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by Robert Lavigne

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Abstract

The author examines recent trends in sterilized intervention among emerging-market economies, to determine the size and extent of this policy in relation to earlier periods of heavy reserve accumulation. He then analyzes whether the domestic costs and risks of substantial and prolonged sterilization are beginning to manifest themselves. In particular, the author discusses the fiscal costs of sterilization and the recent increase in non-market-friendly sterilization methods, such as the rapid rise in reserve requirement ratios.

JEL classification: F31, E52, O24

Bank classification: Financial stability; Exchange rate regimes; International topics

Résumé

L'auteur examine les tendances récemment observées dans les économies émergentes au chapitre des interventions sur le marché des changes afin de déterminer l'ampleur et le degré de stérilisation de celles-ci par rapport aux périodes antérieures de forte accumulation de réserves officielles. Puis, il évalue si les coûts internes et les risques associés à des interventions stérilisées importantes et prolongées commencent à se matérialiser. Il s'intéresse en particulier aux coûts budgétaires de ces mesures et à l'augmentation récente de la popularité de certaines méthodes de stérilisation hétérodoxes, telle la hausse rapide des coefficients de réserves obligatoires.

Classification JEL : F31, E52, O24

Classification de la Banque : Stabilité financière; Régimes de taux de change; Questions internationales

1 Introduction

The gross international reserves of emerging-market economies (EMEs) reached a record level of over US\$5 trillion in 2006, most of it amassed since 2000. This rapid reserve accumulation, which is widely viewed as being symptomatic of persistent global current account imbalances, has attracted the attention of policy-makers and academics alike (for example, International Monetary Fund 2007; International Relations Committee Task Force 2006; Roubini and Setser 2005; Rodrik 2006). Although there is no ceiling to the amount of foreign reserves that a central bank can accumulate, it is widely agreed that sustained unsterilized intervention can produce undesirable side effects, including rising inflationary pressures, conflict between the exchange rate and domestic monetary policy objectives, asset-price bubbles, and growing foreign exchange exposure of the public sector.

To deal with these undesirable effects on domestic monetary conditions, authorities frequently resort to sterilization operations, which can be defined in general as any set of policies designed to mitigate the impact of reserve accumulation on domestic inflation and interest rates. However, sterilization can also generate economic distortions. Indeed, prolonged and one-sided sterilized intervention can delay real exchange rate adjustment, which has likely contributed to the buildup of global current account imbalances over recent years (Dodge 2006). Internally, sterilization can engender a heavy fiscal cost (Calvo 1991), and possibly introduce distortions into domestic financial systems (Mohanty and Turner 2006). Over time, these external and domestic costs can provide an incentive for local authorities to change their sterilization policies.

The costs of sterilized intervention have not been readily apparent in the current period of reserve accumulation, which began circa 2000. In fact, over 2000–03, most central banks in EMEs did not experience the inflationary pressures that typically result from rapid reserve accumulation. Faced with the threat of deflation and sizable negative output gaps following the financial crises in the late 1990s, and the global slowdown in 2001, many central banks welcomed the expansion of domestic credit caused by reserve accumulation. Sterilization policies therefore did not need to be complete, and sterilization bonds could be sold at market rates. With EMEs currently operating at close to full capacity, however, sterilization operations have had to expand. The costs and risks of sustained sterilized intervention may become more evident, especially if inflationary pressures pick up and central banks face a growing conflict between their external and domestic policy objectives.

This paper’s objectives are twofold. First, it examines recent trends in sterilized intervention among EMEs, to determine the size and extent of this policy in relation to earlier periods. The second aim is to establish whether the domestic costs and risks of substantial and prolonged sterilization are beginning to manifest themselves. This aspect of the paper focuses on the fiscal costs of sterilization and, in particular, on the recent increase in non-market-friendly sterilization methods, which are known to have introduced distortions in the domestic banking systems of Asian EMEs in the mid-1990s (Reinhart and Reinhart 1999).

2 An Overview of Sterilization

This paper considers sterilization to be any policy that insulates the domestic monetary base from changes in the central bank’s stock of net foreign assets (NFA).¹ The practical aim of such operations is to minimize the inflationary impact of reserve accumulation. For example, when a central bank buys up foreign exchange in order to keep the domestic currency from appreciating, it can counteract these purchases by issuing bonds in the domestic market. This “sterilization” absorbs the addition to the domestic money supply that is created by the purchases of foreign exchange, effectively neutralizing its impact on domestic interest rates and inflation.

Table 1
A Stylized Central Bank Balance Sheet

Assets	Liabilities
<ul style="list-style-type: none"> • Net domestic assets (Government bonds) • Net foreign assets (Reserves) 	<ul style="list-style-type: none"> • Reserve money <ul style="list-style-type: none"> – currency – reserve deposits

Table 1 provides a highly stylized version of a central bank’s balance sheet, shown in terms of net amounts, that is useful in explaining the basic mechanics of sterilization.² For assets, a typical central bank has a combination of net domestic assets (NDA) (principally, government bonds) and net foreign assets (typically dominated by official reserves). On the liability side, a central

1. For most central banks, NFA is roughly equivalent to official reserves. However, in certain cases it can be significantly different. For a discussion of this issue, see Appendix A.

2. We calculate net amounts by subtracting the gross liabilities for each component (the right side of the balance sheet; e.g., gross domestic liabilities) from its gross assets (the left side of the balance sheet; e.g., gross domestic assets).

bank has its reserve money (or high-powered money), which consists of circulating currency (CC) and reserve deposits (RD) of commercial banks. At all times, any changes in reserve money must be reflected in changes in NDA or NFA, such that the following accounting identity will always hold:

$$\Delta \text{currency} + \Delta \text{reserve deposits} = \Delta \text{NDA} + \Delta \text{NFA}.$$

Sterilization essentially consists of the central bank reacting to offset a change in NFA (e.g., reserve accumulation) by either changing its NDA (e.g., selling bonds) or somehow adjusting its reserve deposits.

There are many sterilization techniques. Open market operations (OMO) are the most commonly used method, consisting of the central bank selling bonds to commercial banks or the public with the aim of reducing the liquidity that was generated from its initial purchase of foreign currency-denominated assets. The OMO sterilization ratio has been proxied in the literature as

$$\Delta \text{NDA} / \Delta \text{NFA}. \tag{1}$$

This ratio indicates the portion of reserve accumulation that is offset by open market operations. There are other ways of offsetting increases in liquidity generated by changes in central bank NFA. One widely used channel is the placement of government budget surpluses (or the transfer of any public resources, for that matter) into central bank accounts. Indeed, this withdrawal of funds from the financial system is the analytical equivalent of central bank bond sales.

Not all methods are based on voluntary bond purchases. There are also non-market-friendly measures, meaning sterilization techniques that in some way require banks to hold sterilization instruments (in a greater quantity or lower price than they would under free market conditions). There are several types of non-market-friendly methods, including forced bond sales at fixed (low) interest rates, mandatory lending by commercial banks to the central bank, and raising reserve requirement ratios (RRR). This last method is widely used in emerging markets. It works by increasing the required reserve deposits of commercial banks such that the rise in the monetary base stemming from reserve accumulation does not affect the currency in circulation, which is a prime determinant of the stock of money in an economy.

