assets, on constraints such as capital and funding availability, and on the demands of borrowers. For instance, if permitted, the banks might sell the sterilisation debt. Even if they retained it, they might take on exposures equivalent to loans through such off-balance sheet instruments as guarantees. In either case, the banks might re-establish their desired balance of risky and low risk assets despite the initial absorption of low-risk government obligations. It is even conceivable that the addition liquidity afforded by sterilisation debt might even lead banks to increase the ratio of risky to safe assets.

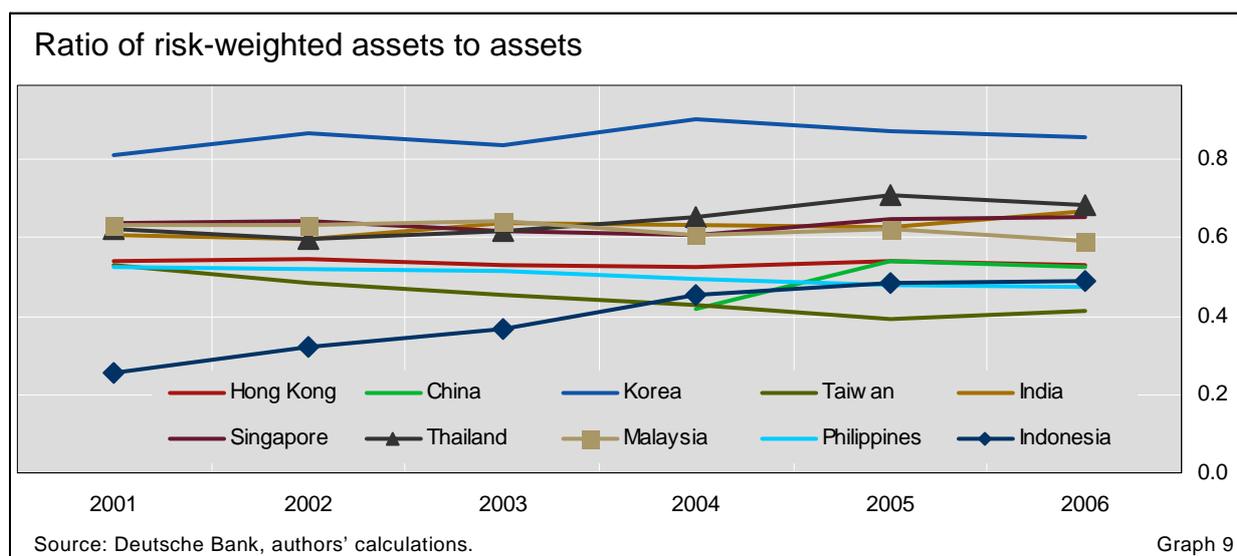
In short, the domestic financial counterpart of foreign exchange reserve growth could influence the growth and the allocation of bank credit. In the limit, an overextension or misallocation of credit could feed back on the health of the financial system. Alternatively, a banking system weighed down with claims on the central bank might face chronic low profitability. Indeed, Yu Yongding (2007) has argued that the build-up of low-yielding sterilisation debt and required reserves on the balance sheets of the Chinese banks is impairing their profitability, with ill consequences in the future.

With this reasoning as background, it is interesting to examine the evolution of the riskiness of bank assets in Asia during the period under review. A decline in riskiness could suggest the dominance of the first-round effect, ie or the case of sterilisation debt filling up the slack between normal deposit growth and weak loan growth (or the "crowding-out" case). Overall unchanged riskiness could point to the dominance of the bank portfolio rebalancing behaviour. A rise in riskiness over time could indicate the dominance of a liquidity effect. Of course, other factors might dominate the effect of the sterilisation debt in the evolution of the riskiness of bank portfolios.

The ratios of risk-weighted assets to total assets for banks in Asia and the Pacific have shown various evolutions between 2001 and 2006 (Graph 9).<sup>33</sup> These aggregate measures of the average riskiness of bank assets are built up from the financial reports of the individual banks listed in Annex 1. Since the largest banks in China were not listed during most of this period, the data for China cover only three years.

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<sup>33</sup> We are indebted to Krista Yue at Deutsche Bank in Hong Kong for the data. Only at the level of banks can one find a comprehensive and reasonably consistent measure of risk-weighted assets, namely that used in computing the Basel ratio. It uses internal information to weight assets according to the Basel ("1") weights. For instance, holdings of government debt (and of claims on the central bank) are unweighted. Interbank claims receive a generally low weight. Commitments to lend and mortgages receive a medium weight, while corporate loans receive a full weight.



One might expect the riskiness of bank assets to increase in a macroeconomic upswing. Nevertheless, of the economies represented, Hong Kong, Malaysia, the Philippines and Taiwan show a decline in the riskiness of bank assets. As the Taiwanese and Malaysian authorities respectively issued central bank certificates to and took deposits from the banking system, the average risk of the banking system's assets fell. The use of foreign exchange swaps by Singapore perhaps leaves the banking system less constrained in its asset choice and thus accounts for the relatively small change in the riskiness of assets despite the scale of the reserve build-up. In contrast, Indian, Korean and Thai banks all showed some increase in their ratio of risk assets to total assets, notwithstanding the sizeable reserve build-up. In the case of India, where the reserve build-up was particularly large in relation to the banking system, the rise in the riskiness of bank assets may reflect the fact that sterilisation in India in this period took the form of the sale of medium-term government (instead of central bank) securities, for which there is a market outside of the banking system. Similarly, the market for monetary stabilisation bonds outside the Korean banks, including foreign banks in Korea and investment trust companies, may have allowed the banks to raise asset riskiness despite the heavy issuance of central bank paper.

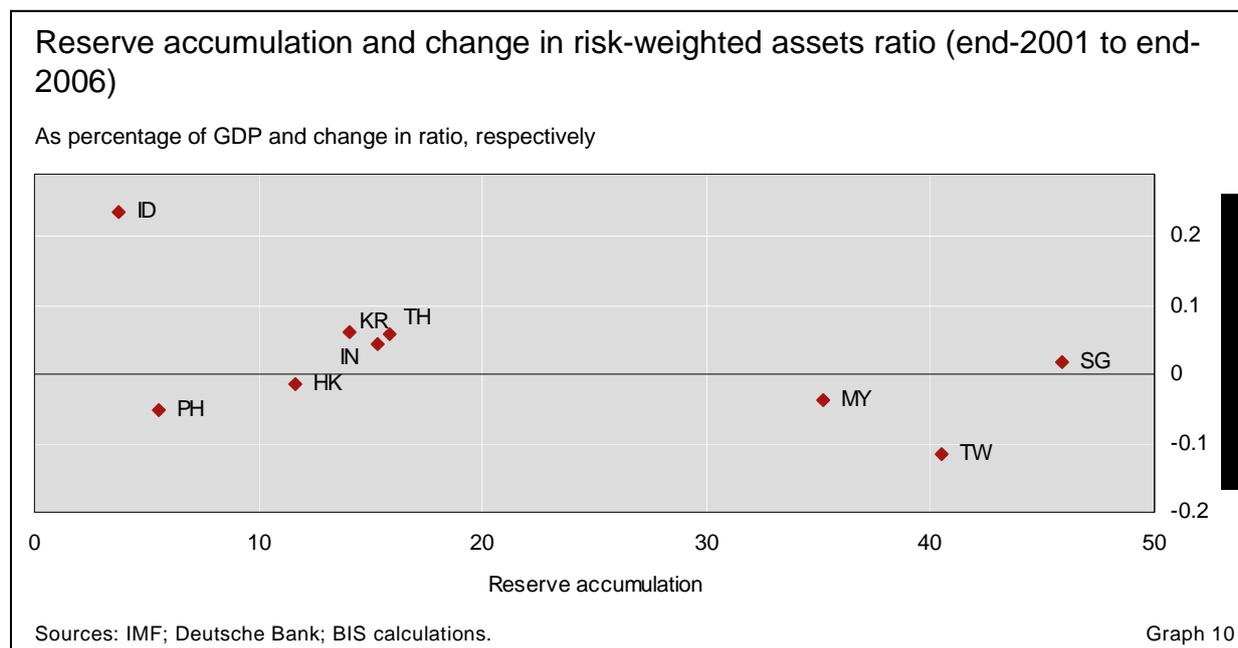
Indonesia is in a class by itself owing to its initial conditions.<sup>34</sup> The rise has to be understood in relation to the previous substitution of government paper for nonperforming bank assets during the financial crisis of 1997-98. As banks have increased their personal and corporate lending, they have moved from being little more than government bond mutual funds to being like banks elsewhere.

