BOFIT Discussion Papers
1 • 2013

Aaron Mehrotra

On the use of sterilisation bonds in emerging Asia

EUROJÄRJESTELMÄ
EUROSYSTEMET

Bank of Finland, BOFIT
Institute for Economies in Transition

BOFIT Discussion Papers
Editor-in-Chief Laura Solanko

BOFIT Discussion Papers 1/2013
15.1.2013

Aaron Mehrotra: On the use of sterilisation bonds in emerging Asia

ISBN 978-952-462-763-4
ISSN 1456-5889
(online)

This paper can be downloaded without charge from
http://www.bof.fi/bofit.

Suomen Pankki
Helsinki 2013

Contents

Abstract 4
Introduction 5
Sterilisation in the context of a central bank balance sheet 7
Descriptive evidence on issuance of sterilisation bonds in emerging Asia 9
Korea 10
Indonesia 11
China 11
Malaysia 11
Thailand 12
India 12
Trends in maturities and yields 13
Trends in holding sector 16
Implications for monetary policy and the financial system 17
Choice of sterilisation instrument 21
Conclusion and policy implications 26
References 28
Appendix 30

Aaron Mehrotra

On the use of sterilisation bonds in emerging Asia*

Abstract

We document recent developments in the use of sterilisation bonds by six central banks in emerging Asia, and discuss the implications for monetary policy and the financial sector. An important development in the sterilisation of foreign exchange interventions in past years has been the frequent use of central banks' own paper. There has been an attempt to lengthen the maturity structure of sterilisation bills, and maturities have risen, especially in 2010–11. The choice of sterilisation instrument is likely to depend partly on their relative costs. In particular, as the yield on central bank securities has fallen relative to the rate of remuneration of required reserves, some central banks in Asia have increasingly used central bank securities for sterilisation.

Keywords: sterilisation bond, central bank bonds and bills, foreign exchange reserves, emerging Asia

JEL classification: E43, E50, E52, E58

---

* This paper has previously been published in the BIS Paper series, No. 66, under the same title.

Author correspondence: Bank for International Settlements, Representative Office for Asia and the Pacific, 78th floor, 2 IFC, 8 Finance Street, Central, Hong Kong, Hong Kong SAR. Email: aaron.mehrotra@bis.org. All opinions are those of the author and do not necessarily represent those of the Bank for International Settlements. I am grateful to Andrew Filardo, Guonan Ma, Madhusudan Mohanty, Philip Turner and James Yetman for their insightful comments. Marjorie Santos Beslmeisl and Agne Subelyte provided excellent research assistance.

Introduction

Since the Asian crisis, central banks in emerging Asia have accumulated large reserves in order to build up precautionary balances and to provide assurance to markets about the sustainability of the exchange rate regime. The experience from the international financial crisis largely vindicated this policy, as central banks had considerable leeway to run down their assets in the face of depreciation pressures. Indeed, foreign exchange reserves in the region shrank at the end of 2008, perhaps most prominently in India, Korea and Malaysia. During the subsequent recovery, as inflation pressures rose, emerging market central banks were generally more willing to accept increased exchange rate flexibility, in particular letting their exchange rates appreciate. Among major emerging economies in Asia, the rates of appreciation against the USD in 2010 ranged from 2.5% (Korea) to 9.9% (Malaysia).[1] While more flexible, economies in the region continue to manage their exchange rates, as foreign exchange reserves have continued to accumulate in an environment of persistent current account surpluses and in most cases strong capital inflows.[2]

The ballooning reserves have led to significant increases in central bank balance sheets, with implications for overall macroeconomic and financial stability.[3] In order to maintain monetary stability, central banks in the region have largely sterilised the interventions in the foreign exchange markets through both non-market and market-based approaches. The former include the use of reserve requirements, the compulsory transfer of public institutions' deposits to the central bank and direct controls on bank lending; the latter encompass sterilisation bonds (either government or central bank paper), foreign exchange swaps, repo agreements and direct borrowing from banks through an overnight deposit facility.

In this paper, we describe the recent use of one market-based approach to sterilised intervention in emerging Asia, the issuance of sterilisation bonds. As discussed by Filardo and Grenville (2012), an important development vis-à-vis sterilisation tools in recent years has been the issuance of central banks' own paper. While some central banks in the

[1] The Hong Kong dollar is an exception to this general trend, as it is pegged to the US dollar via the currency board arrangement – the linked exchange rate system.
[2] While a mercantilist policy could in principle explain the accumulation of reserves, Aizenman and Lee (2007) find that empirical evidence supports precautionary rather than mercantilist motives after the Asian crisis.
[3] From a policy framework perspective, there has arguably been a re-emergence of the importance of quantities, whereby the central bank assets and liabilities structure plays an important role in policy, over and above the short-term policy interest rate.

region have a longer history in using central bank paper for sterilisation purposes (eg Indonesia and Korea), its use has increased notably in the recent past. In addition to concerns about the financial disintermediation that some non-market based measures could entail, the issuance of central bank bills could help deepen the local bond market and further develop a yield curve. There has been an attempt to lengthen the maturity structure, in order to enhance monetary control, and possibly discourage an increase of short-term positions in sterilisation paper by foreign investors in an environment of heavy capital inflows. In most jurisdictions, maturities dropped during the crisis in the face of capital outflows, and lengthened across the board in 2010–11.

While the choice of sterilisation instruments obviously depends on the available toolkit and the financial system characteristics of the different economies, the relative costs of using the different instruments are arguably of major importance. The choice of sterilisation instrument can be seen as a cost-minimisation problem for the central bank, where for a given size and structure of its assets it needs to optimally choose its liability structure, taking their prices as given. We show simple econometric evidence that cost considerations indeed seem to matter for the choice of sterilisation instrument, in particular for the choice between changes in reserve requirements and the issuance of central bank securities, in the cases of China and Indonesia.

This paper is structured as follows. The next section discusses the use of sterilisation bills in the context of central bank balance sheets, and the third section describes the use of sterilisation bonds in emerging Asia. The fourth section discusses the implications of the use of this instrument for monetary policy and the financial sector as a whole. The fifth section presents both descriptive and econometric evidence linking the use of sterilisation instruments to their relative costs. The final section concludes with policy implications.

Sterilisation in the context of a central bank balance sheet

The accumulation of reserves and the sterilisation procedure can be discussed in the context of a central bank's balance sheet.[4] Table 1 provides a stylised version of the balance sheet. The central bank's assets are comprised of foreign and domestic assets, and its liabilities include monetary liabilities (currency and bank reserves), non-monetary liabilities (central bank securities and others) and equity capital. Equity capital includes government transfers to the central bank, coupled with any accumulated profits or losses. The increase in foreign exchange reserve assets is financed by liabilities within the domestic financial system. Of these liabilities, currency is usually assumed to be determined by the public's demand for cash balances. Strong growth in emerging Asia has implied an increase in the amount of currency in circulation in the region, while bank reserves have risen partly on the back of increased reserve requirements by many central banks to mop up excess liquidity.

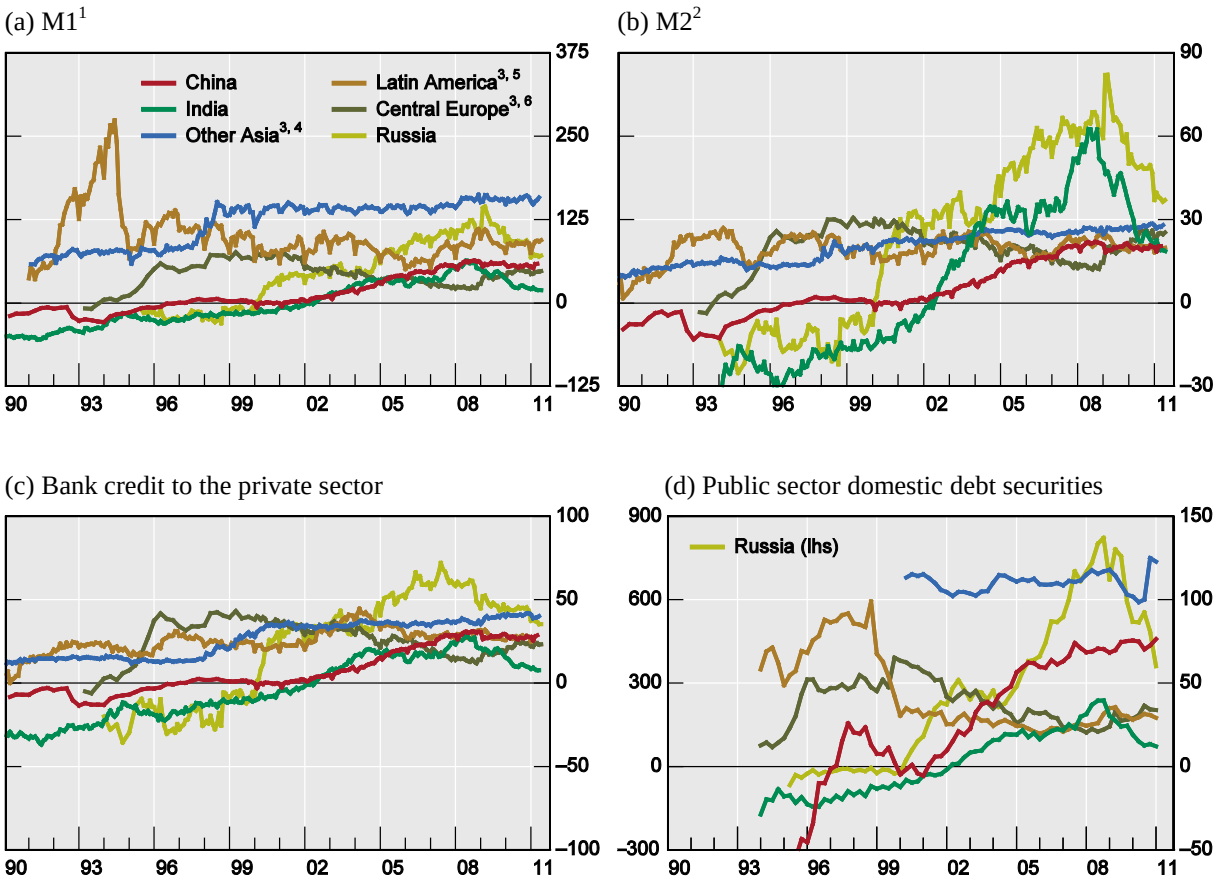
Table 1 A central bank's balance sheet

Assets	**Liabilities**
Foreign assets Domestic assets	Monetary liabilities • Currency in circulation • Bank reserves Non-monetary liabilities • Central bank securities • Government deposits • Other liabilities Equity capital