A measure of the total effects of all sterilization policies should integrate both market-friendly and non-market-friendly policies designed to limit domestic money multipliers. Total sterilization can therefore be approximated via the following ratios:

$$(\Delta RD - \Delta NDA) / \Delta NFA \quad \text{or} \quad (\Delta NFA - \Delta CC) / \Delta NFA.^3 \quad (2)$$

Typically, these ratios are between 0 (no sterilization) and 1 (complete sterilization) during periods when appreciative pressure on currencies is driving the reserve accumulation.

Appendix A explains the various measures of sterilization calculated in this paper and the caveats related to their use.

While sterilized intervention is largely seen to be ineffective in advanced countries (Mundell 1968), it does seem to have more traction in developing countries (Disyatat and Galati 2005). This may be attributable to the fact that bonds and equity in developing countries are not always good substitutes for international financial assets. In fact, perfectly substitutable assets would render sterilized intervention completely ineffective. For example, any sterilized intervention to prevent exchange rate appreciation would initially raise domestic interest rates (all things equal, more government bonds are sold), and would introduce a differential between local and world interest rates. If the country's assets were perfectly substitutable with international ones, this differential would be quickly eliminated through foreign capital inflows, which would cause the currency to appreciate and effectively reverse the effect of the initial intervention. If there was not perfect substitutability, an interest rate differential could persist, allowing at least a part of the effect of the intervention on the exchange rate to remain.

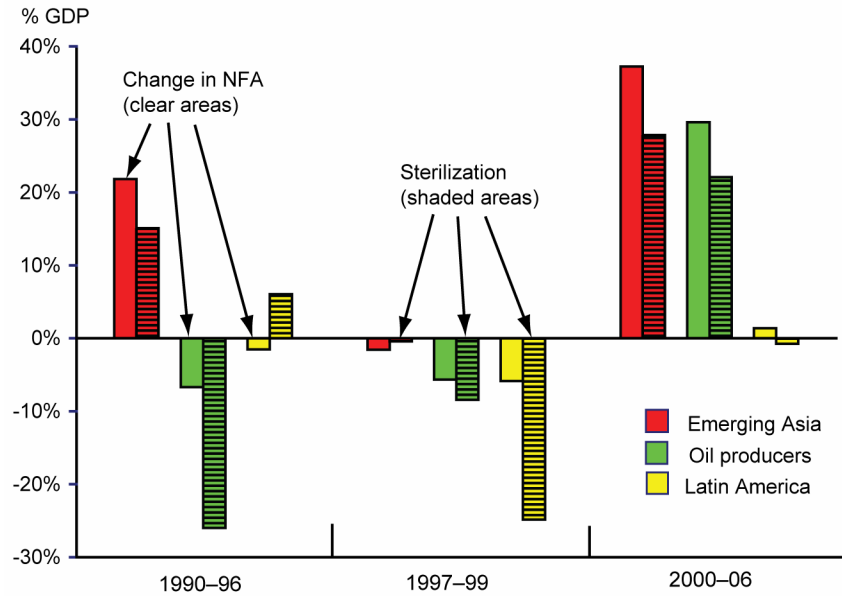
Many factors could cause EME assets to be less than perfectly substitutable for widely held international instruments, including institutional quality and other local characteristics affecting country risk premia. But perhaps the most prevalent factor is the existence of extensive capital controls in many emerging markets. These controls impede flows to and from the local economy, allowing sterilized intervention to have an effect on the exchange rate that is not offset by counterbalancing net foreign capital flows.

Chart 1 shows the extent of reserve accumulation as a percentage of GDP (clear areas) and the corresponding sterilization activities (shaded areas) across major EME regions since 1990. Three time segments are identified: the period of net foreign capital inflows from 1990 to 1996, the crisis years from 1997 to 1999 (during which many countries experienced reserve losses), and the recent cycle of reserve accumulation beginning in 2000, which is largely driven by current account surpluses. To simplify the analysis, EMEs have been divided into three groups:

3. See Mohanty and Turner (2006). The ratios are analytically equivalent.

emerging Asia, Latin America, and oil-producing countries.⁴ The sterilization amounts shown in Chart 1 are for total sterilization (market-friendly and non-market-friendly methods combined), and are calculated using the numerator of ratio (2). These amounts are cumulated over the specified time period and then divided by the cumulative change in NFA.

Chart 1
Change in Net Foreign Assets and Sterilization (% GDP)



Source: International Financial Statistics, Bank of Canada calculations

A number of stylized facts should be noted about the state of sterilized intervention. First, both reserve accumulation and corresponding sterilization have reached record highs (and 2007 is likely to be even higher than any year in the sample). Emerging Asia is the most active region, having accumulated over \$1.3 trillion in reserves from 2000 to 2006, or almost 40 per cent of regional GDP, and offsetting about 75 per cent of this amount with sterilization operations. Second, sterilization ratios appear similar in oil-producing countries, where the recent rise in oil prices has caused the central banks of oil producers (most of which have pegged exchange rates) to accumulate more than half a trillion dollars over 2000–06. However, as will be discussed

4. Emerging Asia consists of China, South Korea, India, Singapore, Malaysia, Thailand, Hong Kong, Indonesia, the Philippines, Sri Lanka, and Pakistan. Oil producers are Russia, Saudi Arabia, Mexico, Iran, the United Arab Emirates, Venezuela, Oman, Kuwait, Iran, and Bahrain. Latin America is made up of Argentina, Brazil, Chile, Costa Rica, Paraguay, Peru, and Uruguay. Situations of hyperinflation in Brazil and Argentina obliged the Latin American sample to begin in 1995.

below, most of these reserves never directly entered the domestic financial system, and were thus not “sterilized” in the usual sense.

Third, over the past three decades there has been only one major instance of protracted sterilized intervention roughly comparable to the current episode: the period of reserve accumulation in emerging Asia from 1990 to 1996. Over that time span, about \$500 billion in reserves were accumulated, of which about 70 per cent were sterilized.⁵ The period therefore represents the most useful reference point for analyzing the effects of prolonged sterilization on domestic financial stability. That said, reserve accumulation in the two periods (1990–96 and 2000–06) differed in at least one important respect. During the early 1990s, most of the reserve accumulation was driven by capital account surpluses, while over 2000–06 most countries were running current account surpluses. But the largest Asian reserve accumulators (China, South Korea, and India) were simultaneously running current and capital account surpluses over 2000–06.

3 Country-Specific Sterilization Activities

There are limits to regional comparisons, and it is important to analyze sterilization activities on a country-by-country basis. Table 2 shows the sterilization coefficients of all countries having accumulated over \$20 billion in reserves since 2000. These countries are all either from emerging Asia or are oil exporters, and they have all sterilized most of their reserve purchases. Data on all countries are provided in Appendix B.

China clearly dominates sterilized reserve accumulation in EMEs. Its reserves have increased by about \$850 billion over the period, almost as much as all other EMEs combined. China sterilized about 80 per cent of this accumulation, a considerable rise from the mere 26 per cent over 1990–96. Though estimates indicate that sterilized intervention accelerated in 2007, the Chinese authorities have a number of tools available to sustain intense sterilization for a protracted period. These include extensive capital controls, administrative controls and regulations, and state ownership of the banking system.

