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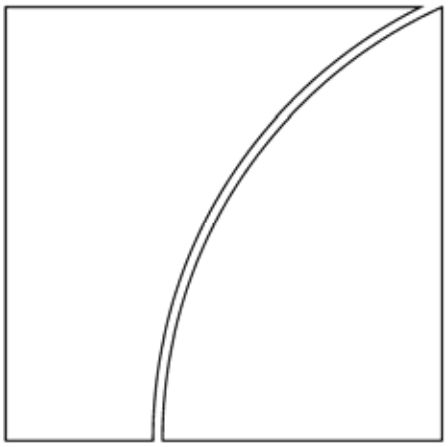

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Implementing monetary policy in the 2000s: operating procedures in Asia and beyond

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Abstract

Just as monetary policy at the strategic level has undergone significant changes over the years, so has its day-to-day implementation. This paper documents the key features of 17 central banks' monetary operating frameworks as of early 2007 and discusses their major developments over the preceding decade. It finds that while some common themes and practices can be identified, there is no unique "best" way to implement monetary policy. Moreover, central banks everywhere – even in industrial economies – have continued to refine their operating frameworks and procedures and to innovate where necessary, responding to changing needs in changing times.

Keywords: monetary policy implementation, operating procedures, policy rate, operating target, reserve requirements, standing facilities, discretionary operations, Asia-Pacific

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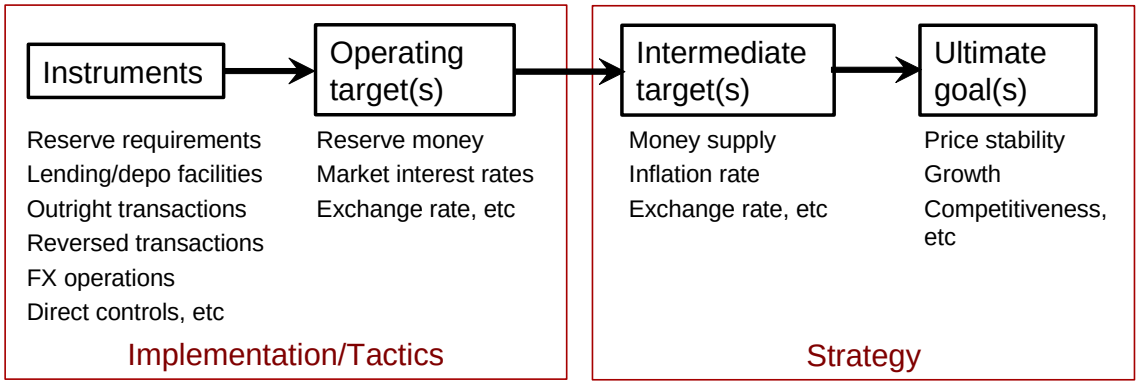
Contents

1. Introduction[1]

At the strategic level, monetary policy has undergone significant changes over the years. Exchange rate pegs or bands, monetary aggregate targets and inflation targets have at different times gained favour as the mainstream intermediate objective that guides policymakers in their pursuit of the ultimate objectives. At the tactical (or operational) level, the day-to-day implementation of monetary policy has also evolved, driven in part by the changing views regarding the preferred intermediate target and in part by the changes in the broader banking and financial systems both at home and abroad.

The tactical and strategic aspects of monetary policy



This operational evolution has been less popular as a subject of academic research than its strategic counterpart, but has nonetheless been examined by specialists in the central banking community. For example, Kneeshaw and Van den Bergh (1989) and Borio (1997) documented the migration of industrial economy central banks in the 1980s and early 1990s, respectively, towards what we now consider mainstream operating frameworks.[2] Van 't dack (1999) observed a similar process among emerging market economies during the 1990s.[3] These and other related studies note that the evolution of monetary policy implementation has accompanied several major financial, institutional and policy developments. These include domestic banking system deregulation, the rise of non-bank financial intermediation and new financial instruments, external accounts liberalisation, increased central bank autonomy, reduced central bank responsibility in public debt management and policy lending, a reduced use of quantities (eg M2) as intermediate targets of monetary policy, a shift away from irregular interval signalling towards explicit announcement of the policy stance at pre-determined dates, and a shift away from end-of-day net settlement to real-time gross settlement (RTGS).