If equity capital is unchanged, and the demand for currency remains constant, reserve accumulation results in a financing need for the central bank. This financing need can be captured by the excess of foreign exchange reserves over currency in circulation. Graph 1 shows this financing need as a ratio of foreign exchange reserves less currency as a percentage of the size of the overall financial system in the major emerging regions (including China and India). Graphs A1 and A2 in the Appendix display these measures for the other economies in our sample. As the financing need becomes large, the central bank's financing operations are likely to have an important impact on the financial system.

[4] The balance sheet discussion draws on BIS (2009) and Mohanty and Turner (2006).

Graph 1 Foreign exchange reserves minus currency held by the public, as a percentage of:



[1] M1, also called narrow money, comprises transferable deposits and currency outside deposit money banks. [2] M2 is a broad measure of money which in general comprises, in addition to M1, time, savings and foreign currency deposits of resident sectors other than central government. The components can vary across economies. [3] Weighted average of the economies listed, based on 2005 GDP and PPP exchange rates. [4] Chinese Taipei, Hong Kong SAR, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand. [5] Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela. [6] The Czech Republic, Hungary and Poland.

Sources: IMF; Datastream; national data; BIS.

The central bank addresses the financing need by issuing domestic monetary liabilities. If the central bank has a target for the short-term interest rate, it cannot allow the increased monetary reserves to lead to increased bank credit and inflation pressures. In such a case, it typically sells domestic assets (although these may be limited relative to the size of the required amount) or issues its own securities to offset the increase in bank reserves. This sterilised intervention can take place either using market- (sterilisation securities; direct borrowing from banks; repo transactions; foreign exchange swaps) or non-market based instruments (direct controls on bank lending; reserve requirements; shifting deposits to central bank). There is substantial evidence in the literature to suggest that a large part of

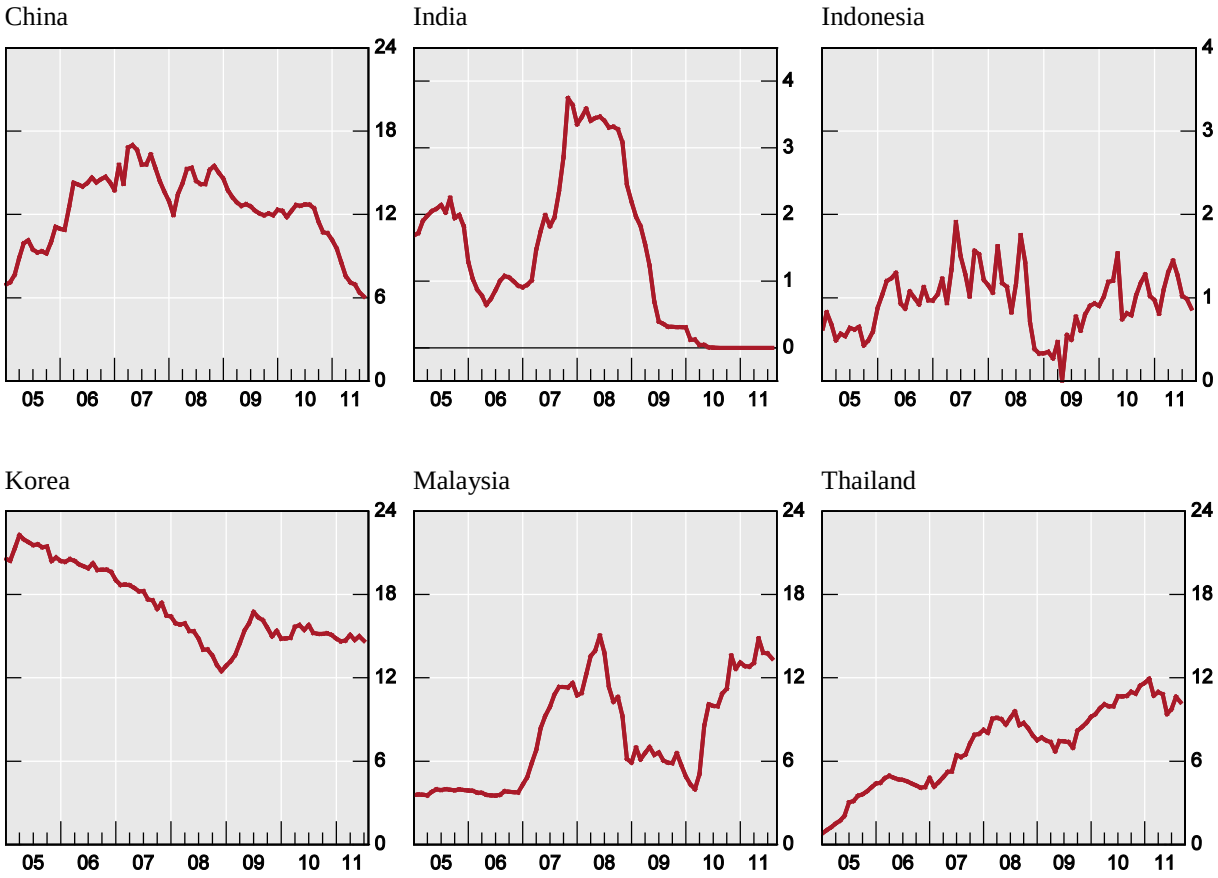
intervention has been sterilised in most economies where intervention has taken place (see eg Mohanty and Turner, 2006; Aizenman and Glick, 2009).[5]

Descriptive evidence on issuance of sterilisation bonds in emerging Asia

Central banks in emerging Asia have been increasingly using their own securities for sterilisation purposes. In this section, we provide a descriptive analysis of the use of sterilisation bonds in six emerging Asian economies. Five of them (China, Indonesia, Korea, Malaysia and Thailand) issue central bank bills, while one (India) issues government and other securities under a separate account held at the central bank solely for sterilisation purposes. Graph 2 shows the amounts outstanding of central bank securities for the six economies in our sample, as shares of GDP. Amounts outstanding in national currency are displayed in Graph A3 in the Appendix.

[5] For China, Ouyang et al (2010) find that roughly 90% of reserve accumulation was sterilised during 2000–08; He et al (2005) also suggest that sterilisation has been effective.

Graph 2 Central bank securities[1], as a percentage of GDP[2]



[1] For India, proceeds from auctions of treasury bonds and securities under the market stabilisation scheme, deposited at the Reserve Bank of India. [2] The scaling variable used is annual GDP data converted to monthly using linear interpolation.

Sources: IMF; CEIC.

Korea

In Korea, sterilisation bonds (monetary stabilisation bills, MSBs) were issued for the first time in 1961, and their importance as a tool to remove excess liquidity has since increased, especially after the Asian crisis. As a share of GDP, outstanding central bank securities amounted to 20% of GDP still in 2005 (the highest in our sample). The share has since declined, but still amounted to roughly 15% of GDP in 2011. In national currency terms, the outstanding volume in 2005 was similar to that in 2011. In contrast to many other Asian economies, non-market based approaches, such as changes in the reserve requirement ratio, have not played an important role in Korea (see Table A4 in Mohanty and Turner, 2006).

Indonesia

The issuance of central bank bills for sterilisation had also begun in Indonesia prior to the Asian crisis. The central bank securities in question are Bank Indonesia Certificates (SBIs). As a share of GDP, the outstanding amount of SBIs has hovered around 1% in recent years, falling close to zero at the time of the international financial crisis. Indonesia has also used statutory reserve requirements to absorb liquidity, among its other instruments for liquidity management.

China

In China, the issuance of central bank bills started somewhat later, and their use has coincided with that of several other instruments for sterilisation, including reserve requirements, open market operations of special government bonds and currency swaps with commercial banks.[6] The People's Bank of China started to issue three-month, six-month and one-year central bank bills in 2003. Longer-term (three-year) bills were issued from December 2004 onwards. In the case of China, market-based issuance of sterilisation bonds has been combined with targeted issuance – bills targeted at those commercial banks that experienced a rapid growth in credit and fairly abundant liquidity. In 2010–11, the outstanding amount of central bank securities fell in both nominal terms and as a share of GDP, standing at roughly 6% of GDP in mid-2011. In 2006–08, their share was close to 15% of GDP.