5. The sterilization ratios in other regions and periods do not seem relevant, since they were largely times of reserve shrinkage. Indeed, when interpreting these figures, it must be kept in mind that only past episodes of reserve accumulation are relevant for understanding the current period of sterilized intervention. Only in these periods is it likely that domestic monetary policy was mainly driven by attempts to offset the effects of the reserve inflows. Instances of reserve shrinkage (e.g., crises) or times when there was little change in reserves (e.g., during floating exchange rate regimes) are not periods where sterilization is economically meaningful. In fact, during those periods “sterilized” amounts are often greater (or in a different direction) than NFA changes. Over the 2000–06 period, Latin America accumulated very little reserves, since most of the countries in the region had adopted floating exchange rate regimes.

Table 2
Sterilization Coefficients of all Countries with over \$20 Billion in Reserves since 2000

	1990–96		2000–06	
	Change in NFA (US\$ billions)	Sterilization coefficient ¹	Change in NFA (US\$ billions)	Sterilization coefficient
China	121.88	0.26	849.55	0.80
Russia	-36.87	NA	278.33	0.71
Saudi Arabia	-4.31	1.30	203.78	0.99
South Korea	28.65	0.57	136.71	0.99
India	28.31	0.00	123.14	0.60
Singapore	53.63	0.96	48.04	0.96
Mexico	47.16 (1990–93)	0.85	46.77	0.60
Malaysia	26.45	0.88	46.50	0.95
Thailand	39.48	0.85	40.92	0.91
Hong Kong	44.33	0.78	22.79	0.82
Indonesia	67.87	0.91	21.08	0.68

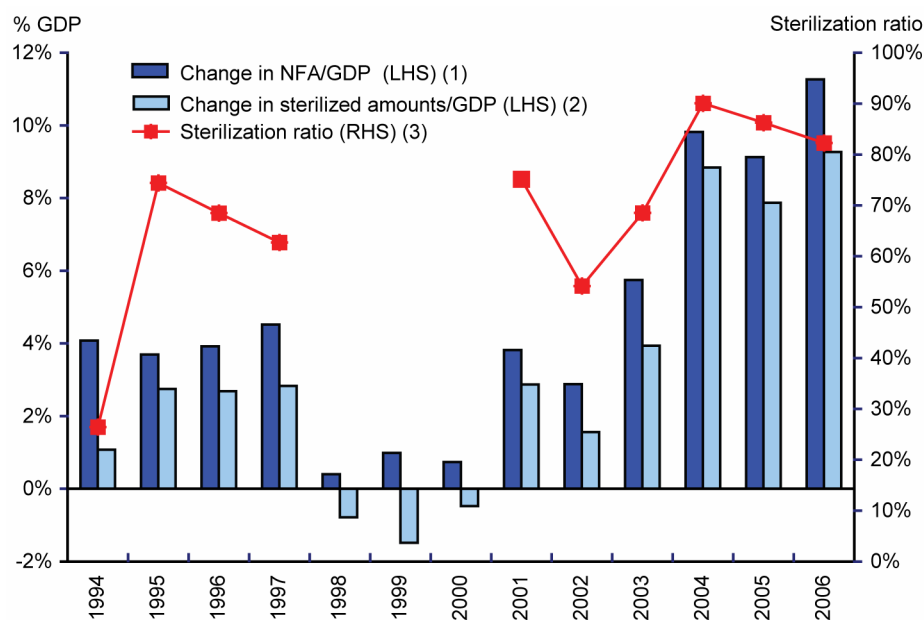
1. The sterilization coefficients are calculated by applying the ratios shown in equation (2) on cumulative annual amounts. Thus, the cumulative amount of sterilization activity (the numerator in equation (2)) is divided by the cumulative change in NFA (the denominator) over the period in question. All NFA values are valuation adjusted and converted into U.S. dollars at the average exchange rate of the period. See Appendix A.

Table 2 also shows that smaller Asian countries have recently sterilized large portions of their reserve purchases, often surpassing the levels reached in the early 1990s. This may be due to the pressure to limit real exchange rate appreciation with respect to China, which is a major competitor in key sectors, as well as a large export market for many of the countries in the region (particularly for intermediate goods). But while China may have the capacity to maintain high sterilization ratios, its Asian competitors, which have more market-based economies, may find their sterilization efforts to be less effective and/or begin to feel the cost of sterilized intervention earlier.

3.1 China, India, and South Korea

Chart 2 shows that the pace of Chinese sterilization activities has picked up since 2004, with the country accumulating reserves equivalent to 8–10 per cent of GDP per annum, sterilizing between 80 and 90 per cent of this amount mostly via open market operations (but not necessarily at market interest rates, given that many sales are mandatory at fixed rates, carried out by state-controlled banks).

Chart 2
China

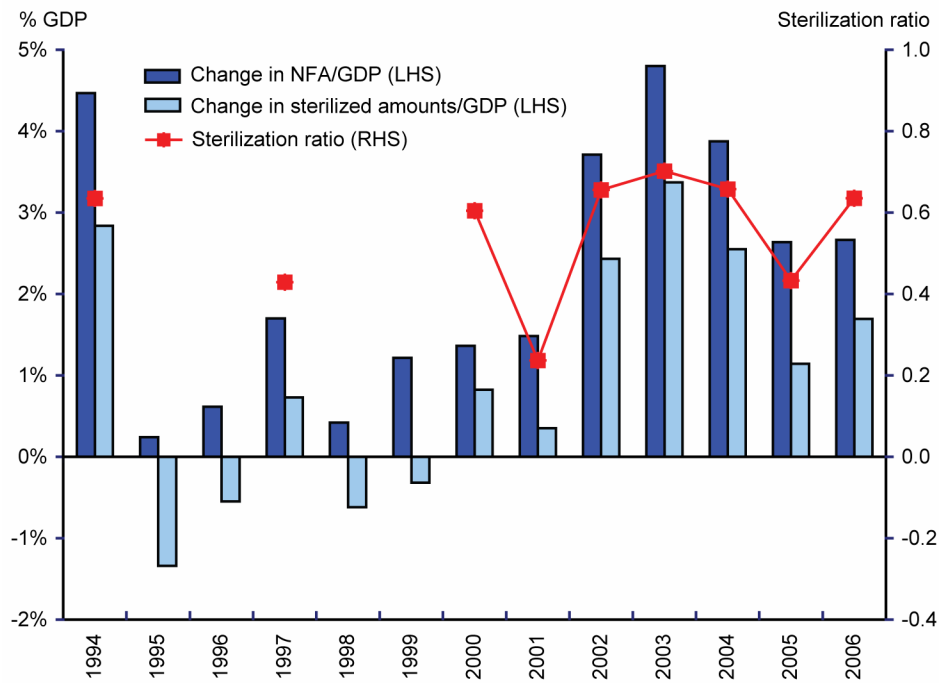


- (1) The change in reserve accumulation in a year ($\Delta(\text{NFA})$) as a percentage of GDP.
 (2) The amounts sterilized in a year ($\Delta(\text{NFA} - \text{currency in circulation})$) as a percentage of GDP.
 (3) The ratio of (2) / (1), or $\Delta(\text{NFA} - \text{currency in circulation}) / \Delta\text{NFA}$ for each year in the sample.