It is interesting to note that the average reported asset riskiness of the Chinese banks has risen notwithstanding higher reserve requirements and heavy sales of People's Bank bills. This may imply that their profitability has not been impaired, contrary to the fears expressed on this score. Or it may mean that banks have taken on off-balance sheet risks to offset the safe assets provided by the central bank. Of course, whether the banks have demanded sufficient compensation for whatever risks that they have taken on remains to be seen.

A juxtaposition of the scale of the reserve accumulation across these economies and the change in the ratio of risk-weighted to total assets (leaving China to one side owing to the

<sup>34</sup> Only a small part of the marked rise in the ratio of risk assets to total assets reflects compositional effects from the addition of banks over the sample period as a result of public listings.

brevity of its sample) shows at most a weak negative relationship. The regression line suggests that a 10% rise in the ratio of reserves to GDP is associated with a 3% drop in the ratio, but the R-squared is only 0.27.



In summary, the question of how heavy foreign exchange purchases and associated sterilisation operations affect the domestic banking system is a difficult one. The first-round effect move the system toward “safe” banking, but the ultimate effect could go either way. On the basis of the evidence examined, there seems to be some tendency for heavy sterilisation to be associated with a move in the direction of safe banking, especially when the main instrument of sterilisation is held exclusively or largely by the banking system.<sup>35</sup>

### 3.2 Intervention and currency mismatch

Critics also warn that heavy official intervention may impinge upon domestic financial stability through its influence on the private sector’s perception of exchange rate risks. For instance, if borrowers were induced by the perception of exchange rate stability to accumulate more debt in a lower-yielding foreign currency, they would become exposed to any subsequent depreciation of the domestic currency. The domestic financial system could in turn become exposed via the increased vulnerability of its clients (Goldstein and Turner (2004)).

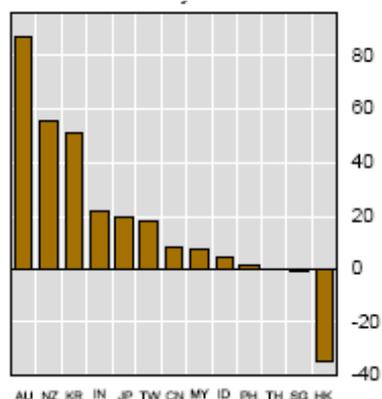
In general, the field for the operation of this sort of currency mis-match has been limited in Asia by interest rates in domestic currencies. Only in India, Indonesia and the Philippines have domestic interest rates been noticeably higher than dollar interest rates. The situation differs from that before the Asian financial crisis, when interest rates in Korea, Malaysia and Thailand tended to exceed those on US dollars. There has been concern in Korea at the growth in yen lending to the Korean corporate sector in 2002, which was associated with stability in the won/yen rate. More recently, it has been the strength of the won against the yen, against a background of a wide interest rate differential, which has led to yen borrowing,

<sup>35</sup> See Mohanty and Turner (2006) for the proposal that sterilisation debt be marketed in the form of long-term paper placed outside the banking system.

equivalent to \$14 billion, apparently mostly by small- and medium-sized companies (IMF (2007, p 26), Bank of Korea (2007, p 53)).<sup>36</sup>

The theme of local currency strength leading to dollar borrowing or forward selling has been important in Korea, India and China. One measure of such foreign selling is the position in domestic currency assets reported by BIS-area banks (Graph 11). The \$50 billion net won assets, for instance, suggests that Korean firms have sold \$50 billion of dollars forward, establishing a short position in dollars in addition to outright foreign borrowing. In these cases, it is the experience of and the prospect for a strengthening of the domestic currency against the dollar that has led to dollar borrowing and forward sales. (In first China, and more recently Korea and India, controls on borrowing dollars by the corporate sector have been tightened or imposed by the authorities.) To the extent that such borrowing and forward sales are being done by exporters, then a balance sheet mismatch (a short dollar position) can be seen as hedging an operating exposure. This is most evident in the case of Korean shipbuilders, who are signing contracts to deliver ships some three to five years from now (Bank of Korea (2007, p 51)). They are exposed to the extent that the contract price in dollars falls relative to the cost of the value added, not least Korean labour. Most interpretations of the return of emerging Asia to building up its debt to foreign banks highlight the role of hedging over the role of a “carry trade” based on suppositions of low exchange rate risk.

Graph 11: Net local currency assets of BIS-area banks



Source: BIS.

We shall not pursue this issue of private sector currency mismatch further in this paper, but will only mention that, from a big-picture perspective, any short-foreign currency position of the corporate sector can be seen as the counterpart to the long-dollar exposure of the official sector (see section 4). Losses in the private sector in the event of domestic currency depreciation would thus be balanced by gains in the official sector. Conversely, valuation losses in the official sector in case of domestic currency appreciation would be offset to some extent by gains in the private sector.

<sup>36</sup> In little more than a year in 2002, yen loans rose from near zero to the equivalent of US\$7 billion. What is remarkable in this case is that the relative stability of the won/yen rate began to set in only at the beginning of 2001. In late 2002, the Financial Supervisory Service of Korea took measures to stem such yen borrowing. Nevertheless, the persistence of a large interest rate gap and the subsequent strengthening of the won against the yen kept private Korean borrowing of yen attractive. In 2007, the Korean authorities re-instated the purposes test for foreign exchange borrowing.

## 4. Central bank profitability and balance sheet risk

Yet another class of domestic financial consequences pertains to the risk and cost that an accumulation of reserves may impose on the balance sheet and cash flow of the central bank itself. Balance sheet risk arises when the counterpart to a central bank's foreign currency assets is mostly domestic currency liabilities.<sup>37</sup> An appreciation of the domestic currency could thus result in valuation losses. Less obvious but also notable is that the benchmark duration for foreign reserves has commonly been extended over time while the duration of interest-bearing liabilities used to finance reserves has generally remained short-term, resulting in an increasing duration mismatch. In addition to these balance sheet risks, the cost of financing the purchase of foreign currency assets by issuing/selling interest-bearing domestic currency liabilities/assets (ie sterilisation) can undermine a central bank's cash flow and profitability. This section examines in turn the exposure to valuation losses and the running cost of acquiring and holding foreign reserves among Asian central banks.

### 4.1 Currency mismatch and exposure to valuation losses

Most Asian central banks have long held a relatively large portion of their assets as foreign currency assets. They also tend to have little or no foreign currency liabilities, resulting in considerable currency mismatch and potential exposure to foreign exchange valuation changes. The economic significance of such exposure is best gauged by the size of a central bank's net foreign assets in relation to GDP. By this metric, Singapore ranked first with its official foreign assets in excess of 100% of GDP, followed by Hong Kong and Taiwan (70-75% of GDP). For these economies, every one percentage point decline in the value of foreign assets would imply a wealth loss of 0.7% to 1.0% of GDP. In contrast, although the headline official reserve figures of Japan, China, Korea and India are large, the economic significance of each percentage point decline in value is more modest by comparison – 0.4% of GDP for China, as of end-2006, and 0.2-0.3% for the other three economies.