Malaysia

Malaysia uses a variety of instruments for liquidity management. Interventions are sterilised using direct borrowing, repos and the issuance of Bank Negara Malaysia Monetary Notes (BNMNs). Over time, policy has shifted towards the use of repo operations and BNMNs (Ooi, 2008). The Bank Negara Malaysia introduced the BNMNs in December 2006 in order to gradually replace Bank Negara Bills (BNBs) and Bank Negara Negotiable Notes for managing liquidity.[7] We consider the Bank Negara Malaysia Monetary

[6] A non-market based tool that has been very prominent during the recovery is the required reserve ratio (see Ma et al, 2011, and the discussion in the fifth section of this paper).
[7] See http://www.bnm.gov.my/index.php?ch=8&pg=14&ac=1349.

Notes/Bank Negara Bills (BNMNs/BNBs) as the relevant sterilisation bonds. As a share of GDP, the volume of outstanding central bank securities more than doubled during 2011 and now stands at above 13% of GDP.

Thailand

For Thailand, the sterilisation bond of interest here is the Bank of Thailand (BOT) bond, which is the principal absorption instrument (Bank of Thailand, 2010, p 73). Thaicharoen and Ananchotikul (2008) note that BOT bonds are efficient in absorbing liquidity on a large scale with longer maturities. For this economy as well, central bank bonds are accompanied by repo transactions and foreign exchange swaps in the management of liquidity. Central bank securities have been slowly increasing as a share of GDP and now stand at close to 10%.

India

The Reserve Bank of India is not allowed to issue its own securities. Large capital inflows were traditionally managed through the day-to-day Liquidity Adjustment Facility (LAF), in particular its repo and reverse repo auctions, and supplemented by outright sales of government securities by open market operations (Mohan, 2008). Liquidity was also absorbed by increasing the surplus balances of the government with the Reserve Bank. However, given the limited stock of government securities, India adopted a new instrument in 2004. This new instrument, the Market Stabilisation Scheme (MSS), is solely used for sterilisation purposes. Under the scheme, the Reserve Bank may issue government treasury bills and medium-term dated securities. The proceeds from the auctions are placed on a separate MSS cash account that is maintained and operated by the Reserve Bank. MSS has become the instrument for medium-term liquidity management, while the LAF is used for the management of liquidity on a daily basis.

Table 2 Management of liquidity in India by market stabilisation scheme (MSS) and cash reserve ratio (CRR)

	2007–08	2008–09	2009–10	2010–11
Liquidity impact of MSS	1054.2	803.1	853.4	27.4
First-round impact of CRR change	–470.0	1022.5	–360.0	–125.0

A positive sign indicates an injection of liquidity into the banking system.

Source: Reserve Bank of India, *Macroeconomic and Monetary Developments*.

In contrast to other economies where the stock of issued central bank securities has been growing over time, in India the amount of MSS outstanding was drawn down quickly during 2009 and 2010, as surplus liquidity was low (Graph 2). Table 2 shows that liquidity management operations through the MSS resulted in an injection of liquidity from the financial year 2007–08 through 2010–11. In contrast, adjustments of the cash reserve ratio (CRR), in line with a tightened policy stance in an inflationary environment, resulted in absorptions of liquidity for all other years except 2008–09.[8]

Trends in maturities and yields

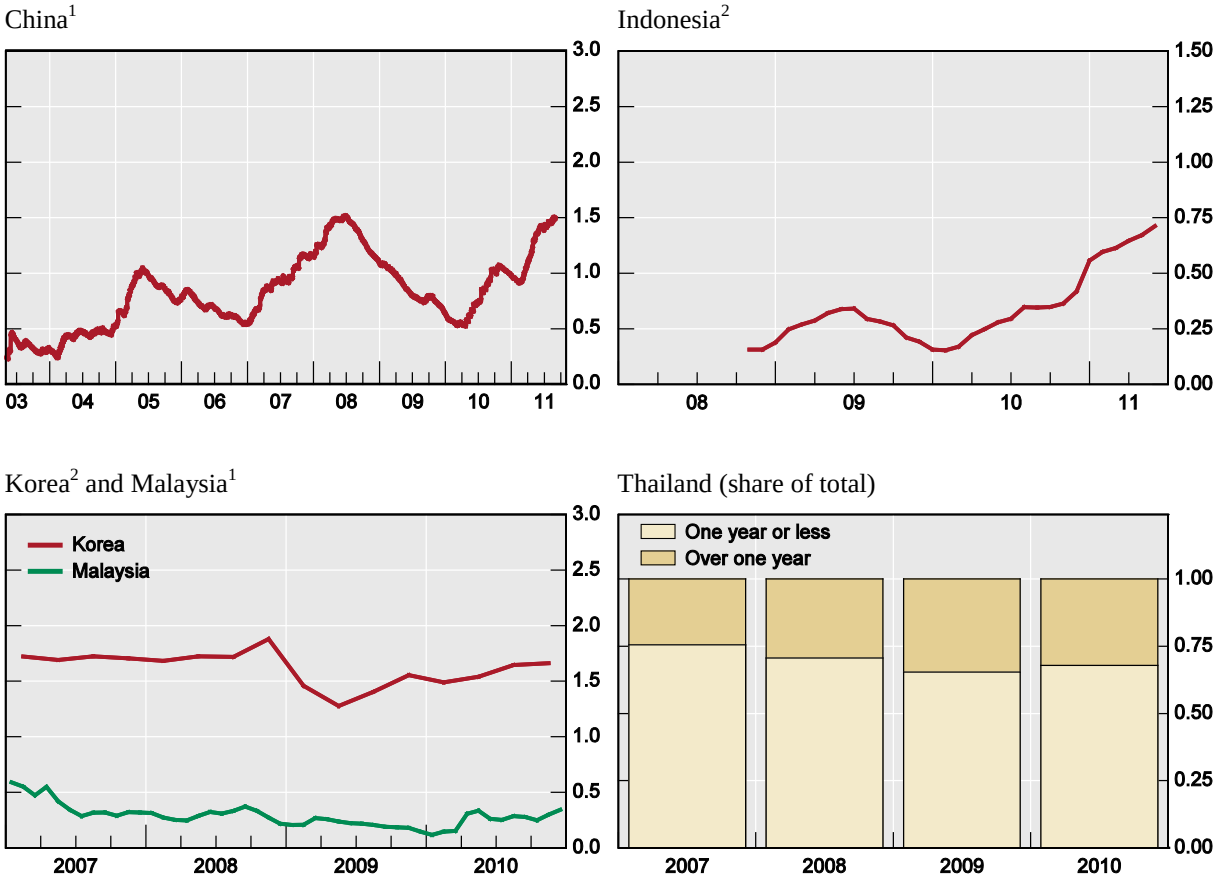
Some central banks have aimed at lengthening the maturity of the issued sterilisation bills. For instance, the Bank Negara Malaysia (2011) claims that this could in principle enhance monetary control and improve the cost-effectiveness of sterilisation in an environment of rising interest rates, as surplus liquidity is being absorbed at a lower rate for a longer period. Where capital inflows are strong and foreign investors are taking short-term positions in domestic currency, longer maturities could help avert some of the speculative inflows. Nevertheless, central banks might prefer to issue paper at different maturities than the central government, in order to avoid possible crowding out effects. Figure 3 shows the average maturity of outstanding sterilisation bonds for the different economies. For all econo-

[8] Mohan (2008) suggests that the MSS is better than the LAF for dealing with longer-term flows, and the CRR is appropriate for dealing with fairly long-term flows.

mies, the average maturity of outstanding sterilisation bonds (central bank paper) is indeed lower than that for the general government.[9]

In most countries, the financial crisis brought about a decline in maturities in the face of FX depreciation pressures, but maturities have again increased lately. For Korea, there has been relatively little movement in the average maturity over time. In 2009, the share of MSBs with maturities of less than one year rose, with the increase in the 91-day maturity being especially stark. In 2010, the maturity of outstanding bonds increased, with the share of MSBs with maturities of at least one year growing.

Graph 3 Average maturities of central bank bonds and bills, in years



[1] Weighted average of remaining maturity by notional amount. For Malaysia, the series is computed by assuming that issuance takes place on the last day of each month. [2] Average maturity of outstanding bills.

Sources: CEIC; national data; BIS calculations.

[9] According to BIS securities statistics, the remaining maturity of domestic central government debt in 2010 was 6.0 years in Thailand, 5.0 years in Korea, 4.5 years in Malaysia and 0.9 years in Indonesia. Data are not available for China.

The maturity dynamics in Malaysia have been similar to the ones in Korea, although the average maturity has been shorter. The average maturity on new issues fell from close to half a year in 2007 to below four months in 2009, only to pick up again to over five months in 2010.[10] In early 2008, BNMNs were used aggressively to mop up excess liquidity during periods of strong portfolio and trade flows (Bank Negara Malaysia, 2009). As concerns in the international financial system intensified, monetary operations were focused on shortening the average maturity of sterilisation operations. This was instrumental in an environment of strong portfolio outflows. The fall in the maturity for the central bank bills is in line with the fact that the average maturity for all monetary instruments declined from 39 days in April 2008 to 19 days by end-December 2008. The increase in the maturity period of sterilisation bonds coincided with the economic recovery of 2009–10, and again went in hand with the increasing maturity profile of all monetary instruments (from 27 days in 2009 to 40 days in 2010).