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[1] The author wishes to thank the participants at the BIS meetings on monetary policy operating procedures for providing information and inspiration on the subject matter of this paper. Gratitude is also due to Eric Chan and Gert Schnabel for data assistance, and to Claudio Borio, Dietrich Domanski, John Groom, Hirotaka Hideshima, Spence Hilton, Nazrul Hisyam bin Mohd Noh, Jonathan Kearns, Daniel Lau, Robert McCauley, Thammarak Moenjak, William Nelson, Priyanto B Nugroho, Eli Remolona, Chris Ryan, Ilhyock Shim and Pierre Siklos for providing specific comments to the earlier drafts. The author takes responsibility of all remaining mistakes. Views expressed are those of the author and not necessarily those of the Bank for International Settlements.

[2] BIS Papers no 9 (2001) provides a comparison of the operating frameworks of the United States, Japan and the euro area as of the turn of this century.

[3] Using the framework of Van 't dack (1999), Ryoo (2006) surveys the operating procedures in a number of East and Southeast Asian central banks, including some not covered in this paper.

Against this backdrop, several stylised trends in the choices of operating frameworks and instruments can be identified. For instance, many central banks now express their *official monetary policy stance* in interest rate terms (eg a central bank facility/operation rate, or a target for a market rate). At the same time, the day-to-day *operating objective* of central banks has focused more on stabilising some measure(s) of short-term interest rate, less on targeting quantities (eg reserve money). With regards to the nature of *instruments*, there has been a reduced use of direct controls, and more use of indirect instruments based on market mechanisms and incentives. Where they apply, reserve requirements have tended to become more simplified and less onerous, serving less as a main monetary control instrument, and more as a means to make reserve demand more predictable and to buffer short-term interest rate volatility. Standing facilities have also become simpler, serving less as a source of subsidised lending or a main policy signalling device, and more as a back-stop or safety valve for short-term liquidity needs to help contain interest rate volatility.

More recently, Buzeneca and Maino (2007) confirm these general trends in monetary instrument usage with information from the IMF's Information System for Instruments of Monetary Policy (ISIMP). Implicit in their analysis is that the practices among "developed" economies would represent a kind of "state-of-the-art", something to which "emerging" and "developing" economies should aspire.[4] However, a closer look at the choices in individual economies and the evolution thereof reveals that operating frameworks and practices are not a simple function of the level of economic development. In fact, considerable differences prevail, even among the "developed" economies.

Behind the broad global trends, how much diversity remains? And perhaps more interestingly, why does this diversity remain? This paper seeks to shed some light on these questions by surveying the monetary policy operating procedures in a group of 14 Asia-Pacific central banks,[5] plus the Federal Reserve, the European Central Bank and the Bank of England. It documents the main features of these central banks' operating frameworks as of early 2007 and highlights the notable changes that took place in the late 1990s and early 2000s.[6] Of the 17 economies covered, 11 would be considered "developed" according to the classification in Buzeneca and Maino (2007), the other six would be "emerging" or "developing".[7] This sample size and mix lends itself to an assessment of where the trend ends and the diversity begins.

Following the conceptual framework laid out by Borio (1997), the rest of this paper is organised as follows. Section 2 sets the scene with an overview of the *institutional aspects* of monetary policy decisions and operations among the 17 central banks. It discusses in turn the frequency of monetary policy decision announcements, the choice of *policy rates* and its connection, if any, to the strategic policy framework. Section 3 surveys the different choices

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[4] The authors classified the economies in the ISIMP into three groups labelled "developed", "emerging" and "developing", which in fact correspond to "high income", "upper middle income" and "lower middle and low income" according to the World Bank analytical classification based on Gross National Income per capita (2004 calendar year data). International Monetary Fund (2004) discusses the difficulties developing and post-conflict economies face in emulating the market-based operations of industrial economies.

[5] The 14 Asia-Pacific central banks are those in Australia, China, Hong Kong SAR (hereafter, Hong Kong), India, Indonesia, Japan, South Korea (hereafter, Korea), Macao SAR (hereafter, Macao), Malaysia, New Zealand, the Philippines, Singapore, Taiwan (China) (hereafter, Taiwan) and Thailand.

[6] Markets Committee (2008) provides a more updated snapshot of the operating frameworks for 14 central banks (of which, five are not covered in this paper).