Chinese sterilization occurs largely via the banking sector, meaning that the banks have been obliged to accumulate large amounts of low-yielding government paper over the years. Further pressure has been put on bank profits by the decision to supplement open market operations with increases in the reserve requirement ratio (which has increased by 750 basis points since 2004) in an effort to reign in credit growth and surging asset prices.

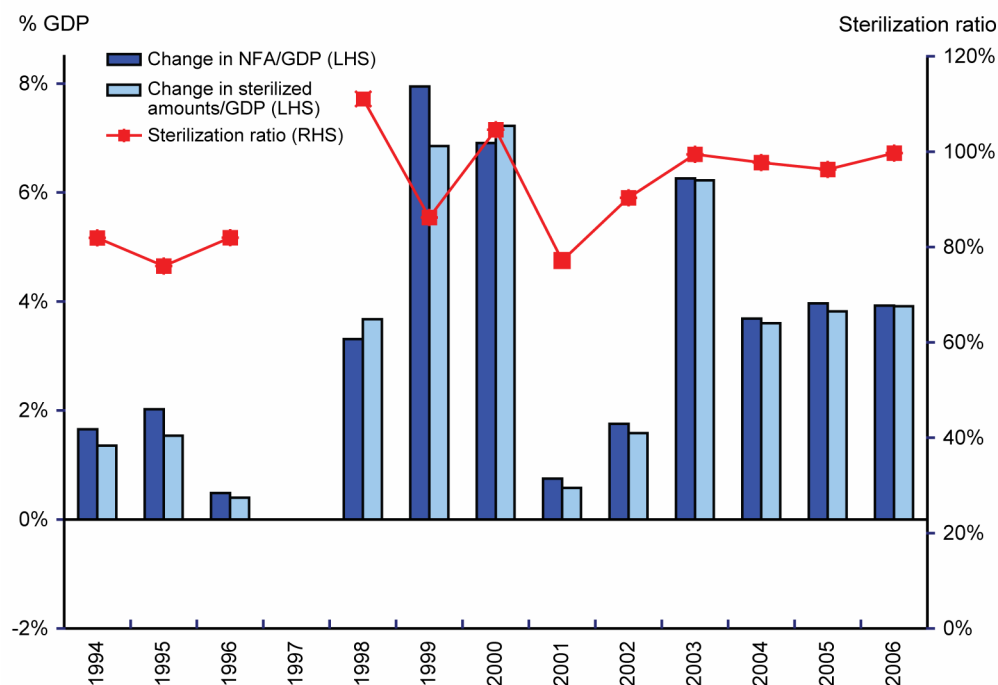
India is also increasingly relying on non-market methods to sterilize its reserve accumulation, which averages about 3 per cent of GDP per annum (Chart 3). High carrying costs may explain why the Reserve Bank of India increased its reserve ratios by 50 basis points in 2006, bringing the total increase to 125 basis points since 2003. Reserve ratio tightening is expected to continue, with bank credit growing at a rapid pace and inflationary pressures on the rise.

Chart 3
India



South Korea (Chart 4) is experiencing similar relative increases in reserves, sterilizing nearly all of them with open market transactions. It, too, however, has recently opted to raise its reserve requirement ratio from 5 per cent to 7 per cent.

Chart 4
South Korea



3.2 Oil exporters

The most significant change with respect to 1990–96 is the dramatic rise in reserve accumulation by oil exporters, particularly Russia and Saudi Arabia.⁶ This is almost totally driven by rising oil prices. In the case of Saudi Arabia, the combination of a very large current account surplus and a rigidly fixed exchange rate regime naturally generates significant reserve accumulation, almost all of which is placed into special investment accounts designed to manage the government’s foreign assets.⁷ Large open market bond sales are not required to sterilize these inflows, because most of the country’s foreign currency export revenues are immediately placed in foreign currency assets, never directly entering the domestic financial system. In addition, Saudi Arabia has made dollar loans to sovereigns in the region (e.g., Lebanon), which has effectively sterilized some oil revenues (of course, this was not likely the main intent of the loans). Still, inflation

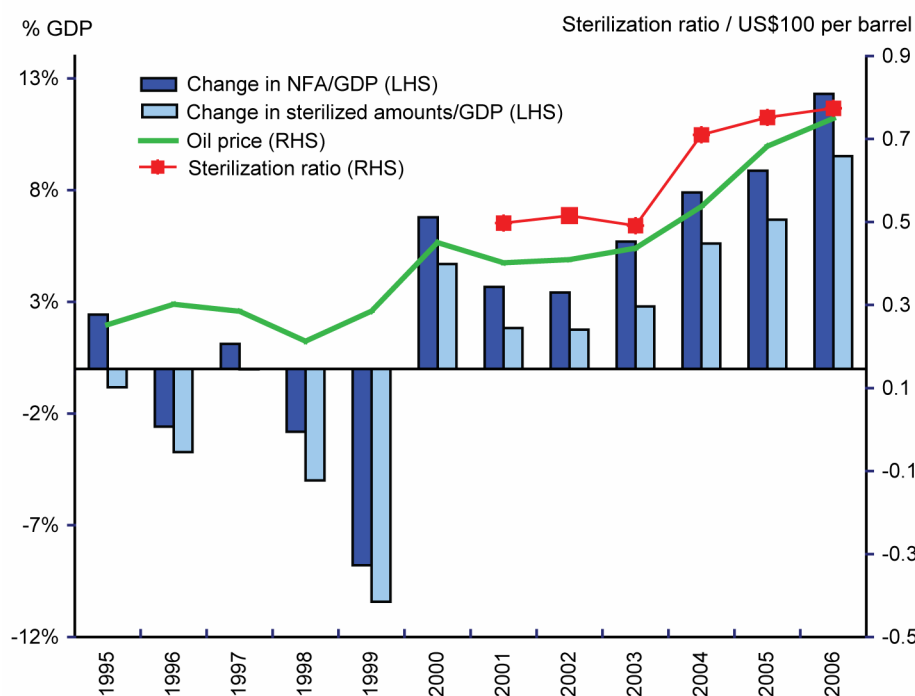
6. This paper’s use of NFA to estimate reserve accumulation is particularly valuable in the case of Saudi Arabia. Whereas the country’s official reserves are now less than \$30 billion, its central bank NFA have increased by \$200 billion.

7. Although other oil exporters in the region have formally opened up sovereign wealth funds to manage their petrodollar earnings, Saudi Arabia has yet to do so.

pressures are rising in the kingdom, at least partially as a result of the recent dollar depreciation. This has led to recent increases in the country's reserve requirement ratios.

Russia has also been managing large export receipts. An oil stabilization fund is used to manage a sizable share of export revenues, and some reserves have been used to pay back external debt. Russia has also handled some of the export revenue pressures by allowing a gradual appreciation of its nominal exchange rate and generating significant budgetary surpluses. The country's sterilization ratio rose from about 50 per cent in 2003 to 75 per cent in 2006 (Chart 5), and in recent years this has mostly taken the form of open market operations. The rising ratios could be the result of a number of factors, including high oil prices and a declining output gap after several years of strong growth, both of which demand increased sterilization intensity to keep inflationary pressures in check. Despite its increasingly intense sterilization effort, however, inflation rates in Russia have remained elevated (10 per cent CPI inflation, on average); the authorities were obliged to raise their RRR 150 basis points in 2006.