In China, the average maturity of outstanding bills has fluctuated notably. Three-year bills were issued between December 2004 and May 2005 and again in 2007, leading to a significant increase in the average maturity of both new issuance and outstanding bills. As the financial crisis hit, the PBoC halted the issuance of three-year bills in July 2008, resuming it again in April 2010.

Bank Indonesia has also aimed at issuing longer-term paper (SBIs) to deepen the money market and to encourage liquidity management from a longer-term perspective (Bank Indonesia, 2011). By July 2010, the amount of outstanding one-month SBIs had dropped to zero. From September 2010 onwards, three-, six- and nine-month SBIs were issued, with a gradual reduction in outstanding three-month SBIs. By January 2011, the amount outstanding of three-month SBIs had fallen to zero as well. The average maturity of outstanding SBIs had increased from less than three months to over six months by early 2011 (Graph 3).

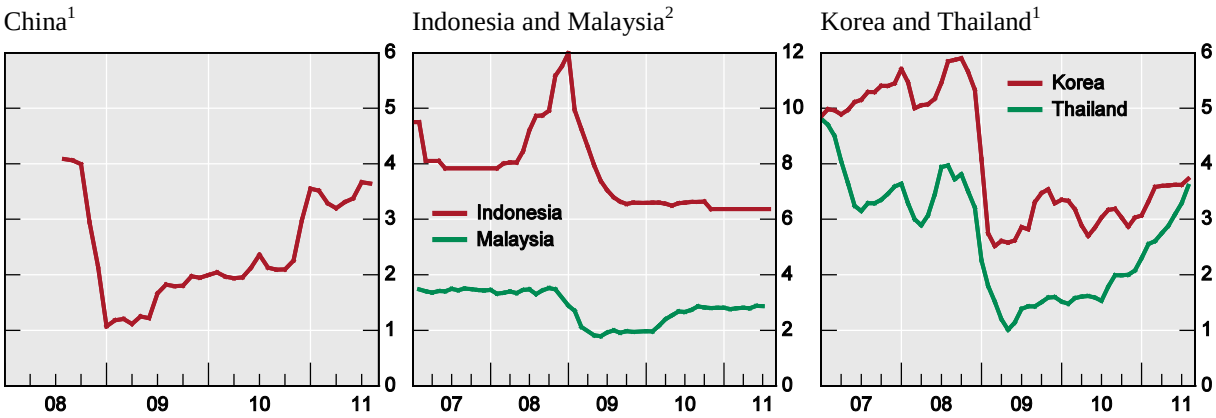
Similarly, in 2010, the Bank of Thailand aimed to lengthen the maturity profile of BOT bonds to “establish a more appropriate structure of the absorption tools” (Bank of Thailand, 2011, p. 90). Bonds with remaining maturities of one year or less still dominated

[10] Prior to 2007, the average duration of outstanding Bank Negara Bills, Negotiable Notes and Monetary Notes was gradually increasing (Table 2 in Ooi, 2008). The average duration increased from 75 days in 2003 to 104 days in 2006.

the outstanding stock of central bank bonds (Graph 3), but their share fell from 75% in 2007 to 68% in 2010.

The yields on sterilisation bonds have moved rather uniformly across countries (Graph 4). They fell as the financial crisis intensified in late 2008–early 2009. The yields have climbed notably in China from the levels witnessed during the crisis (from roughly 1% to over 3%), but remain relatively low. The yields paid on central bank bills in Korea and Thailand were at similar levels in mid-2011. Thailand has seen climbing yields since mid-2010, but the differences between maturities have narrowed notably since 2009 (not shown). In Indonesia, the yields are higher across the maturity spectrum, but have remained very stable since 2009.

Graph 4 Yields on central bank bonds and bills, in per cent



[1] One-year yield. The series for Thailand includes T-bills, Bank of Thailand bonds and government bonds. [2] Three- and six-month yields, respectively.

Sources: CEIC; national data.

Trends in holding sector

Is there evidence of a proportionally higher share of sterilisation bonds being held by households and non-bank firms over time, in which case sterilisation would have become more complete? Data for Thailand suggest that the share of "other non-financial corporations", "public non-financial corporations" and "households and non-profit institutions serving households" as holders of Bank of Thailand bonds increased from some 7% of the total amount outstanding in 2007 to 15% in 2010. In the case of Indonesia, non-banks now hold a substantial share of SBIs (Table 3). The share increased from 19.8% of outstanding SBIs at end-2009 to 31.2% at end-2010. However, a very large part of non-bank holdings

are in the hands of non-residents (88.1% at end-2010). This stands in contrast to Thailand, where non-resident holdings of BOT bonds increased from 0.2% in 2007 to 0.7% in 2010.

Table 3 Bank Indonesia Certificates, IDR trillions

	Non-bank holdings		**Total outstanding**
	Resident	Non-resident	
End-2009	6.51	44.18	255.52
End-2010	7.43	54.93	200.11

Source: Bank Indonesia.

In the case of Korea, foreigners held slightly below 16% of outstanding MSBs at the end of 2010. And for Malaysia, with the exception of 2008, between 32% and 52% of total outstanding Bank Negara Bills and Monetary Notes have been held by non-residents in recent years (Table 4).

Table 4 Central bank securities

	Non-resident holdings	**Total outstanding**
	MYR millions	
2007	36,065.8	69,010.0
2008	4,165.4	43,710.2
2009	11,923.9	33,357.4
2010	31,623.7	100,376.8

Source: Bank Negara Malaysia Monthly Statistical Bulletin.

Implications for monetary policy and the financial system

An obvious benefit of using market-based instruments such as sterilisation bonds over non-market based measures is that central banks are able to withdraw liquidity without creating market distortions or disintermediation in parts of the financial system associated with increases in reserve requirements. Reserve requirements may cause lending to be directed away from banks or the domestic financial system more generally. If borrowing by domestic firms is redirected to banks abroad, sterilisation becomes ineffective, and the riskiness

of the domestic financial system may increase.[11] Indeed, to the extent that the central bank does not pay a market interest rate to remunerate reserves, reserve requirements act as a tax on the domestic banking system.[12]

From the viewpoint of monetary policy, sterilisation may be more effective if households and non-bank firms are the ultimate holders of the sterilisation paper. The impact of foreign exchange interventions on base money can be fully sterilised simply as commercial banks buy sterilisation paper from the central bank. However, as discussed later in this section, central bank paper is a relatively liquid asset, and its ownership by commercial banks might do little to restrain lending in the economy. Moreover, if the origin of the currency appreciation and the foreign exchange intervention is a current account surplus, foreign exchange earnings by exporters initially lead to an increase in bank deposits. In the case where a commercial bank sells the foreign exchange proceedings to the central bank and receives a sterilisation bond in return, it maintains the deposit and holds the sterilisation bill. Only if non-banks subsequently purchase the sterilisation bond by drawing down their deposits would broad money be reduced.

Non-bank ownership of sterilisation paper is more likely if the sterilisation paper markets are liquid and long-term paper is available. As sterilisation bond markets have deepened and central banks have aimed at replacing short-term paper with longer maturities, these conditions have arguably strengthened in recent years in the Asian region. Filardo and Grenville (2012) show that the correlation between the growth in central bank assets and reserve money has been basically zero in emerging Asia in the 2000s, with virtually no impact on the inflation rate. Therefore, the monetary effect of reserve accumulation was effectively sterilised.

Mohanty and Turner (2006) suggest that if longer-term bills replace central bank bills with shorter maturity, this could have a longer-term impact on excess liquidity and enhance monetary control. The case of China provides an example. When the issuance of three-year bills was resumed in 2007, the issuance of one-year bills dropped from CNY 2.5

[11] Government deposits with the central bank as a sterilisation instrument do not have the same drawback as reserve requirements of pushing lending abroad. However, as pointed out by Filardo et al (2012), government deposits tend to be volatile, reflecting the timing of tax payments, public expenditures and debt managers' portfolio allocation decisions.

[12] Reinhart and Reinhart (1999) show that changes in reserve requirements may have an impact on the real exchange rate. If the central bank increases reserve requirements to sterilise its intervention, and depositors pay the tax, domestic deposits become less attractive. If borrowers pay the tax instead, loans become more expensive – in both cases depreciation pressure on the real exchange rate may ensue. Moreover, depending on the incidence of the tax, there may be effects on domestic spending and production.

trillion in 2006 to CNY 1.6 trillion in 2007 (six-month bills fell from CNY 95 billion in 2006 to zero in 2007). This coincided with increased monetary control to the extent that the PBoC was able to achieve its targets for broad money growth more closely. In particular, in 2007, the actual growth in broad money was 16.7%, very close to the 16% target set by the PBoC. In contrast, in 2006, actual growth in M2 was almost 3 percentage points higher than the target (16.9% versus 14%), with relatively large deviations experienced also in 2003–05.[13]

Evidence about the link between the level of monetary control and the lengthening maturity structure can be also found for Indonesia. While Indonesia does not specify intermediate money growth targets, headline inflation rates have been falling throughout 2011 to levels consistent with the inflation target as the average maturities of outstanding central bank bills have increased.