[7] Malaysia is the only "emerging" economy, while China, India, Indonesia, the Philippines and Thailand would be labelled "developing". The sample has some overlap with that in Buzeneca and Maino (2007), but includes seven economies not covered by the two authors. These include four "developed" ones (Hong Kong, Macao, Singapore and Taiwan, all of which happen to be small and very open economies) and three "developing" (Indonesia, the Philippines and Thailand).

of *operating targets* and discusses their evolution and implications for interbank overnight interest rate volatility. Since day-to-day monetary policy implementation basically revolves around getting the quantity and price of bank reserves right so as to achieve the desired operating target, it is natural to present the "nuts and bolts" of monetary operations with reference to the demand for and supply of bank reserves.[8] Thus, section 4 looks at the two broad factors affecting the *demand for bank reserves*: settlements needs and reserve requirements. In particular, it reviews the features of reserve requirements and relates these features to the functions of such requirements. Section 5 then examines the two main aspects of the *supply of reserves*: the autonomous factors that a central bank takes as given and the various instruments with which a central bank injects or withdraws liquidity from the system. It discusses the evolution of the roles of standing facilities and discretionary operations, as well as the connection between the choice of instruments and financial market development. Section 6 concludes.

This paper finds that, while a number of common themes and practices can be identified, there is no unique "best" way to implement monetary policy. Even among just the four major industrial economy central banks in the sample, considerable differences still exist, reflecting, inter alia, differences in the domestic financial environment, history, legal and regulatory constraints, and even political philosophy.[9] Moreover, judging by the number of new developments in virtually all aspects of monetary policy implementation, it is clear that central banks in "developing", "emerging" and "developed" economies alike have continued to refine their operating frameworks and procedures and to innovate where necessary, responding to changing needs in changing times.[10]

2. The institutional aspects of monetary policy decisions

In order to understand the implementation of monetary policy at the operational level, it is helpful to begin with the institutional aspects of monetary policy decision-making. This section overviews the different practices with regards to the frequency of policy announcements and the expression of policy stance. It also assesses whether there is any connection between the choice of policy rate and the higher-level monetary policy strategy. Table 1 summarises these various aspects for the central banks sampled in this paper. Unless otherwise stated, the data in this and all other tables reflect the situation as of March 2007.

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[8] See section 1 in Borio (1997) for the conceptual underpinnings of how the various aspects of monetary operations can be analytically classified as supply and demand factors in the market for bank reserves.

[9] In a rare recent academic piece that touches on monetary operations, Woodford (2000) provides an interesting discussion of how the familiar, academically mainstream operating framework of the Federal Reserve is in fact by no means the mode among industrial economies. This discussion is in part a response to the alarm raised by Friedman (1999) over the potential threat of electronic money to the Federal Reserve's role as a monopoly supplier of reserves. For earlier academic works on monetary operations, see the references in Bindseil (2004). Current research on this topic tends to be conducted mainly at central banks.

[10] In fact, a number of significant changes did occur after the March 2007 sample date. The major developments in the second half of 2007 and in early 2008 are outlined in the Annex of this paper.

2.1 Frequency of policy decision announcements

Almost all of the sampled central banks make monetary policy decision announcements at pre-determined dates (column 1).[11] A popular frequency of policy announcement is once every four to six weeks (equivalent to about eight to 12 times a year). There is a minority of central banks with quarterly, semi-annual or even non-scheduled announcements.[12] However, some central banks' decision-making bodies convene more frequently than the frequency of announcements suggests. For example, the European Central Bank (ECB) Governing Council meets twice a month but typically announces policy decisions only in the first meeting of each month. The Singaporean authorities hold regular monetary and investment policy meetings, even though it makes monetary policy statements only once every half a year. In any case, central banks typically reserve the right to meet or to announce policy changes in between scheduled dates if deemed necessary.