Chart 5
Russia



4 Delayed Real Exchange Rate Adjustment

If sterilized intervention is successful, it could delay real effective exchange rate (REER) adjustment by neutralizing the effect on domestic inflation of the foreign exchange intervention necessary to keep the nominal exchange rate at a desired (i.e., low) level. Chart 6 suggests that this has been the case in emerging Asia since 2000. Indeed, the region has managed to avoid an appreciation of its REER despite very sizable current account surpluses. Meanwhile, Latin America and oil exporters in aggregate have experienced real appreciations of over 20 per cent since 2004. This REER appreciation could be the result of several factors, including more flexible exchange rates among non-OPEC members in these regions as well as somewhat lower sterilization rates than in emerging Asia (see Table 2), which may have resulted in higher inflation.

Chart 6
GDP Weighted Real Effective Exchange Rate (Base year 2000)

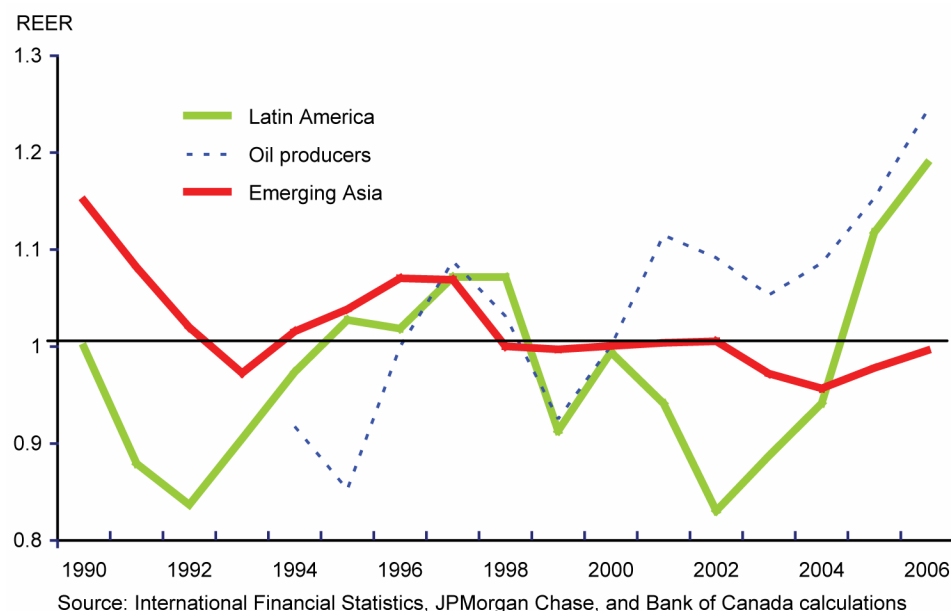
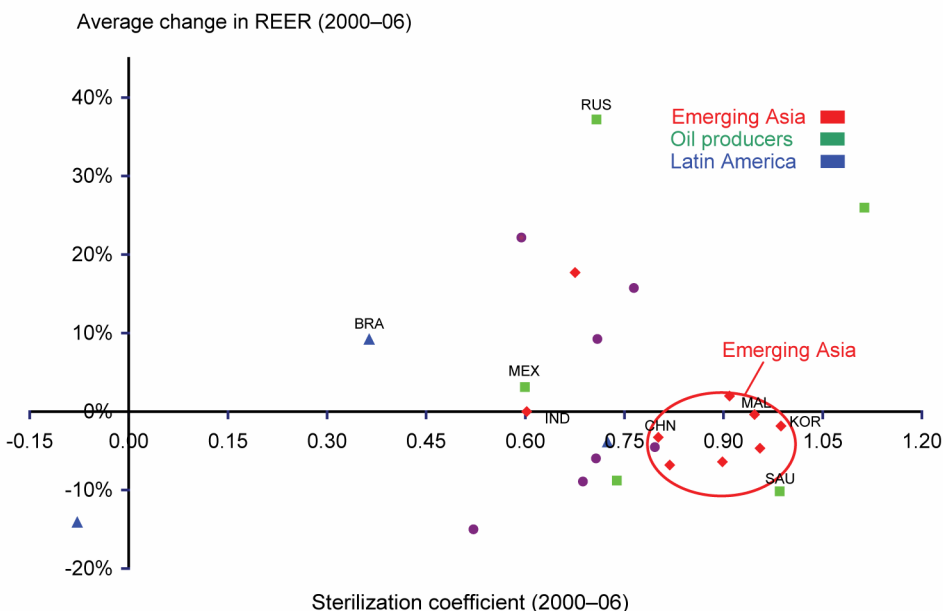


Chart 7, which plots the average REER appreciation over 2000–06 against the sterilization coefficients from Table 2, shows that the aggregated result for emerging Asia is not merely caused by the fact that China dominates the sample. In fact, most Asian countries have both sterilized intensely and avoided real exchange rate appreciation. While this is not proof of a causal link between the two variables, it is interesting that other emerging-market countries with

lower sterilization coefficients (say, around 0.7–0.8) have experienced greater real appreciations of their currencies.

Chart 7
Average Change in Real Effective Exchange Rate vs. Sterilization Coefficient (2000–06)



5 The Domestic Consequences of Sterilization

How long can policies of sustained sterilized intervention continue? There is no well-defined limit regarding the extent to which countries can sterilize their purchases of foreign exchange to prevent their currencies from appreciating. There are, however, costs to sterilization. On the external side, there are the distortionary effects of maintaining an undervalued real exchange rate, which includes implicit subsidization of the export sector and the maintenance of extensive capital controls, factors that increase the threat of retaliatory protectionist measures. But there are also domestic constraints, including the fiscal cost of sterilization and the distortions that non-market-friendly measures can introduce into domestic financial systems.⁸ Of course, there are also considerable economic opportunity costs associated with reserve accumulation, since there

8. Market-based sterilization can also produce financial distortions, including a shortening of maturity of the public debt stock (most sterilization bonds are short term) (Mohanty and Turner 2005) and high short-term interest rates that can attract short-term speculative inflows (Montiel and Reinhart 1999).

are probably better ways for utilizing EME resources than hoarding low-yielding foreign assets (Rodrik 2006; Summers 2006).

5.1 Quasi-fiscal costs

Quasi-fiscal costs of sterilized intervention arise from the interest differential between the rate authorities must pay on the sterilization bonds they issue and the return they receive on the asset their reserves are placed in.⁹ Historically, in emerging markets the difference is usually positive, since domestic bonds are generally higher-yielding than the most common reserve asset: U.S. Treasury instruments. Table 3 shows the difference between nominal yields on domestic one-year bonds and U.S. Treasury bills for the top reserve-holding countries in 2006. This provides a rough estimate of quasi-fiscal costs, albeit one that abstracts from the multiple interest rates on domestic debt instruments, and the different currency composition and maturity structure of a central bank's foreign assets.

Table 3
Interest Rate Differentials and Nominal Appreciation in 2006

	Interest rate differential	Nominal appreciation		Interest rate differential	Nominal appreciation
China	-1.42%	+3.2%	Singapore	-1.80%	+4.2%
Saudi Arabia	0.00%	0%	Malaysia	-1.52%	+3.0%
South Korea	-0.66%	+6.7%	Thailand	-0.11%	+6.0%
India	+1.25%	+1.8%	Hong Kong	-1.46%	+0%
Russia	-1.32%	+8.7%	Indonesia	+4.43%	+6.0%

Notes: Spreads are calculated as the difference between U.S. Treasury bill yields and the closest domestic equivalent. Nominal currency appreciation is against the dollar in 2006.