The use of market-based paper for sterilisation purposes could prove to be counterproductive for monetary policy in some cases. If the central bank sterilises strong capital inflows by issuing short-term securities, foreign investors may be encouraged to take short-term positions in the currency using sterilisation paper – the relatively large foreign holdings of central bank securities in the cases of Indonesia and Malaysia were highlighted in the previous section. Thus, the issuance of short-term sterilisation paper could in fact encourage capital inflows and threaten the success of sterilisation. The issuance of short-term paper may also create interest rate risks for the central bank. As the need for future liquidity absorbing operations increases, there could be a heavy interest cost burden if domestic interest rates rise. Large sterilised intervention by means of issuing securities may also damage the credibility of domestic monetary policy. The central bank may be unwilling to tighten policy sufficiently when faced with inflationary pressures, as the costs of sterilisation increase when the difference between local and foreign interest rates increases. This could lead to an inflationary bias in policy over time.

For the financial system, the increased use of sterilisation bonds could be seen as helpful in developing and deepening the local debt markets. In an emerging economy, bond issuance could help develop a yield curve. But such a process is endogenous, as the tendency to resort to market-based measures of sterilisation increases as local bond markets deepen. With thin markets, market-based measures may cause big fluctuations in do-

[13] See Table 6 in Geiger (2008) and the statistical update at http://mgeiger.wordpress.com/statistics/.

mestic interest rates. As noted by Mohanty and Turner (2006), the low interest rate environment has probably played a role in the increased use of market-based sterilisation measures. Given the improved monetary control in emerging Asia, especially over the past decade, low interest rates are likely to continue contributing to the use of market-based tools for sterilisation in the region.

Bank lending behaviour could be affected if banks hold large volumes of sterilisation bonds, as discussed by Ooi (2008). The perception of sterilisation bonds as a source of risk-free profits could curtail bank lending to the private sector, reducing productive investment. Indeed, Cook and Yetman (2012) find that there is a negative relationship between increases in foreign reserve holdings and the growth rate of bank lending for banks in some economies in emerging Asia.

The liquidity characteristics of sterilisation bonds may play an important role in determining the impact on the bank lending channel. If banks perceive sterilisation bonds as very liquid assets, and the ownership of liquid assets has a positive impact on lending, banks may be inclined to extend loans to the non-bank private sector even when holding substantial amounts of sterilisation bills, running counter to the ultimate aim of sterilisation. Tobin (1963) argues that banks consider short-term government bonds as close substitutes to excess reserves, as they can easily be sold to finance new lending.[14] Similarly, if there is easy access to wholesale funding, credit growth may be rapid despite sterilisation. In contrast, if no profitable lending opportunities are available for commercial banks, the monetary authority may lower the interest rate on the sterilisation bonds that the commercial banks hold and therefore lower the costs of sterilisation (Filardo and Grenville, 2012). Over time such a process encourages the commercial banks to seek new lending opportunities, possibly with higher risk. Risk taking may be particularly relevant in a low interest rate environment (Borio and Zhu, 2012). Alternatively, if the commercial banks are state-owned, the monetary authority may be able to conduct sterilisation operations at a lower cost than when dealing with privately owned banks. This could be a relevant issue when considering sterilisation costs in China, for example.

[14] Kumhof (2004) presents a theoretical model featuring the possibility that sales of sterilisation bonds at high interest rates actually raise consumption demand.

Choice of sterilisation instrument

The choice of sterilisation instrument depends on the available toolkit and the financial system characteristics of the different economies. Another important consideration is the relative cost of using the different instruments. In this section, we focus on the latter aspect. In particular, we investigate whether the relative cost has been of importance for three emerging Asian central banks, as they have mopped up liquidity from the financial system by central bank paper issuance and increases in reserve requirements. The use of the non-market based instrument of reserve requirements has been prominent during the recovery, especially in the case of China, but changes in the reserve requirement ratio have been applied also, eg in Indonesia and Malaysia. While both methods could be used to freeze liquidity simultaneously, their relative importance could vary across time as the relative costs change.

The problem facing central banks can be summarised as follows. An increase in foreign exchange reserve assets needs to be financed by liabilities within the domestic financial system. A central bank addresses this financing need by issuing domestic monetary liabilities, but may choose to sterilise the resulting liquidity by the instrument of its choice. The choice of sterilisation instrument can be seen as a cost-minimisation problem for the central bank, where for a given size and structure of assets, it needs to optimally choose its liability structure, taking their prices as given.

We simplify the decision problem of the central bank here by considering only two sterilisation instruments, central bank paper and reserve requirements, and their relative cost. The difference between the amount of liquidity withdrawn by the two instruments is specified to be a function of the difference of the yield on central bank paper i^{bond} and the rate of remuneration on required reserves, i^{rr}:

$$(B_t - RRR_t) = f(i_t^{bond} - i_t^{RR}). \qquad (1)$$

Here, B and RRR denote the amounts of liquidity absorbed by central bank securities and reserve requirements, respectively. The relationship described in (1) is admittedly a simplification, but other motivations for choosing a particular instrument can also be addressed in a cost-minimisation framework. Consider a central government that needs to issue debt in order to finance budget deficits. At times of large government paper issuance, the central bank may be more reluctant to issue its own paper in order to not directly compete with the

government – central government debt issuance could then be regarded as increasing the cost of issuing central bank securities. The level of outstanding stock of central bank securities could matter as well. As the cost of sterilisation is likely to increase as the volume of issuance increases, the central bank may be increasingly reluctant to issue central bank paper and possibly choose to increase the reserve requirement ratio instead – again implying that the relative costs of the instruments matter.

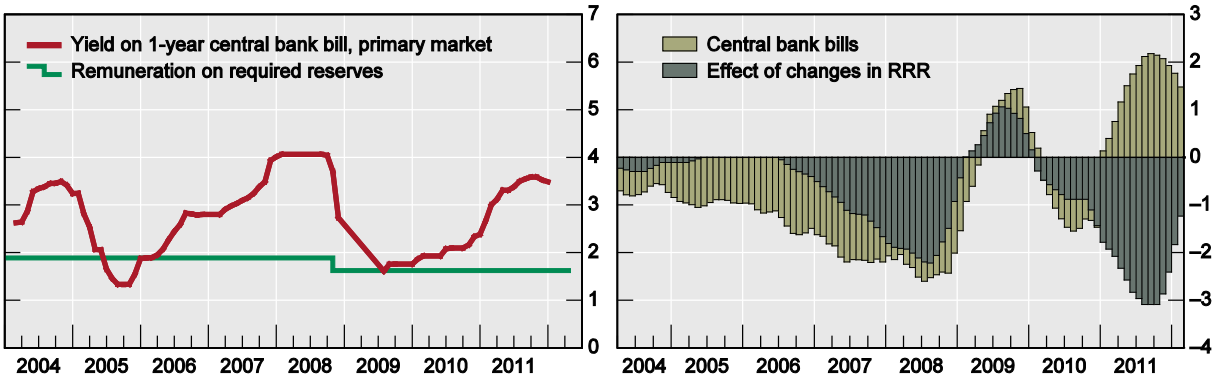
What does descriptive analysis suggest about the choice of sterilisation instrument and the relative costs? Starting with China, we follow Ma et al (2011) and display the one-year PBoC bill auction yield relative to the remuneration rate on required reserves (Graph 5, top left-hand panel), and the liquidity withdrawal/injection by the different sterilisation tools (Graph 5, top right-hand panel). For most of the time since 2004, the rate of remuneration on required reserves has been below the yield on one-year central bank bills. Therefore, reserve requirements have been a lower-cost instrument for the People's Bank of China for withdrawing liquidity than central bank paper. And changes in relative costs over time seem to matter. When the yield on central bank paper increased in 2007 and 2011, reserve requirements were increasingly used to absorb liquidity, while the importance of central bank securities fell. During January–June 2011, China increased reserve requirements for large banks six times (a total of eleven times since the start of 2010). Further, in the fall of 2011, reserve requirements were extended to cover banks' margin deposits, further draining liquidity. In contrast, when the yields on central bank securities climbed in 2011, their impact on liquidity was one of injection rather than withdrawal.