Notwithstanding the mismatch, the actual exposure of these central banks' balance sheets to currency appreciation depends on the currency allocation of their reserve portfolios. Absent detailed public information on currency allocation, Asian authorities are typically thought of as holding mostly US dollar assets. Under this assumption, the 30% appreciation of the Korean won, for example, against the dollar from 2002 to early 2005 would have eroded Korea's official wealth by some 9% of GDP over three years, all else being equal.<sup>38</sup> However, if Asian central banks are at all diversified into currencies that have appreciated against the US dollar (eg euro, sterling, Australian dollar), valuation losses from domestic currency appreciation would be less than what the all-US dollar assumption indicates.<sup>39</sup> For example, despite a small spot appreciation of the Hong Kong dollar against the US dollar in late 2003, Hong Kong's Exchange Fund in fact recorded valuation gains in 2003, thanks to the even stronger appreciation of the non-US dollar foreign currency component (at least 20%) of the portfolio.

How much does exchange valuation really matter in practice? Valuation is only one factor affecting profit and loss – other net cash flows (eg interest earnings and payments, see

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<sup>37</sup> It is worth noting that, while central banks' reserve management functions are increasingly subjected to advanced risk management techniques, different deputy governors often bear responsibility for domestic liabilities and foreign assets. Thus, an integrated asset and liability management perspective cannot always be assumed.

<sup>38</sup> Yetsenga (2007) provides estimates of valuation losses among Asian central banks for the period July 2006 to June 2007, apparently under the all-US dollar assumption. Korea's estimated valuation losses are much more modest (0.5% of GDP) given the much lower rate of won appreciation in this period.

<sup>39</sup> With a substantial fraction of emerging Asia's reserves not included in the aggregate currency breakdown statistics published by the IMF, it could be that emerging Asia is more diversified than is often presumed.

section 4.2) can sometimes offset any impact of exchange valuation on the headline P&L.<sup>40</sup> Moreover, valuation losses are often charged to provisions or reserves, and not run through the central bank's final profit and loss statement. Such accounting conventions could play a role in muting the fiscal (political) repercussion of valuation losses if central bank profit disposition is based on *reported* and not *actual* profits. However, one risk behind this apparent convenience is that the central bank may still be transferring notional profits to the fiscal authorities even as the market value of its assets falls short of that of its liabilities. In Asia, such accounting conventions are currently practiced in at least Taiwan and Japan.<sup>41</sup> One known counterexample is Hong Kong, where assets are valued at market prices and the announced investment income is inclusive of foreign exchange valuation effects.

Regardless of whether there are visible fiscal repercussions down the road, exchange valuation losses may still have a near-term impact on the central bank's capital. How much of an effective appreciation of the domestic currency a central bank can withstand depends on the size of its capital/reserve fund relative to the size of its net foreign assets.<sup>42</sup> Furthermore, how fast a valuation loss of a given size can be made up for by seigniorage income flow depends on the size of the monetary base relative to that of foreign assets (this ratio tends to be low among Asian central banks) and the level of domestic interest rates. The worst scenario is one in which valuation changes are so big that they turn the central bank's cash flow negative.

Even if capital is eaten up by valuation or other losses, there is in principle the option of recapitalisation. The perceived seriousness of shortfalls in the central bank's capital thus presumably depends on how averse the central bank might be to seeking such recapitalisation from its government owner. The risk is that the legislation that restores positive capital may carry some political baggage for the central bank. The three case studies below illustrate how central bank losses could play out in practice.

### ***Policy towards valuation losses: the case of Taiwan in the late 1980s***

Taiwan in the second half of the 1980s provides a useful case study of how a large domestic currency appreciation plays out in an economy with large foreign reserves. At the time, Taiwan's foreign exchange reserves were at levels in relation to GDP reached recently by several other Asian economies, so the comparison is quite apt.

In the wake of the period of yen appreciation after the Plaza Accord in 1985, pressure for appreciation focused on the New Taiwan dollar and the Korean won. The Taiwanese authorities resisted appreciation all the way from around 40 TWD to the US dollar at end-1985 to below 29 TWD by end-1987 – an appreciation of almost 40% in two years. By 1989, the currency had settled in the range 25–27 TWD per US dollar. The account below starts with the central bank's accumulation of reserves during this episode, then discusses the scale of the valuation losses entailed by the sharp appreciation of the currency in 1986-87, and then traces through the gradual and implicit fiscal assumption of those losses.

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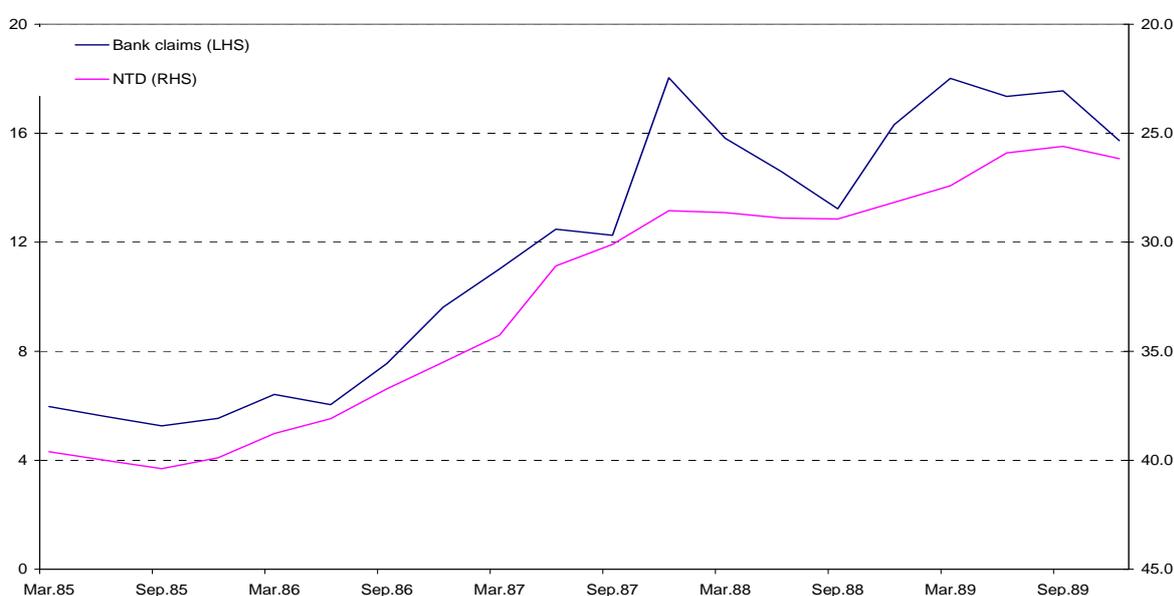
<sup>40</sup> According to the hypothesis of open interest rate parity, valuation losses should be offset over the long run by interest rate gains. Recent evidence is on the side of low yielding currencies not appreciating sufficiently to offset the interest differential.

<sup>41</sup> In Japan, since the Ministry of Finance holds most of the foreign exchange reserves, one might expect a more direct fiscal impact. However, this expectation is only partially borne out. Valuation losses on the foreign reserves are, although publicly reported, not counted as fiscal spending. Thus, the fiscal impact of a stronger yen is institutionally at least muted.

<sup>42</sup> For instance, if net worth is 50% the size of net foreign assets, that means one can afford to lose at most 50% the value of net foreign assets (equivalent to 100% effective appreciation of the domestic currency) and still maintain technical solvency. If net worth is only 20% the size of net foreign assets, then one can only afford to lose 20% of the value of net foreign assets (ie a 25% effective appreciation).