Source: International Financial Statistics, Bank of Canada calculations

The yield differential on short-term government debt for most countries is negative, meaning that short-term interest rates in the United States are higher than in most EMEs.¹⁰ This suggests that the difference between the returns on reserve assets and the cost of sterilization instruments is

9. The term “quasi” reflects the fact that, often, these costs may be borne by the central bank as well as by the treasury.

10. Several factors may be driving this historically anomalous negative spread, including heavy capital inflows into emerging Asia speculating on exchange rate appreciation, as well as low inflation and considerable fiscal probity in these countries. Financial repression could be playing a role in certain countries.

very low (if not negative), and that ongoing sterilization activities are not posing much of a fiscal problem for authorities. Certain countries, however, such as India and Indonesia, are still bearing significant quasi-fiscal costs, and for others, such as South Korea, Saudi Arabia, and Thailand, the recent 2007 easing of the U.S. policy rates will likely have pushed quasi-fiscal costs into positive range.

For central banks that mark the value of their balance sheets to market prices, the perceived quasi-fiscal cost of sterilization will have risen over the past few years along with the U.S. dollar's depreciation against their currencies. In fact, the valuation losses on the stock of dollar-denominated reserves (when measured in local currency) considerably outweighed the interest rate differential for all the major reserve accumulators. For instance, the Bank of Korea, which does mark the value of its foreign assets to market, saw its net value drop in 2006 due to an appreciating currency and the rising cost of sterilization bonds (DBS Research Group 2007).¹¹ It is not clear whether these unrealized losses will have much effect on the incentives of countries to change their policies for reserve accumulation.

Although they are still relatively low, quasi-fiscal costs can be expected to rise, for two reasons. First, if emerging-market spreads return to historical levels, the costs of sterilization can be expected to grow for all EMEs as interest rates on sovereign and domestic bonds rise. Second, it seems likely that protracted sterilization will ultimately cause real domestic interest rates to rise in order to induce the private sector to hold the growing supply of government sterilization bonds.¹² Indeed, Charts 8 and 9 show that cumulative sterilization is rising in the largest Asian EMEs as a portion of domestic credit (i.e., bank assets) and M2. The same pattern is observed when the denominator is GDP or debt securities. In aggregate, all of these measures of market size and financial depth indicate that sterilization is taking up a significant part of financial activity in emerging Asia.

11. Moreover, interest costs on the stock of these instruments have surpassed revenues from net issuance.

12. Until recently, many local EME banks were risk averse, preferring to invest in low-yielding public debt. This behaviour, which has helped to keep sterilization costs low, cannot be expected to persist, since banks are under growing pressure to increase their profitability in an environment of financial liberalization.

Chart 8
Cumulative Sterilization (as % Domestic Credit)

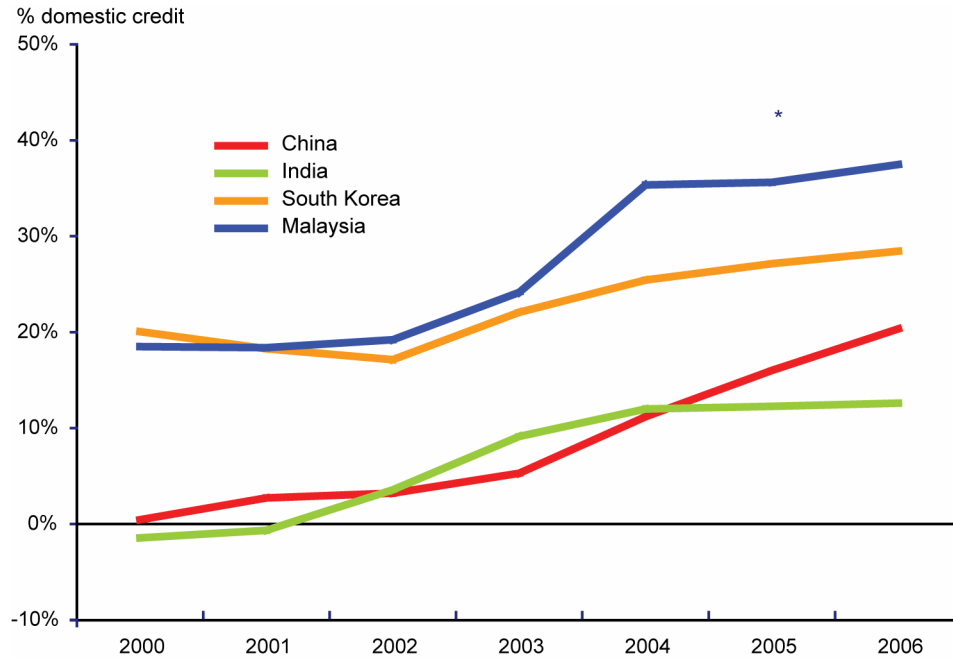
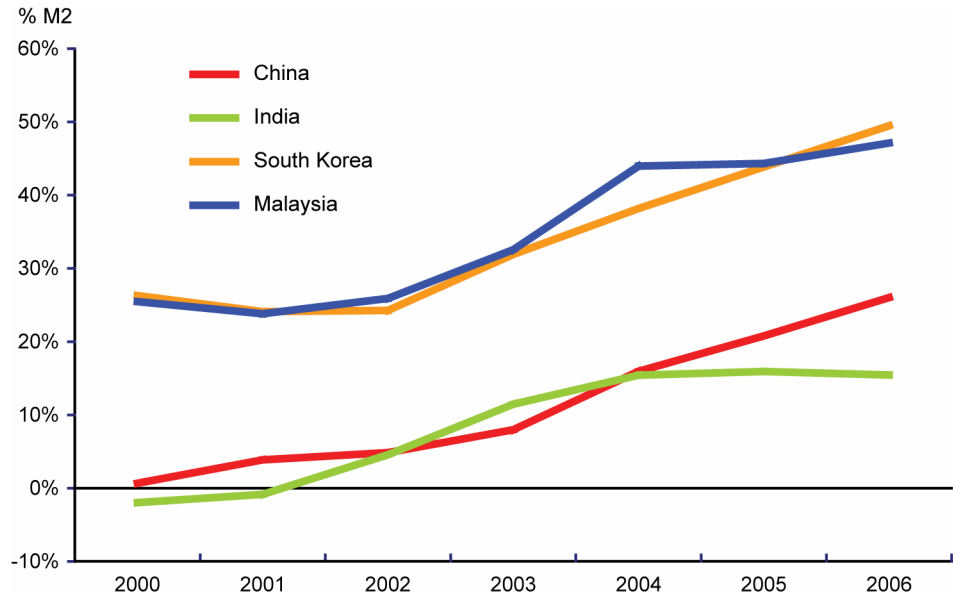


Chart 9
Selected Countries, Cumulative Sterilization (as % M2)



It is difficult to establish thresholds at which cumulative sterilization will begin to put upward pressure on interest rates or possibly contribute to financial instability. The experience of Asia and Latin America in the 1990s suggests that these ratios are country specific, and that the capacity of a financial system to shoulder rising sterilization activity depends on many complex factors, such as the soundness of the institutional framework supporting financial markets, the state of public finances, and central bank credibility. But while the levels of these ratios may be difficult to interpret, their monotonic rise across almost all Asian countries is notable and is loosely consistent with the increasing potential cost of sterilization activity.