Graph 5 Sterilisation tools and costs

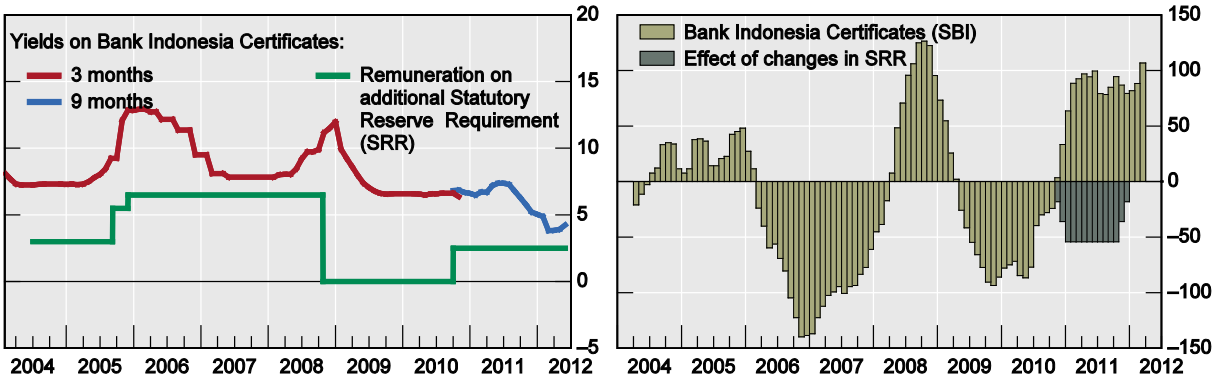
Central bank bills yield and remuneration on required reserves, in per cent

Reserves withdrawal (–) or injection (+) by sterilisation tool, in trillions of local currency[1]

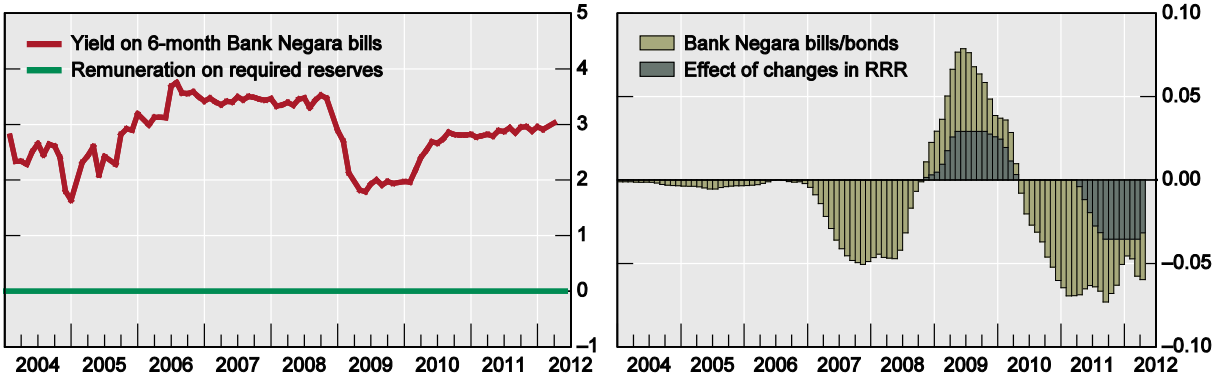
China



Indonesia



Malaysia



[1] Components of net domestic assets; year-on-year change of three-month moving average; positive (negative) indicates injection (withdrawal) of liquidity.

Sources: CEIC; national data; estimates of Ma et al (2011).

A similar picture emerges for Indonesia (Graph 5, centre panels). In 2006, as the cost of issuing SBIs relative to the remuneration on additional statutory reserves fell, there was

significant issuance of central bank paper. A similar dynamic occurred between end-2008 and end-2009. In both cases, the adjustment occurred via the issuance of central bank securities rather than by changing the reserve requirement ratios. Indeed, reserve requirements in Indonesia were not adjusted during the sample prior to the increase from 5% to 8% per annum in November 2010.

For Malaysia, the picture is somewhat different from China and Indonesia (Graph 5, bottom panels). There, increases in central bank bill yields sometimes coincide with increased securities issuance, as in 2010, or increased issuance overlaps with relatively flat yields, as in 2007. Required reserves are not remunerated in Malaysia, so any change in relative costs stems solely from fluctuations in central bank securities' yields.

Table 5 Choice of sterilisation instrument

	China (1)	**China (2)**	**Indonesia (3)**	**Indonesia (4)**	**Malaysia (5)**	**Malaysia (6)**
$i^{bond} - i^{RR}$	–1.414*** (0.333)	–1.397*** (0.332)	–10.061** (4.460)	–6.548 (4.788)	0.015*** (0.006)	0.014** (0.006)
Obs	95	95	78	77	99	99
Adj R-squared	0.403	0.379	0.126	0.046	0.128	0.108

Note: Ordinary least squares estimates. Dependent variable: Liquidity absorbed by central bank securities less liquidity absorbed by reserve requirements. Variables transformed as described in the footnote to Graph 5. Columns (1), (3) and (5) report estimations with the interest rate differential at current lag; Columns (2), (4) and (6) report results with the interest rate differential at first-period lag. HAC Newey-West consistent standard errors in parentheses. Samples: China: February 2004–March 2012; Indonesia: July 2004–December 2010; Malaysia: January 2004–March 2012.

Does econometric evidence support the graphical observation about the importance of the relative costs of instruments? We estimate simple least square regressions, where the difference between the liquidity withdrawal by the two instruments is regressed on the differ-

ence between their remuneration, for China, Indonesia and Malaysia.[15] The results are shown in Table 5 (columns 1, 3 and 5). For China and Indonesia, the interest rate variable, at the contemporaneous lag, obtains a negative and statistically significant coefficient. This suggests that when the cost of issuing central bank securities increases relative to the rate of remuneration on reserve requirements, the relative use of central bank paper to absorb liquidity falls.[16] However, for Malaysia, higher yields on central bank paper coincide with increased paper issuance, with a positive and statistically significant coefficient, suggesting that the relative costs of the instruments matter less in this economy.

What could explain the finding of the interest rate differential being of importance for China and Indonesia, but not for Malaysia? The mere size of the interest rate differential is unlikely to provide the explanation, as it does not differ notably between the three economies (see Graph 5). But differences in the *amounts* of cost saving could still be important. Indeed, simple back-of-the-envelope calculations suggest that using the reserve requirement instead of the central bank bill provided a cost saving for the People's Bank of China of roughly 0.1% of GDP in 2010 (as reported by Ma et al, 2011), and, similarly, 0.1% of GDP for Bank Indonesia in 2009. However, cost saving was less important for Malaysia, amounting to 0.01% of GDP in 2010.[17]

The above approach does not deal with potential endogeneity. In particular, when the issuance of central bank paper increases, the relative costs of using this instrument may rise, if commercial banks are increasingly reluctant to hold additional central bank securities. But note that such endogeneity would imply a *positive* relationship between the two variables – we actually obtain a *negative* coefficient for China and Indonesia. When lagged values of the interest rate variable are used instead, we still obtain a negative and statistically significant coefficient on the interest rate variable for China, and a negative but no

[15] Liquidity withdrawal/injection is specified as in Graph 5, as the year-on-year change of three-month moving average of net domestic assets.

[16] For Indonesia, the sample ends in December 2010, in order to maintain a consistent time series (three-month SBIs were not issued after December 2010). If we extend the sample until March 2012 by considering nine-month SBIs from January 2011 onwards, the estimated coefficient is still negative but falls below conventional levels of significance. We obtain similar result using the remuneration rate of zero on required reserves for computing the interest rate differential (based on remuneration on non-additional statutory reserves). We also note that the rather low R-squared values in the cases of Indonesia and Malaysia suggest that only a part of the dynamics of the explanatory variable can be explained by the behaviour of interest rates alone.

[17] These calculations use the yield on the one-year PBoC bill for China, the three-month SBI for Indonesia and the six-month Bank Negara Bill for Malaysia, together with the rate of remuneration on reserve requirements for all three economies. The amount of cost saving for Indonesia is likely to be underestimated, as it is based on the remuneration for additional statutory reserves – the other part of statutory reserves is not remunerated.

longer statistically significant coefficient for Indonesia (Table 5, columns 2 and 4). In sum, we obtain evidence that the relative costs of instruments indeed matter, at least in the cases of China and Indonesia.

Conclusion and policy implications

In this paper, we have investigated the issuance of sterilisation bonds in emerging Asia. An important development in recent years in the conduct of sterilisation has been the issuance of central banks' own paper. While some central banks in the region, such as Indonesia and Korea, have a longer history in issuing their own paper, the stock of outstanding central bank bills has increased rapidly in recent years. This partly reflects the increase in net foreign assets in central bank balance sheets, ie the sterilisation need has increased, and partly the deepening of the local financial markets that has supported the move to market-based methods for sterilisation.

We document that while the average maturities of outstanding bonds fell during the international financial crisis, maturities lengthened across the board in 2010–11. This is consistent with the aims of monetary authorities in many jurisdictions, and is argued by some central banks to enhance monetary control. The average maturities in our sample at end-2010 were longest in China and Korea, and the sharpest increases in maturities have recently been experienced in China and Indonesia.

The choice of the sterilisation instrument can be seen as a cost-minimisation problem for the central bank, where for a given size and structure of its assets, it needs to optimally choose its liability structure, taking their costs as given. We show both descriptive and simple econometric evidence that cost considerations indeed seem to matter for the choice of sterilisation instrument, in particular for the choice between changes in reserve requirements and the issuance of central bank securities, in the cases of China and Indonesia. This is line with the casual observation that in China, as yields on central bank paper climbed in 2007 and 2011, the central bank actively hiked reserve requirements to withdraw liquidity.

What implications do our findings have for policymakers? The increase in maturities is encouraging, as it may help to withdraw excess liquidity for a longer period, especially in an environment of persistent capital inflows. Evidence from China suggests that increased issuance of longer-term bills has coincided with increased monetary control in

terms of meeting the intermediate money growth targets. Inflation approached the central bank's inflation target in Indonesia as maturities increased during 2010–11. In principle, the increase in maturities should also facilitate effective sterilisation through the increased attractiveness of sterilisation paper.

As sterilisation bonds are market-based instruments, their use in sterilised intervention is likely to lead to fewer distortions in the economy in the long run, relative to reserve requirements. Moreover, the increased stock of central bank paper has added to the depth of the bond markets and has probably helped to further develop a yield curve. However, large volumes of relatively liquid central bank bills on the balance sheets of commercial banks may have impacts on the bank lending channel in ways not intended by the monetary authority. This, and the possibility that higher yields on central bank bills lead to increasing sterilisation costs, may lead the monetary authority to increasingly return to non-market based sterilisation instruments. We find some evidence for this, as the use of the different sterilisation instruments appears to be related to their relative cost.