The Taiwanese authorities' choice to tolerate a gradual appreciation (instead of a step revaluation, as preferred by the US authorities at the time) was intended to buy time and breathing space for the local enterprises. However, given considerable capital account openness, such a policy induced the domestic private sector to form appreciation expectations, which in turn encouraged US dollar borrowing for conversion into local currency. BIS-area bank claims on Taiwan jumped by more than US\$12.5 billion in 1986-87 (Graph 12), a sizeable sum even in relation to the cumulative \$34 billion current account surpluses in those years. The US dollars sold by the private sector were bought by the Taiwanese authorities. As a result foreign reserves rose sharply from just over US\$22.5 billion at end-1985 to around US\$76.7 billion by end-1987 (ie from 36% to 75% of current year GDP). Outstanding certificates of deposit (NCDs) issued by the central bank for sterilising such inflows expanded over thirty-fold from a nominal amount of TWD26.7 billion at end-1985 to TWD 946.1 billion (about US\$ 33 billion) at end-1987.

Graph 12: Cross-border claims of BIS-area banks on Taiwan and the exchange rate



Source: BIS.

Against this background, foreign exchange valuation losses mounted for the central bank. By June 1987, losses reportedly exceeded TWD 300 billion, equivalent to 9% of GDP and about half a year's fiscal budget (Wang (1999)). With a further rise of the TWD of 8% in the second half of 1987, the unrealised loss could have reached TWD 450 billion by the end of the year (about 13% of GDP). CBC (2006) reports that unrealised exchange valuation losses were "as high as NT634.9 billion at the end of April 1989" (evaluated at TWD 25.55 to the US dollar), amounting to 16% of 1989 GDP.

Such valuation losses appear to have taken years of seigniorage to work off.<sup>43</sup> Under the presumed pressure from the gradual realisation of these losses, reported central bank net income fell from 1¼% of GDP in fiscal year 1985 to negligible levels in 1987-1990 (see

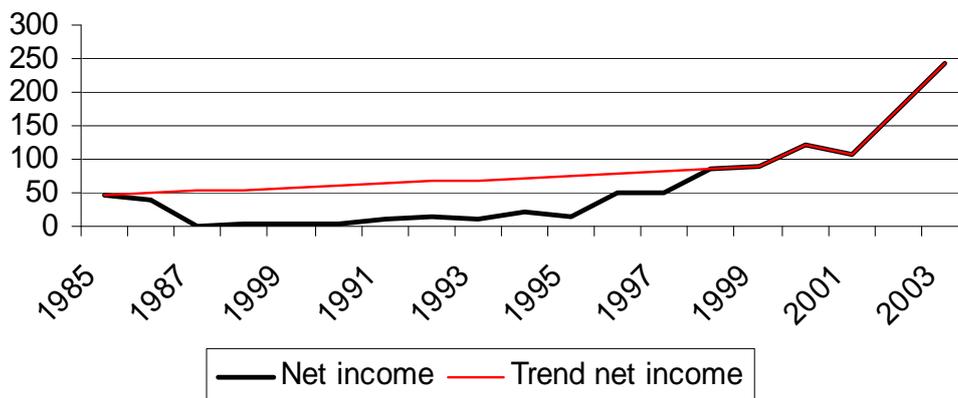
<sup>43</sup> Wang (1999) reports that there were only TWD61.9 billion in provisions available in mid-1987, possibly reflecting the earlier depreciation of the TWD from its fixed rate of 38 in 1978 to around 40 in the early 1980s.

Graph 13). Only after the depreciation associated with the 1997-98 Asian crisis did reported net income return to the 1985 level.<sup>44</sup>

With regards to the fiscal impact, in principle, half or more of the reduction in central bank net income would have passed through to the fiscal budget in the form of lower transferred profits.<sup>45</sup> CBC (2006) reports that no funds were transferred to the government in 1986-90. The graph below contrasts the stated net income of the CBC with (logarithmically) interpolated net income for 1986 through 1997 based on reported net income in 1985 and 1998. The gap between the two cumulates to TWD567 billion, in the range of the reported unrealised valuation losses. The hypothetical foregone government revenue would be half or more of this sum.

Graph 13: CBC profits

In billions of NT dollars



In theory, the gradual recognition in the government budget of the wealth loss could have led to lower aggregate spending if government spending was cut or taxes were raised in response to the interruption of the flow of seigniorage profits to the budget. However, the observed rise of government debt outstanding between 1986 and 1995, from 3.5% to 22.6% of GDP (CBC (1995, p 30)), leaves room for the interpretation that the wealth loss simply resulted in higher government debt rather than pressure on spending.

The sharp rise in external debt of the private sector as the currency appreciated highlights the potential fallacy of equating the government wealth loss to a national wealth loss. Given the succession of current account surpluses and capital inflows into corporate equities, the Taiwanese private sector was probably holding a net long US dollar position in 1985. As it became clear that the domestic currency was going to appreciate, firms borrowed US dollars from abroad to invest in domestic currency assets. In effect, the private sector transferred a long-dollar position to the government. Thus, the counterpart of some of the official sector loss was a private sector gain (or at least a smaller private loss). One could even stretch and regard this transfer as an indiscriminately distributed adjustment assistance. In any case, some of this private profit was presumably captured by corporate taxation.

<sup>44</sup> The Central Bank of China Act, Article 43 (first introduced in first amendment in 1979) reads "The gain or loss from the Bank's assets or liabilities denominated in gold, silver, foreign currencies and other forms of international reserve, due to changes in parity of the national currency, or changes in the value, parity or exchange rate of these assets and liabilities relative to the national currency, shall not be listed as the Bank's annual profit or loss. Any gain from the above changes shall be entered into an Exchange Reserve Account, and any loss shall be offset in the balance of that Account".

<sup>45</sup> The profit-sharing rule between the CBC and the government is stated in CBC Act Article 42: at the close of each fiscal year, the CBC is to set aside 50% of its net profit as legal retained earnings (can set aside less if the accumulated legal retained earnings are already as large as the central bank's current capital). The rest can be transferred to the government.

Overall, the lesson would appear to be that, in practice, the recovery from losses or even technical insolvency of a central bank resulting from large reserves and sharp currency appreciation is stretched out over time. Both this gradualism and locus of the risk in the government balance sheet probably attenuate the macroeconomic effects of the wealth loss, as compared to the experience of the same loss in the private sector. Yu Guo-hua, former CBC governor (1969-1984) and the president of the Executive Yuan during the appreciation episode, interpreted the losses to the central bank as simply a price to pay for protecting local enterprises' profits from the presumably more unpleasant alternative of a sharp appreciation (Wang (1999)). Central bank losses in this case were not really seen as a weakness, but as a means to a presumably more important public purpose. Moreover, with local consumers benefiting from the improved terms-of-trade, public perception may have found it difficult to connect a "strong" currency with a "weak" central bank.<sup>46</sup>

### ***The Bank of Korea in 2003-2006***

The stress on the income and capital of the Bank of Korea arising from the appreciation of the won from around 1200 per dollar towards 900 per dollar in 2004-06 led to initial policy responses similar to those observed in Taiwan in the late 1980s. In 2003, the Bank of Korea recorded profit before income taxes of KRW3.175 trillion and paid income taxes of KRW1 trillion. By 2005, with a loss of KRW1.878 trillion, income taxes fell to zero. At end-2006 the exchange valuation losses stood at KRW26.1 trillion, well in excess of capital of KRW2.0 trillion (Bank of Korea (2007, p 66)). The unrealised losses were thus about 3% of GDP.

However, if further losses are realised in the income account at the same rate as 2005-06 and capital is exhausted in a year or two, the Korean approach will change gears. In particular, under the 1999 Bank of Korea law, the government is committed to making good any capital deficiency. This may imply that, rather than just foregoing income, the government will have to seek appropriations from the legislature. It is possible that appropriations associated with this keep-well arrangement will add to the political salience of the wealth loss and make it more likely that fiscal spending or taxes are affected.