5.2 Market distortions

In the mid-1990s, rising interest rates and increasingly ineffective open market operations pushed many EMEs to engage in non-market-friendly methods of sterilization, essentially forcing financial institutions to hold sterilization assets at less than market rates. There are concerns that this trend is resurfacing among the heavy sterilizers in Asia.

Because almost all sterilization activity is focused on the banking system in developing countries, non-market-friendly sterilization methods can essentially be viewed as a tax on banks. From a macroeconomic perspective, such taxes may mean that savings will be less efficiently intermediated than before. Indeed, disintermediation is likely to increase with the introduction of such taxes, because they will make the banking sector less profitable and less attractive for borrowers and depositors. If banks have a comparative advantage at allocating resources, then a relative fall in their activity may mean that savings will be allocated less efficiently in the economy. Disintermediation is also problematic from a financial stability perspective, since the portion of financial activity that is formally supervised by authorities will decline, raising the risk of unsound lending practices.¹³ There are current signs of rising disintermediation in China, since increased lending curbs on bank credit (due to rising reserve requirements) are obliging firms to resort to non-bank financing.¹⁴

The consequences for financial stability will depend on how the banks adjust to these measures, which necessarily put downward pressure on their profits. In the extreme case where banks are able to pass the cost completely on to borrowers, this would result in higher interest rates, a fall in the amounts borrowed (disintermediation), and at least some drop in bank profits (Fama 1985). At the opposite extreme, if the cost of non-market sterilization were to be totally passed

13. Disintermediation need not result only from non-market sterilization, however. If market-based sterilization leads to prolonged high real interest rates on public bonds, it could produce so-called “lazy banks” that have little incentive to deal with the private sector.

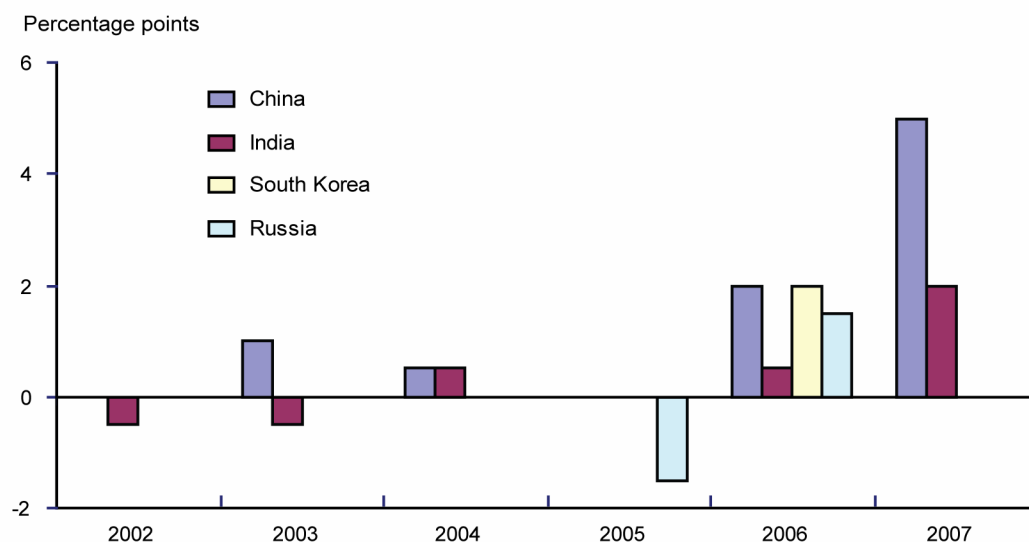
14. See “China loan curbs hit businesses,” *Financial Times*, 10 December 2007.

on to depositors, there would also be an increase in disintermediation (fewer deposits because of lower rates), and reduced bank profits. There is a firm empirical relationship between higher reserve requirements and bank lending/borrowing spreads (Reinhart and Reinhart 1999).

However, if, as is often the case in countries in the midst of financial liberalization, the pressure to maintain profits is overwhelming, then it is also conceivable that banks may opt to take on greater risk in their portfolios. Indeed, to offset the low-yielding (but quite safe) sterilization assets that the banks are obliged to hold, they may find it optimal to increase the riskiness of their loans to the private sector. In the case of higher reserve requirement ratios that restrict total credit growth, banks may opt to make riskier loans (at higher rates of charge) by lowering lending standards. If the intermediation spread is dictated by the government (as in China), banks would either have to completely absorb the cost in their profits or expand riskier off-balance-sheet activities, such as direct investment in financial markets. Another means by which the balance sheets of banks become more risky is the simple fact that low-quality loans are difficult to terminate and are often evergreened (this may, in particular, be the case in China, where non-performing loans to state-owned enterprises may be quite difficult to liquidate). Since the quantity of loans must be reduced in reaction to the increased reserve requirements, the inability to reduce the stock of weak loans means that new loans to customers with good credit quality must be rationed. Under such conditions, the share of bad-quality loans increases in proportion to total bank assets.

The extensive use of non-market-friendly sterilization activities could well increase a country's financial vulnerability. Yet, although any one development of riskier loan portfolios, the expansion of off-balance-sheet activities, lower bank profits, disintermediation, or higher bank spreads potentially presents some degree of risk to domestic financial stability, it may not be a source of undue concern. But when these factors begin to occur simultaneously in many countries that are heavy sterilizers, they warrant closer attention. The rapid increase in RRRs over the past year in large emerging markets, and especially in China (Chart 10), is a case in point.

Chart 10
Changes in Reserve Requirement Ratios (RRR)



Source: International Financial Statistics, Bank of Canada calculations

Capital controls that are generally required to make sterilized intervention effective are also non-market-friendly measures that can introduce distortions in the local economy. Controls on outflows limit the types of investment vehicles available to local residents and shelter the local financial sector from international competition. Inflow controls limit the pool of available capital for domestic investment. Of course, there are short-run reasons that may rationalize such controls, including efforts to dampen speculative inflows and protect weak domestic financial systems, but, over the medium term, capital controls generally result in delayed financial development and increased inefficiencies. Moreover, the controls usually decline in efficiency over time, since markets find ways of avoiding them. Indeed, the controls give investors an incentive to mask or misreport their capital flows, such that they can no longer be effectively monitored by financial supervisors. As with disintermediation, this could lead to the development of unsound investment and lending practices without official oversight.

6 Conclusion

Sterilized intervention has reached historical highs, especially in emerging Asia and among oil-exporting countries. Preliminary 2007 figures indicate that reserve accumulation has increased at an accelerating pace, suggesting that sterilization operations have had to intensify to keep inflationary pressures in check. In this environment, quasi-fiscal costs, though still low, may rise.

There has been a marked increase in the use of non-market methods, which may have undesirable consequences on financial stability over the medium term. The situation needs to be monitored carefully for signs of change in sterilization policies. There is a risk that if markets sense that sterilization efforts are unsustainable, they could begin to speculate on a real exchange rate appreciation by buying local assets.¹⁵ These inflows would require more sterilized intervention, further exacerbating the situation.