Finally, given the very uneven global growth prospects and the associated capital inflows into emerging Asia, there is little evidence to suggest that sterilisation through the issuance of central bank securities would assume a smaller role in the years to come.

References

Aizenman, J and R Glick (2009): "Sterilisation, monetary policy, and global financial integration", *Review of International Economics* 17(4), 777–801.

Aizenman, J and J Lee (2007): "International reserves: precautionary versus mercantilist views, theory and evidence", *Open Economies Review* 18(2), 191–214.

Bank for International Settlements (2009): "Capital flows and emerging market economies", *CGFS Papers*, no 33.

Bank Indonesia (2011): *2010 Economic report on Indonesia*.

Bank Negara Malaysia (2009): *Annual report 2008*.

_____ (2011): *Annual report 2010*

Bank of Thailand (2011): *Annual economic report 2010*.

_____ (2010): *Annual economic report 2009*

Borio, C and H Zhu (2012): "Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism?", Journal of Financial Stability 8(4), 236–251.

Cook, D and J Yetman (2012): "Expanding central bank balance sheets in emerging Asia: a compendium of risks and some evidence", BIS Papers, no 66.

Filardo, A and S Grenville (2012): "Central bank balance sheets and foreign exchange rate regimes: understanding the nexus in Asia", BIS Papers, no 66.

Filardo, A, M Mohanty and R Moreno (2012): "Central bank and government debt management: issues for monetary policy", BIS Papers, no 67.

Geiger, M (2008): "Instruments of monetary policy in China and their effectiveness: 1994–2006", UNCTAD Discussion Papers, no 187.

He, D, C Chu, C Shu and A Wong (2005): "Monetary management in mainland China in the face of large capital inflows", Research Memorandum, no 07/2005, Hong Kong Monetary Authority.

Kumhof, M (2004): Sterilisation of short-term capital inflows – through lower interest rates? Journal of International Money and Finance 23(7–8), 1209–1221.

Ma, G, X Liu and X Yan (2011): "China's evolving reserve requirements", BIS Working Papers, no. 360.

Mohan, R (2008): "Capital flows to India", BIS Papers, no 44.

Mohanty, M S and P Turner (2006): "Intervention: what are the domestic consequences?", BIS Papers, no 24.

Ooi, S K (2008): "Capital flows and financial assets in emerging markets: determinants, consequences and challenges for central banks: the Malaysian experience", BIS Papers, no 44.

Ouyang, A Y, Rajan, R S and T D Willett (2010): "China as a reserve sink: The evidence from offset and sterilisation coefficients", Journal of International Money and Finance, 29(5), 951-972.

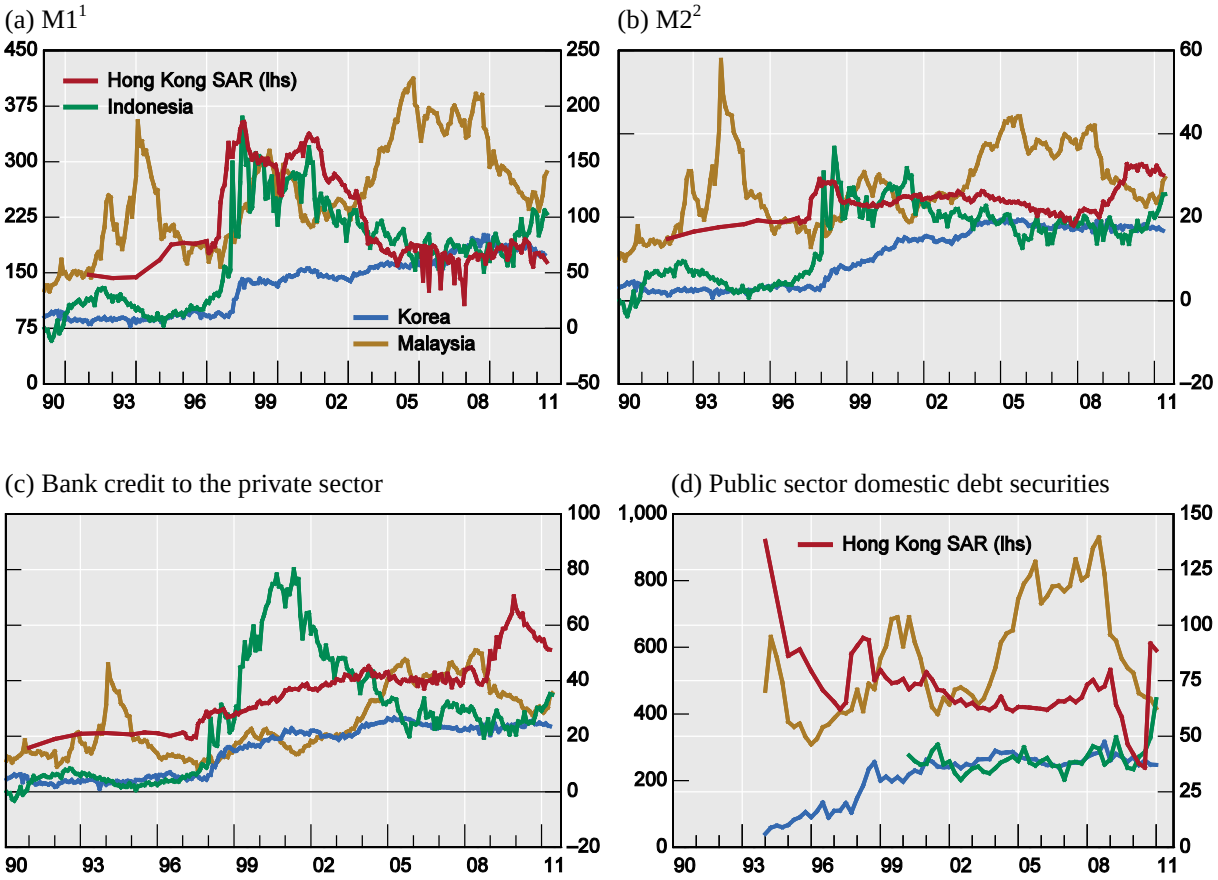
Reinhart, C and V Reinhart (1999): "On the use of reserve requirements in dealing with capital flow problems", International Journal of Finance and Economics, 4(1), 27–54.

Thaicharoen, Y and N Ananchotikul (2008): "Thailand's experiences with rising capital flows: recent challenges and policy responses", BIS Papers, no 44.

Tobin, J (1963): "An essay on principles of debt management", Fiscal and Debt Management Policies, Commission on Money and Credit.

Appendix

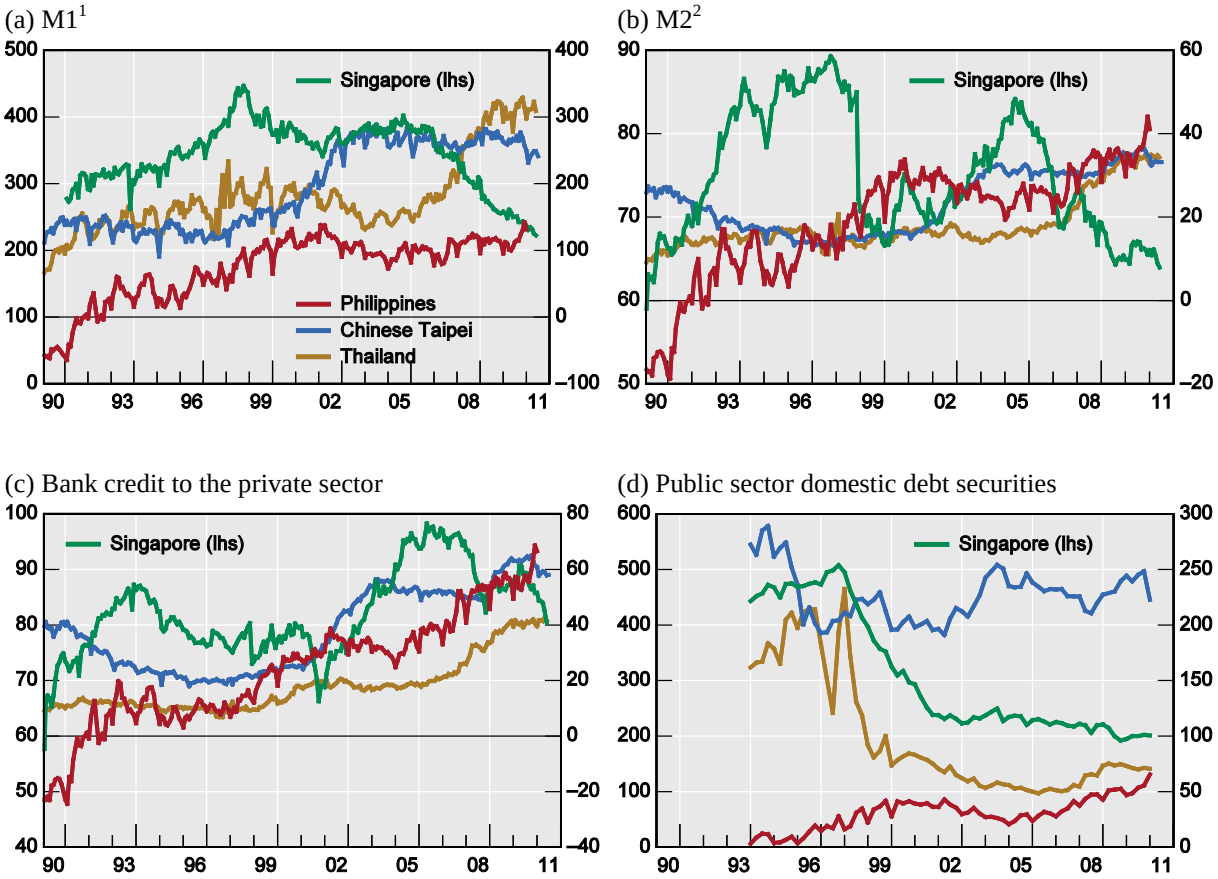
Graph A1 Foreign exchange reserves minus currency held by the public, as a percentage of:



[1] M1, also called narrow money, comprises transferable deposits and currency outside deposit money banks.
[2] M2 is a broad measure of money which in general comprises, in addition to M1, time, savings and foreign currency deposits of resident sectors other than central government. The components can vary across economies.