Once again, government losses here cannot be taken as a proxy for national losses. The Korean corporate sector is thought to be structurally short the dollar, owing to external debt denominated in US dollars. Broad evidence for this can be seen in Table 1 below, which shows that the official sector's reserve assets exceeded the nation's long position in foreign currency as a whole. The difference can be seen as the corporate sector's short-dollar position. This can be seen not as a currency mismatch but rather as a hedge against the operating exposure of Korean exporters to won strength. Accordingly, the corporate sector's balance sheet gains from won appreciation would to some extent represent a counterpart to the official sector's balance sheet losses. Even from the strictly fiscal standpoint, the government's tax share of the corporate valuation gain from a strong won should be expected to offset to some extent the government's losses from a strong won.

Table 1

#### **Currency composition of the Korean net international investment position, end-2003**

	<b>Billion US dollar</b>	<b>Percent of GDP</b>
Total	-86	-14
Won	-186 <sup>1</sup>	-31

<sup>46</sup> A similar case can be found in Germany, where the appreciation of the Deutsche mark against the US dollar in the early 1970s put the Bundesbank into a position in which its assets fell short of its measured liabilities. And yet, neither the central bank's standing as a counterparty, nor the German public's trust in it, seemed to diminish as a result.

Foreign currency	100 <sup>2</sup>	17
<i>Memo: Reserve assets</i>	155	26

<sup>1</sup>Sums portfolio equity investment in Korea and direct foreign investment into Korea. <sup>2</sup>Total less won. This treats foreign-currency bonds that are convertible into Korean equity as foreign-currency.

Source: BOK, author's estimates.

### ***The Bank of Thailand, 2006***

While the Bank of Korea's profit and loss account seems to reflect foreign exchange losses only as they are realised, the Bank of Thailand marks its foreign exchange assets to market and shows the result in its profit and loss account. As a result of the rise of the baht by 14% against the dollar and 15% against the yen in 2006, that year the Bank of Thailand recorded a net B100 billion loss on foreign exchange, or approximately \$3 billion (Bank of Thailand (2007)). This resulted in a similarly sized overall loss of about 2½% of GDP. This loss more than wiped out the Bank's recorded capital and left it with stated negative net worth.

Much debate in Thailand has focused on the proper interpretation of these results. Bank of Thailand officials have emphasised that the profit and loss is not the measure of the success of a central bank, but rather the level of inflation in relation to the target. The timing of these developments has proven awkward, coming at a time of consideration of various legal initiatives, ranging from the measures to set the Bank of Thailand's mandate as an inflation targeter and to strengthen its independence to measures that would widen its permitted foreign reserve investments.

### ***Summing up***

The experience of Taiwan, which experienced a very large appreciation while already holding reserves in excess of a third of GDP, suggests that large central bank losses on reserve holdings can take a decade to offset through the central bank's cutting off the flow of seigniorage to the government. Such a gradualist approach made it more likely that the losses ended up as larger government debt than spending cuts or tax rises. The Taiwanese story had an element of transfer from the public sector to the private sector that is worth bearing in mind.

The appreciations of the won and baht have been less to date and as a result the losses to the net worth of the Bank of Korea and the Bank of Thailand remain an order of magnitude smaller. Yet the accounting for profit and loss of the foreign exchange losses in these two cases is likely to make the issue of central bank losses more salient. The fiscal and political outcomes are hard to predict, however.

## **4.2 The quasi-fiscal cost of financing and holding reserves**

Apart from the exposure to foreign exchange valuation changes, the running financial (quasi-fiscal) cost associated with sterilised intervention is another – perhaps more frequent – complaint against such operations. Experience from past decades has led to the view that sterilisation is costly because it essentially amounts to exchanging higher-yielding domestic assets (government bonds, central bank deposits or paper) for safe but lower-yielding ones (eg US Treasuries). Conventional wisdom also warns that sterilisation operations will get costlier over time, as the interest rates on sterilisation debt are driven up. This would in turn attract more inflows, fuelling a vicious cycle that renders sterilisation more difficult and expensive over time. In addition to the flow cost of sterilisation operations, there is also a stock opportunity cost to contend with. By accumulating and holding on to a large stock of foreign currency assets, a central bank may be forgoing potentially higher yields on domestic assets.

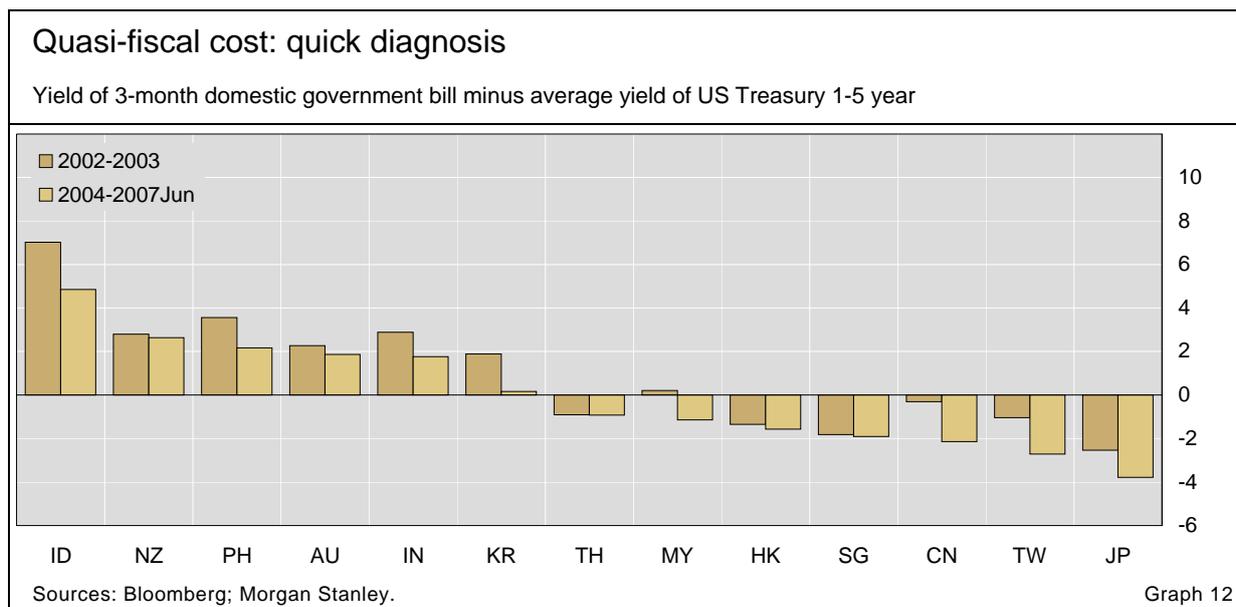
These conventional arguments have their roots in episodes of large capital inflows into emerging markets in the 1970s, 1980s and 1990s. The experience in Latin America, in particular, contributed much to the formation of these views. There and then, heavy intervention and sterilisation typically occurred in the context of exchange rate based stabilisation programmes, with high inflation, high (often double-digit) domestic interest rates and shallow domestic bond markets. These characteristics, however, were not evident in Asia in the current decade.

For a quick diagnosis, one can look at the difference between short-term domestic interest rates (proxy for gross cost of sterilisation operations) and medium-term US Treasury yields (proxy for gross return on foreign reserves). In 2002-2003, the differentials for Japan, Taiwan, China, Singapore, Hong Kong and Thailand were on average negative (Graph 12). This suggests that, rather than being cash-flow costly, reserve accumulation in these economies was in fact potentially cash-flow remunerative. Among economies with positive interest rates differentials, only Korea and India engaged in sizeable sterilised foreign currency purchases during this period, making them the only clear cases of costly reserve accumulation.<sup>47</sup> Even so, with US medium-term rates on net rising faster than most Asian rates in 2004-2006, the running cost of sterilisation in fact subsequently decreased into 2007.<sup>48</sup>

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<sup>47</sup> High interest rate economies such as Indonesia and the Philippines happen to be at the bottom of the reserve accumulation league table, given the lack of appreciation pressure through the third quarter of 2005. As central banks in economies have since engaged in sterilised intervention to resist appreciation, the operations have proven costly, particularly in Indonesia.