15. Speculators may be further emboldened by the relatively persistent factors driving the upward pressure on exchange rates, namely current account surpluses and foreign direct investment flows.

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Appendix A: Measuring Sterilized Intervention

Sterilization measures can be derived from the basic central bank accounting identity:

$$RM = NDA + NFA, \tag{A1}$$

where NDA is a central bank's stock of net domestic assets (principally, government bonds), NFA is the stock of net foreign assets for the central bank (typically, this is equivalent to the country's net stock of international reserves), and RM is the central bank's reserve money (that is, high-powered money or its monetary base), which consists of both currency in circulation (CC) and the reserve deposits of commercial banks (RD). The identity can be rewritten in first differences as

$$\Delta CC + \Delta RD = \Delta NDA + \Delta NFA. \tag{A2}$$

Sterilization using open market transactions has been proxied in the literature as the ratio $\Delta NDA / \Delta NFA$, which represents the extent to which an increase in reserves is offset by a sale of domestic bonds.

Of course, this simple ratio assumes that the change in net domestic assets is completely driven by the attempt to offset the effects of the reserve inflows. Indeed, the ratio abstracts from endogeneity issues, whereby reserve accumulation could be caused by domestic monetary policy (e.g., international interest rate differentials). This suggests that the simple ratio is economically meaningful only during periods where the causality of the relationship is clear.¹ In this paper, the ratio is applied during periods of massive foreign exchange inflows (driven primarily by non-monetary factors, such as low wages, high oil prices, or large current account surpluses) into countries with relatively fixed exchange rate regimes. In cases where it is clear that the reserve accumulation is an attempt to limit nominal exchange rate appreciation, any resulting sterilization activities can be realistically considered to be a direct reaction to the foreign exchange intervention.

1. Another possibility is to use simultaneous equations, but this is not feasible for reasons of data availability for a large panel of countries.

A measure of the total effects of all sterilization policies should also integrate non-market policies designed to limit domestic money multipliers. Indeed, the reserve deposits of commercial banks (which are a portion of the monetary base) can be adjusted in addition to NDA in order to target a desired level of currency in circulation, which is the ultimate anchor of the stock of money in an economy. Total sterilization can therefore be approximated via the following ratios:

$$(\Delta RD - \Delta NDA) / \Delta NFA \quad \text{or} \quad (\Delta NFA - \Delta CC) / \Delta NFA.^2 \quad (\text{A3})$$

Typically, these ratios are between 0 (no sterilization) and 1 (complete sterilization) during periods when appreciative pressure on currencies is driving the reserve accumulation. However, the ratio can be greater than one or negative. This is particularly true for countries with floating exchange rates, as they have no need to accumulate reserves and their monetary policies are largely disconnected from any changes in their central bank's NFA positions.

It should be understood that these ratios encapsulate all factors – market based or regulatory, monetary or fiscal, intentional or not – that determine the extent to which the currency in circulation is affected by reserve accumulation. Thus, countries that have no formal sterilization instruments or policies can nonetheless be identified as being heavy sterilizers if they systematically use their fiscal surpluses (e.g., Singapore), or the payment of external debt (e.g., Russia), or some other non-monetary means to withdraw liquidity from their financial systems.

The literature typically uses gross reserve accumulation instead of NFA. However, these two measures are not equivalent, and this paper's use of a central bank's net foreign assets for the estimation of sterilization has a number of advantages. First, it is the most direct representation of the amount of liquidity that a central bank needs to sterilize. Indeed, the International Monetary Fund (IMF) defines gross reserves as very liquid foreign assets (usually only bonds or cash), which exclude many of the new types of assets that central banks are investing in today (e.g., equities and derivatives). Second, net changes in reserves are what count for sterilization purposes. For instance, countries with IMF loans have very different net and gross reserves. Finally, stabilization funds, sovereign wealth funds, and special investment accounts may not be registered as reserves, but they do have some impact on central bank balance sheets.

2. See Mohanty and Turner (2006).

It is also important to note that all NFA measures have been adjusted for valuation effects stemming from exchange rate changes. This has been done by deflating central bank foreign asset levels by an index of the nominal exchange rate in U.S. dollars (the base year is 2000 for all countries). This is necessary, for instance, to ensure that a rise in a central bank's gross assets is not merely an accounting result stemming from a depreciated exchange rate, which automatically raises the value of its foreign assets in terms of domestic currency. It is assumed that all foreign assets are denominated in dollars, and that their gross liabilities are denominated in domestic currency. These assumptions, which are necessary for computational purposes, are not unrealistic, since it is believed that most EME reserves are still held in dollars, and it is unlikely that foreigners would want to hold the liabilities of a central bank not denominated in its local currency.

Appendix B: Country Sterilization Coefficients¹

	1990–96		2000–06	
	Change in NFA (US\$ billions)	Sterilization coefficient	Change in NFA (US\$ billions)	Sterilization coefficient
Emerging Asia				
China	121.88	0.26	849.55	0.80
Hong Kong	44.33	0.78	22.79	0.82
India	28.31	0.00	123.14	0.60
Indonesia	67.87	0.91	21.08	0.68
South Korea	28.65	0.57	136.71	0.99
Malaysia	26.45	0.88	46.50	0.95
Philippines	20.59	0.86	6.48	0.90
Singapore	53.63	0.96	48.04	0.96
Sri Lanka	1.95	0.76	1.15	-0.03
Thailand	39.48	0.85	40.92	0.91
Oil-Producing Countries				
Bahrain	3.89	1.69	0.13	0.74
Iran	-1.82	4.72	-2.68	1.11
Kuwait	0.32	0.92	0.21	0.77
Mexico	47.16 (1990–93)	0.85	46.77	0.60
Oman	-0.76	0.56	8.52	0.78
Russia	-36.87	1.78 (1993–96)	278.33	0.71
Saudi Arabia	-4.31	1.30	203.78	0.99
United Arab Emirates	3.53	0.76	12.74	0.83
Venezuela	10.35	0.85	7.95	0.12
Latin America				
Argentina	11.84	-0.06	-7.62	0.05 (2003–06)
Brazil	33.44 (1994–96)	0.57	-26.44	0.36
Chile	17.29	0.92	5.40	3.20
Costa Rica	0.18	7.33	1.47	0.72
Paraguay	0.66	0.62	0.45	-0.08
Peru	10.57	0.86	7.95	0.73
Uruguay (2004–06)	-0.15	4.88	0.19	0.93 (2003–06)
Others				
Cyprus	0.16	0.39	-0.73	0.71
Egypt	0.97	0.60	0.09	-7.34
Hungary	4.11	0.86	1.46	0.59
Israel	0.92	0.78	0.31	0.52
Jordan	0.20	0.95	0.75	0.66
Morocco	0.56	0.53	1.44	0.71
South Africa	-0.23	14.61	1.94	0.80
Tunisia	1.07	0.59	2.09	0.69
Turkey	28.79	0.97	-0.03 (2003–06)	0.64

Source: International Financial Statistics, Bank of Canada calculations

1. See Table 2 and Appendix A for a description of the methodology underpinning these figures.