Sources: IMF; Datastream; national data; BIS.

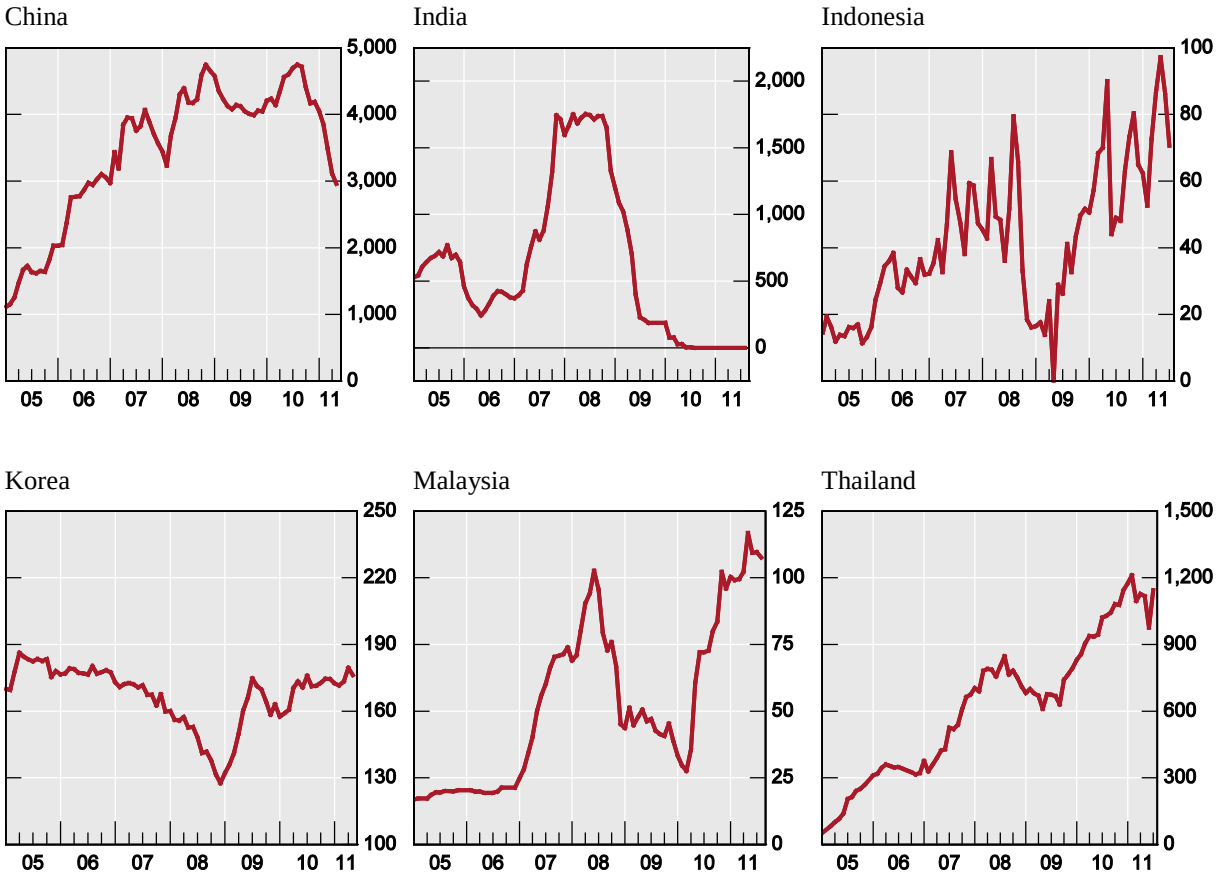
Graph A2 Foreign exchange reserves minus currency held by the public, As a percentage of:



[1] M1, also called narrow money, comprises transferable deposits and currency outside deposit money banks.
[2] M2 is a broad measure of money which in general comprises, in addition to M1, time, savings and foreign currency deposits of resident sectors other than central government. The components can vary across economies.

Sources: IMF; Datastream; national data; BIS.

Graph A3 Central bank securities[1], in billions of national currency[2]



[1] For India, proceeds from auctions of treasury bonds and securities under the market stabilisation scheme deposited at the Reserve Bank of India. [2] For Indonesia and Korea, in trillions.

Sources: IMF; CEIC.

BOFIT Discussion Papers

A series devoted to academic studies by BOFIT economists and guest researchers. The focus is on works relevant for economic policy and economic developments in transition / emerging economies.

2012

No 1 Walid Marrouch and Rima Turk-Ariss: Bank pricing under oligopsony-oligopoly: Evidence from 103 developing countries

No 2 Ying Fang, Shicheng Huang and Linlin Niu: De facto currency baskets of China and East Asian economies: The rising weights

No 3 Zuzana Fungáčová and Petr Jakubík: Bank stress tests as an information device for emerging markets: The case of Russia

No 4 Jan Babecký, Luboš Komárek and Zlatuše Komárková: Integration of Chinese and Russian stock markets with World markets: National and sectoral perspectives

No 5 Risto Herrala and Yandong Jia: Has the Chinese growth model changed? A view from the credit market

No 6 Sanna Kurronen: Financial sector in resource-dependent economies

No 7 Laurent Weill and Christophe Godlewski: Why do large firms go for Islamic loans?

No 8 Iftekhar Hasan and Ru Xie: A note on foreign bank entry and bank corporate governance in China

No 9 Yi Yao, Rong Yang, Zhiyuan Liu and Iftekhar Hasan: Government intervention and institutional trading strategy: Evidence from a transition country

No 10 Daniel Berkowitz, Mark Hoekstra and Koen Schoors: Does finance cause growth? Evidence from the origins of banking in Russia

No 11 Michael Funke and Michael Paetz: A DSGE-based assessment of nonlinear loan-to-value policies: Evidence from Hong Kong

No 12 Irina Andrievskaya: Measuring systemic funding liquidity risk in the Russian banking system

No 13 Xi Chen and Michael Funke: The dynamics of catch-up and skill and technology upgrading in China

No 14 Yin-Wong Cheung, Menzie D. Chinn and XingWang Qian: Are Chinese trade flows different?

No 15 Niko Korte: Predictive power of confidence indicators for the russian economy

No 16 Qianying Chen, Michael Funke and Michael Paetz: Market and non-market monetary policy tools in a calibrated DSGE model for Mainland China

No 17 Pierre L. Siklos: No coupling, no decoupling, only mutual inter-dependence: Business cycles in emerging vs. mature economies

No 18 José R. Sánchez-Fung: Examining the role of monetary aggregates in China

No 19 Konstantins Benkovskis and Julia Wörz: Non-price competitiveness of exports from emerging countries

No 20 Martin Feldkircher and Iikka Korhonen: The rise of China and its implications for emerging markets - Evidence from a GVAR model

No 21 Pierre Pessarossi and Laurent Weill: Does CEO turnover matter in China? Evidence from the stock market

No 22 Alexey Ponomarenko: Early warning indicators of asset price boom/bust cycles in emerging markets

No 23 Gabor Pula and Daniel Santabárbara: Is China climbing up the quality ladder?

No 24 Christoph Fischer: Currency blocs in the 21st century

No 25 Duo Qin and Xinhua He: Modelling the impact of aggregate financial shocks external to the Chinese economy

No 26 Martin Feldkircher: The determinants of vulnerability to the global financial crisis 2008 to 2009: Credit growth and other sources of risk

No 27 Xi Chen and Michael Funke: Real-time warning signs of emerging and collapsing Chinese house price bubbles

No 28 Yi David Wang: Convertibility restriction in China's foreign exchange market and its impact on forward pricing

No 29 Risto Herrala and Rima Turk Ariss: Credit conditions and firm investment: Evidence from the MENA region

No 30 Michael Funke and Michael Paetz: Financial system reforms and China's monetary policy framework: A DSGE-based assessment of initiatives and proposals

No 31 Zuzana Fungáčová, Pierre Pessarossi and Laurent Weill: Is Bank Competition Detrimental to Efficiency? Evidence from China

2013

No 1 Aaron Mehrotra: On the use of sterilisation bonds in emerging Asia

www.bof.fi/bofit

BOFIT Discussion Papers
http://www.bof.fi/bofit_en • email: bofit@bof.fi
ISSN 1456-6184, online