<sup>48</sup> It is worth mentioning that, the trend-lengthening of the duration of foreign reserve portfolios over the past decades may have in practice helped to mitigate the carry cost of foreign reserves. As longer-dated foreign reserve assets (eg five-year US Treasury securities) tend to yield more than shorter-dated reserve assets (eg three-month Treasury bills), the carry cost is limited accordingly. See McCauley and Fung (2003) and McCauley (2007).



Annex 2 presents the detailed cost calculations for India and Korea. To summarise, estimates for the incremental net flow cost in a 12-month period were in the range 0.10%-0.20% of GDP for Korea and 0.06%-0.10% of GDP for India, depending on the intensity of intervention and the levels of relevant interest rates. For Korea, the “perfect storm” episode was the 12 months to March 2004, when the 12-month increase in central bank foreign assets (both gross and net) was the largest and the assumed relevant interest rate differentials were the widest. For India, there was no such clear “perfect storm” episode. June 2004 and July 2006 saw the largest 12-month increase in net foreign assets, but the local peak in interest rate differentials during that period occurred at around November 2004.

As for the stock cost, any estimate is based on some notion of warranted reserves, ranging from zero to an amount that matches some criterion or criteria (imports, short-term debt, portfolio holdings subject to reversal, etc. On the basis of zero reserve holdings, estimates were in the range 0.06%-0.62% of GDP per annum for Korea and 0.40%-0.60% of GDP for India, depending on the size of foreign reserve holdings and interest rate differentials. Of course, if warranted reserves are taken to be higher, say enough to cover 3-months’ imports and short-term debt, then the stock costs would be much lower (Genberg, et al (2005, p 26)). The question here is whether these costs are in fact seen as too large to be justifiable.

### ***Sterilisation drives up interest rates?***

Commentaries on capital inflows into emerging markets invariably warned of the rise in interest rates as perhaps the deadliest domestic consequence of sterilised intervention. As the central bank issues more and more sterilisation debt, the price of these securities will have to fall and yield will have to rise, rendering future operations costlier.<sup>49</sup> Another way to argue interest rate rise: large reserves are seen as tempting politicians to take on large

<sup>49</sup> Note that the adverse impact on interest rates argued here is opposite in direction to that argued under monetary control (see sections 2.1 and 2.3). Both arguments cannot hold true simultaneously. Moreover, the argument here assumes the central bank is independently pushing sterilisation debt to an uninterested private sector. However, the inverse relationship between loan-to-deposit ratios and the degree of reserve accumulation discussed in section 2.2 suggests that there is scope to allow for an alternative interpretation: the central bank is in fact responding to the strong private sector demand for safe domestic currency assets.

expenditure projects. This jeopardises the outlook for government finances. Government bond investors would thus require a premium to hold bonds.<sup>50</sup>

Did this happen in Asia? Rates for Taiwan's NCDs and Korea's MSBs remained clearly on a down trend through 2004. MSB yields picked up notably in early 2005, prompting some observers to think that the Korea authorities were finally running into difficulties. However, yields subsequently assumed a slower pace of increase. As of end-2006, yields on 1-year MSBs were still lower than yields back in 2002. NCDs in Taiwan began to climb in late 2004, but remained low in absolute terms (less than 2%) and relative to their 2002 levels. Government bond yields did rise in China (late 2003 to 2004) and in India (since 2004), possibly suggesting an oversupply, though also consistent with higher inflation expectations and monetary policy tightening. Whether this observed rise in interest rates is a direct consequence of sterilised intervention is open to debate.<sup>51</sup>

## 5. Concluding remarks

This paper assesses whether the large reserve accumulators in Asia over the period 2002-2006 have experienced the predicted adverse domestic consequences of resisting currency appreciation with sterilised intervention. The evidence examined suggests that the well-cited perils in the Calvo tradition have so far not been as evident or widespread in Asia as many observers anticipated.

With respect to monetary control, be it in terms of liquidity operations, inflation performance and credit growth, India is the only top reserve accumulator showing clear, multiple symptoms consistent with the perils. The evidence to date on China has been mixed, with its current upsurge in inflation largely confined to food prices. In terms of the riskiness of the banking system, India is again the only top reserve accumulator that has seen the ratio of risk-weighted to total assets rise, albeit only mildly, over the sample period. The rise in the riskiness of assets across listed banks in China in 2004-06, notwithstanding increases in required reserves and heavy sales of central bank paper bears further investigation.

Regarding central bank income and balance sheet risks, while it is true that the carrying cost is significantly positive only for India among the large reserve holders, the exposure to exchange valuation losses applies more widely across the region. Diversified currency allocation and net private sector foreign currency debt are only partial mitigating factors. Experience in Taiwan suggests that the government may have to forego a decade's seignorage income to make good official valuation losses on foreign exchange reserves. In the cases of Korea and Thailand, central bank losses might require legislative recapitalisation of the central bank, and the political ramifications would remain to be seen.

All in all, although China has been more often implicated in the dire prophecies associated with reserve accumulation, it is in fact India that has exhibited more of the classic symptoms. Why then has Asia-ex-India been able to weather five years of intervention and over USD 1.5 trillion of reserve accumulation without showing conclusive signs of the predicted adverse consequences? The key may lie in Asia's specific economic circumstances in the early 2000s. Large banking systems with weak corporate loan demand against the backdrop of

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<sup>50</sup> This must be a yield curve argument. With monetary policy setting a short-term interest rate, sterilisation is intended to keep the short-term rate from falling. For sterilisation to force up yields, the sterilisation debt must be sold out the yield curve, where market participants can exact a premium for large issues.

<sup>51</sup> Even if interest rates did rise, it is not guaranteed that more inflows would automatically ensue. For instance, capital flows into Korea and Taiwan typically head for equities rather than bonds. A rise in local interest rates may not necessarily have a major impact on capital flows. In fact, if higher interest rates are seen as a drag on growth, they may even inspire capital outflows.

weak corporate investment and macroeconomic slack characterised much of the region, and in China, too there was ample corporate savings in relation to investment. These conditions may have helped to weaken any inflationary consequences that reserve accumulation could have brought otherwise. As a corollary, the relatively low domestic interest rates in most of Asia have allowed sustained sterilisation operations at little or no carry cost. By contrast, conditions in India have been less favourable: a smaller banking system, and, in recent years, strong loan demand by a corporate sector running a financial deficit (associated with a current account deficit) have kept domestic interest rates high and have made the classic risks recognisable.

If the conclusion is so far, surprisingly so good, there remain grounds for concern.. Possible response lags and timing differences may mean that the adverse consequences are even now on their way. While evidence to date suggests no strong relationship between credit growth and the extent of reserve accumulation, the latter's relationship to asset prices merits further investigation, especially in light of the surge in Chinese equity prices in 2006 and 2007. While Indonesia and the Philippines have been spared from appreciation pressure for most of the sample period, their reserve growth has finally also picked up since mid-2006 and mid-2005, respectively. The smaller banking systems and higher interest rates in these two economies might make large-scale reserve accumulation more risky and costly for them than for most of their Asian neighbours.

Whether the Asia exception can be sustained in a global environment of higher inflation remains to be seen. It may be that higher global food and energy prices could lead Asian policy-makers to allow more appreciation of their currencies. As the Korean and Thai cases suggest, such a policy shift could make more evident the risks of the previous resistance. In short, the domestic financial consequences of resisting appreciation and accumulating reserves may remain a topic of policy discussion for some time to come.

## Annex 1: Sample banks used to measure bank asset riskiness

### China

Bank of Comm  
Bank of China  
China Construction Bank  
China Merchants Bank-H  
ICBC Ltd.  
China CITIC Bank  
Industrial Bank  
Shanghai Pudong Bank  
China Minsheng Bank

### Hong Kong

BOC Hong Kong Holdings  
Bank of East Asia Ltd  
ICBC (Asia)  
CIFH  
Dah Sing Banking Group  
Dah Sing Financial Gp  
Hang Seng Bank  
Wing Hang Bank  
Wing Lung Bank

### India

Bank of Baroda  
Canara Bank  
Union Bank Of India  
HDFC  
HDFC Bank  
ICICI Bank  
OBC  
PNB  
State Bank of India  
IDFC  
Axis Bank  
Karnataka Bank  
Dev Credit Bank  
YES Bank  
Kotak Mahindra Bank  
Centurion Bank

### Korea

Daegu Bank  
Pusan Bank  
Industrial Bank Of Korea  
Woori Finance Holdings Co Ltd  
Shinhan Financial  
Hana Financial  
Samsung Card

### Malaysia

AMMB Hlds  
Bumiputra Commerce  
Hong Leong Bank  
Maybank  
Public Bank

### Philippines

Banco de Oro  
BPI  
Metropolitan Bank  
Security Bank Corp  
Union Bank

### Singapore

DBS Group  
OCBC  
UOB

### Taiwan

Shin Kong FHC  
Chinatrust Financial  
First Financial Holding Co Ltd  
Fubon FHC  
Mega FHC  
SinoPac Holdings  
Taishin Financial HldgsChang Hwa

### Thailand

Bangkok Bank  
Bank of Ayudhya  
Kasikornbank  
Krung Thai Bank  
Siam City Bank  
Siam Commercial Bank  
Thai Miliatary Bank

## Annex 2: The costs of reserve accumulation

Cost estimation has been the subject of many previous studies, and yet there seems to be little agreement on how to define, much less estimate, such costs. We find that there are at least two main ways of thinking about the financial costs associated with reserve accumulation through sterilised intervention. One is the cost of sterilisation operations over a period of time (flow cost). And another is the financial opportunity cost of holding a given stock of reserves at a point in time (stock cost).<sup>52</sup>

There are some subtle but important differences between the two concepts. A stock (holding) cost can in principle be estimated for any central bank that holds any amount of foreign assets, regardless of whether the acquisition of such assets involved sterilisation or not. A flow (sterilisation) cost, in contrast, applies only when the acquisition of foreign assets is associated with interest-costing/foregoing sterilisation operations during the period in question. The stock or opportunity cost seems to be the more widely studied by economists, but the flow cost seems to be of more practical and budgetary relevance for the authorities. Confusingly, the term “cost of sterilisation” is sometimes loosely applied to mean “the opportunity cost of holding reserves”.

In this Annex, we consider estimates based on both concepts for the period of strong capital inflows and heavy sterilised intervention in Asia since 2002. Our approach is to focus on the costs estimated for the two most challenged candidates – namely, Korea and India, owing to their relatively high domestic interest rates – under relatively conservative assumptions. The idea is that if costs so estimated are still within acceptable limits, then we can argue that costs can only be less problematic for other economies facing more favourable conditions.

### Flow cost: the cost of sterilisation operations over a period of time

We need three main ingredients to estimate the flow cost of sterilisation operations over a certain period of time:

1. *How much sterilisation is done.* Since foreign reserves are held at the central bank in most Asian economies (Japan is a clear exception), we proxy sterilisation amount with the difference between the change in central bank foreign assets and the change in base money, expressed as a percentage of GDP. This measure essentially assumes that whatever foreign asset growth that does not have a counterpart in base money growth requires active sterilisation, ignoring the possible contribution of other autonomous factors (eg government deposits). It also does not cover “passive sterilisation” via reserve remuneration or a hike in reserve requirements. However, this measure allows for active sterilisation using more than one instrument. Thus it is a more inclusive measure compared to the commonly used approach of proxying sterilisation with just the net change in central bank domestic assets or the net change in central bank paper outstanding.<sup>53</sup>

2. *What the authorities pays on the sterilisation instrument(s) used.* Existing studies typically apply a short-term domestic rate or domestic government bond yield across the board, without any reference to the sterilisation instrument(s) used. We find it more appropriate to relate cost to the instrument(s) actually used or likely to have been used. For Korea, since

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<sup>52</sup> We concede that we also do not have the definitive way of estimating costs (if such a way exists). In practice, the definition of costs depends on how the problem is framed in political terms, which varies across economies. For example, the “local” concept of costs in India is based only on the amount of new government securities issued under the Monetary Stabilisation Scheme adopted in April 2004.

<sup>53</sup> These two common alternatives, though convenient, are less than ideal also because they do not make any reference to the change in foreign assets and thus do not necessarily have anything to do with intervention. They could be capturing liquidity management operations for reasons other than foreign exchange intervention.

both the central bank and the MOFE contribute to financing sterilised interventions, we use both the BOK's Monetary Stabilisation Bonds (MSBs) and the MOFE's own bonds and assume average maturities of 1 year and 5 years, respectively. For India, we assume the instrument in question to be 5-year Indian government bonds.<sup>54</sup>

3. *What the authorities earn from the acquired foreign assets.* We assume foreign reserves earn the equivalent of medium-term US Treasury notes (average 2- to 5-year maturity). This is a relatively conservative assumption, though not as conservative as studies that just apply a very short-term (less than 1 year) US T-bill rate. However, the medium-term T-notes assumption is probably more realistic. When foreign reserves are sufficiently large, there is no need to keep all reserves in short-dated, liquid but low-yielding instruments.<sup>55</sup> Reserve managers can – and do – diversify their foreign reserve portfolios in more lucrative ways.

Tables A1 and A2 show the flow cost estimates for Korea and India for selected periods over 2003 and 2006. Overall, the estimates do not appear large. For Korea, the flow cost (net of interest earnings on foreign assets) for the 12-month period ending March 2004 totalled about 0.2% of GDP. This period was arguably a “perfect storm” episode: the increase in central bank foreign assets (both gross and net) was the largest and the assumed relevant interest rate differentials were the widest. Interest differentials for Korea narrowed subsequently, helping to lower the net cost.<sup>56</sup> For India, there was no clear “perfect storm” episode. The two 12-month periods with the largest increase in net foreign assets are the period ending June 2004 and that ending July 2006. In both cases, the estimated flow cost was at most 0.1% of GDP. However, with Indian interest rates rising since 2004, the cost was kept high, despite the smaller-scale operations, compared to Korea.

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<sup>54</sup> Medium-term Indian government securities could be a plausible assumption for before the inception of the Market Stabilisation Scheme (MSS) in April 2004. In practice, the MSS has involved mostly the issuance of short-term securities.

<sup>55</sup> Also, with the possibility of doing repurchase agreements (repos), the nominal maturity of the security becomes a less relevant constraint on liquidity.

<sup>56</sup> However, the differential facing the MOFE did not narrow as much as did that facing the BOK. This together with the bigger share of foreign reserves financing attributable to the MOFE after 2003 contributed to the larger cost incurred to the MOFE.

Table A1

**Estimated flow cost of sterilisation operations over 12 months: Korea**

	Dec 2003	Mar 2004	Sep 2004
Quantities (% of GDP <sup>1</sup> ):			
$\Delta$ FA less $\Delta$ RM <sup>2</sup>	4.93	8.45	6.43
$\Delta$ NFA less $\Delta$ RM <sup>2</sup>	3.34	4.11	1.64
$\Delta$ MSBs	2.93	3.07	3.02
$\Delta$ FL <sup>2</sup>	1.60	4.34	4.79
Interest paid on MSBs 1-year (%) <sup>3</sup>	4.42	4.35	3.18
Interest paid on Gov bonds 5-year (%) <sup>3</sup>	4.75	4.78	4.70
Interest earned, UST ave.2-5 year (%) <sup>3</sup>	2.28	2.30	2.71
Interest differential MSB-UST(%) <sup>3</sup>	2.14	2.06	1.48
Interest differential Gov bonds-UST(%) <sup>3</sup>	2.47	2.48	1.99
<b>Cost to BOK (% of GDP<sup>1</sup>):</b>			
based on $\Delta$ NFA- $\Delta$ RM	0.07	0.09	0.02
based on $\Delta$ MSBs	0.06	0.06	0.05
<b>Cost to MOFE (% of GDP<sup>1</sup>):</b>			
based on $\Delta$ FL	0.04	0.11	0.10

<sup>1</sup> 2003 GDP for the Dec 2003 calculation, 2004 GDP for the others. <sup>2</sup> FA = foreign assets at central bank; NFA = net foreign assets at central bank; RM = reserve or base money; FL = Foreign liabilities at central bank (proxy for MOFE's share of foreign reserves). <sup>3</sup> Average over the period.

Table A2

**Estimated flow cost of sterilisation operations over 12 months: India**

	Dec 2003	June 2004	July 2006
Quantities (% of GDP <sup>1</sup> ):			
$\Delta$ FA less $\Delta$ RM <sup>2</sup>	2.67	3.77	2.70
$\Delta$ Government securities	2.19	(MSS)	(MSS)
Interest forgone/paid, govt bonds 5-year (%) <sup>3</sup>	5.31	5.06	7.02
Interest earned, UST average 2-5 year (%) <sup>3</sup>	2.28	2.54	4.58
Interest differential (%) <sup>3</sup>	3.03	2.52	2.38
<b>Cost to RBI (% of GDP<sup>1</sup>):</b>			
based on $\Delta$ FA- $\Delta$ RM	0.08	0.10	0.07
based on $\Delta$ securities	0.07		

<sup>1</sup> 2003 GDP for the Dec 2003 calculation, 2004 GDP for the others. <sup>2</sup> FA = foreign assets; NFA = net foreign assets; RM = reserve or base money. <sup>3</sup> Average over the period.

### Stock cost: the financial opportunity cost of holding a stock of foreign reserves

What are the foregone opportunities of holding safe but low-yielding foreign reserve assets? If the central bank (or the Ministry) were to cease holding foreign assets, what would it hold instead? And how much of a gain would this alternative bring?

Generally, instead of holding a unit of foreign assets (earning  $x\%$ ), the authorities could have held more domestic asset (earning  $y\%$ ), or pay off costly liabilities (saving  $z\%$ ), or done a combination of the two. More specifically, however, the alternative(s) chosen ought to respect the balance sheet composition and institutional constraints. One could run into difficult cases in figuring out the alternatives. For instance, if for some reason a central bank is not able or allowed to purchase all the domestic government paper it needs to replace foreign reserves, what other domestic assets can it plausibly hold? Apart from domestic government paper, there are potentially many other domestic assets, some of them possibly very high yielding (eg equities). However, not all can serve as institutionally plausible alternatives. Not respecting the implausibility of certain alternatives could grossly over- or under-estimate the opportunity cost.<sup>57</sup>

We estimate the stock opportunity costs for Korea and India at selected points in 2002-2006. We make the following assumptions regarding the alternatives to holding foreign reserves.<sup>58</sup> For Korea, the MOFE's alternative is to redeem the corresponding amount of bonds outstanding, while the BOK's alternative is first to pay off all outstanding MSBs and then exhaust the remainder on acquiring the benchmark 3-year government bond. For India, we assume that the alternative to foreign reserves is 5-year domestic government securities.<sup>59</sup>

Tables A3 and A4 show that estimates for stock cost are well under 1% of GDP per year. For Korea, the total cost was no more than 0.7% of GDP at the height of reserve accumulation in Q1 2004, with the BOK and the MOFE bearing about two-thirds and one-third of this total, respectively.<sup>60</sup> As mentioned above, the decline in Korean interest rates through 2004 at a time when US rates began to rise helped to contain the cost. For India, the stock cost was just under 0.5% of GDP at March 2004, just before the Monetary Stabilisation Scheme was launched, but tended to rise subsequently in light of rising domestic interest rates.

Table A3

#### Estimated cost (per annum) of holding foreign reserves: Korea

	Dec 2002	Mar 2003	Dec 2003	Mar 2004	Dec 2005
Net foreign assets, BOK (% of GDP <sup>1</sup> )	16.01	17.88	21.32	20.82	21.27

<sup>57</sup> For example, it is reasonable to think that Hong Kong's next best plausible option after paying off all Exchange Fund paper is to hold more shares in the Hang Seng Index (the only domestic currency financial asset the Exchange Fund currently holds)? Can the People's Bank of China be expected to consider holding more non-performing bank assets as an alternative to foreign reserves?

<sup>58</sup> The assumptions are based on institutional plausibility rather than on optimality (in the sense of achieving the highest possible gain). In theory, the first next-best option is always the highest-interest alternative available. If the first alternative somehow cannot accommodate the entire stock of foreign reserves to be disposed of, then the next-most-costly alternative should be adopted, etc.

<sup>59</sup> Up to March 2004, the central bank would bear the opportunity cost. Thereafter, the government, instead of the central bank, would bear the marginal opportunity cost under the Market Stabilisation Scheme.

<sup>60</sup> In October 2003, a Citigroup study reportedly estimated the holding cost for Korea at 1.5% of GDP. Since the study was said to take the reserve stock to be 27% GDP, Citigroup's estimate implied a cost factor of over 5%. However, it is not immediately clear from the citing reference whether this refers to a gross or net cost. Using our assumptions, a gross cost (not yet net of yield on foreign assets) estimate for March and December 2003 is 1.22% and 1.25% of GDP, respectively.

Yield diff. over UST 2-5 year (%): <sup>2</sup>					
MSB 1-year	2.02	2.27	2.14	2.06	0.03
Korean government bond 3-year	2.61	2.66	2.27	2.23	0.32
Korean government bond 5-year	2.41	2.47	2.47	2.48	0.58
<b>BOK's gains from alternatives</b> (% of GDP <sup>1</sup> ):					
Pay off MSBs, then buy 3-year bonds	0.36	0.42	0.47	0.44	0.01
Switch all NFA to 3-year bonds	0.42	0.47	0.48	0.47	0.07
<b>MOFE's gains from alternatives:</b>					
Pay off 5-year bonds	0.10	0.11	0.14	0.21	0.05

<sup>1</sup> 2003 GDP for the Dec 2002, Mar 2003 and Dec 2003 calculations; 2004 GDP for others. <sup>2</sup> Average over the previous 12 months

Table A4

**Estimated cost (per annum) of holding foreign reserves: India (central bank)**

	Dec 2002	Mar 2003	Dec 2003	Mar 2004	Nov 2004	Dec 2005
Net foreign assets (% of GDP <sup>1</sup> )	12.23	12.89	16.61	15.52	18.12	20.72
Yield diff. over UST 2-5 year (%): <sup>2</sup>						
Indian government bonds 5-year	3.46	3.62	3.03	2.80	2.81	2.65
Gains from alternatives (% of GDP <sup>1</sup> ):						
Switch all NFA to 5-year bonds	0.42	0.47	0.50	0.43	0.51	0.55

<sup>1</sup> 2003 GDP for the Dec 2002, Mar 2003 and Dec 2003 calculations; 2004 GDP for others. <sup>2</sup> Average over the previous 12 months

Certainly, the zero-foreign reserve alternative assumption underlying these estimates is unrealistic, as it ignores the penalty the economy would incur in the eyes of rating agencies and the international financial markets. But this assumption represents a kind of worst-case scenario. If the “appropriate” level of reserves is higher than zero, then the more realistic estimate of the opportunity cost of holding the current level of reserves ought to be less than that indicated by our baseline calculation. For example, if we consider the “appropriate” or “warranted” level of reserves for Korea at March 2004 to be US\$123 billion (three months imports plus short-term external debt), then the opportunity cost of holding the “excess” US\$40 billion of reserves would be only about 0.30% of GDP (Genberg et al (2005), p 26).

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