2.2 What exactly do central banks announce?

The majority of the sampled central banks express their monetary policy stance in terms of an interest rate – the *policy rate* (column 2). Two main types of policy rates are represented. One type is an announced target for a market interest rate (eg the overnight interbank market rate). The central banks of Australia, Japan, Korea,[13] Malaysia, New Zealand and the United States have this type of policy rate. The other type is an official rate of a central bank operation or facility. The ECB, for example, indicates policy stance with the minimum bid rate of its main refinancing operation (MRO), which is a weekly tender for supplying liquidity to financial institutions at a 1-week maturity. The Bank of England used to use its repo rate as the policy rate between 1997 and mid-2006 and has since recast its policy rate as the official Bank Rate.[14] In part influenced by the Bank of England's former practice, the Bank of Thailand's policy rate is also an official repo rate. India and the Philippines signal monetary policy with both the official repo and reverse repo rates.[15] Taiwan signals policy with the official discount rate, while Indonesia uses the BI Rate, defined at the time of its inception in 2005 as the target auction rate for the 1-month Bank Indonesia certificates (SBIs) issued by the central bank. China represents a special case: its formal policy rates are, unlike the others', not directly related to the money market but are instead the reference rates for 1-year bank lending and deposits – clearly a legacy of central planning and of a banking system that is still undergoing deregulation.[16]

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[11] As will be discussed in section 4, pre-determined monetary policy announcement dates could have implications for financial institutions' reserve demand behaviour (and thus interbank market interest rate volatility) during the reserve requirement maintenance period.

[12] The two small open economies with currency board regimes, Hong Kong and Macao, have no independent monetary policy per se. However, both monetary authorities have official overnight lending facility rates (called Base Rate in both cases) that are linked to the US Fed funds rate target. The Base Rate is adjusted whenever the Federal Reserve changes its policy rate.

[13] The Bank of Korea announced in July 2007 plans to switch from using the overnight call rate target as the main policy signal to using an official transaction rate in early 2008 (see Annex for details of the reform).

[14] The Bank Rate is both the reference for the short-end of the money market yield curve (the regular weekly open market operations are conducted at Bank Rate) and the remuneration rate for bank reserves voluntarily contracted and held under the new scheme launched in May 2006 (more on this in section 4). The history of the Bank's policy rate (definitions and levels) since 1970 can be found on the Bank's website: http://www.bankofengland.co.uk/statistics/rates/baserate.pdf

[15] The Reserve Bank of India announces also a Bank Rate, which used to be the main policy rate but now serves only as a medium term signal.

[16] In fact, some practices in China today are illustrative of what how things used to work in a larger number of economies in the earlier era of highly regulated banking systems.

However, not all central banks express their policy stance with an interest rate. Central banks running exchange rate based regimes with no capital controls obviously cannot independently set policy interest rates. The currency board regimes of Hong Kong and Macao are typically identified by their respective spot exchange rate anchors. Their domestic money market interest rates are endogenously determined by the forces of capital flows.[17] Under Singapore's unique regime, the Monetary Authority expresses its policy stance with a qualitative statement about the centre, width and gradient of its target band for the Singapore dollar nominal effective exchange rate (NEER).[18] Although the Singaporean regime allows much more flexibility than the single anchor regimes of Hong Kong and Macao, the high degree of capital mobility means that the Singapore dollar interest rate level is still broadly endogenous.

Policy rate choice and monetary policy strategy: any relationship?

Judging by the choices of the central banks in the sample, there is no obvious mapping between the expression of policy stance and the strategic aspects of the policy framework (columns 2 and 4). For instance, among the seven central banks that formally adopt an inflation targeting regime, three signal policy with a target for the overnight rate (Australia, Korea, New Zealand), while four do so with an official central bank operation rate (Indonesia, Philippines, Thailand, United Kingdom). Conversely, while both India and the Philippines have the same choice of policy rates (official repo and reverse repo rates), the two economies have different monetary policy frameworks.

Moreover, looking back into the recent past, there have been changes in the choice of policy rate without any change in the higher-level policy regime and vice versa. For example, as part of its operational framework reform, the Bank of Thailand moved from the 14-day repo rate to the 1-day repo rate in January 2007, but left all the strategic aspects of its inflation-targeting framework unchanged. The Bank of England also migrated over the past decade from a 14-day repo rate to a 7-day repo rate to the current official Bank Rate, while remaining in an inflation-targeting framework. Bank Negara Malaysia switched from using the "3-month intervention rate" to using the Overnight Policy Rate (OPR) in April 2004, without altering its dollar peg-cum-capital controls regime. The OPR remains the policy rate after exiting from the dollar peg in July 2005. All these examples lend support to the view that there is no one-to-one link between the choice of policy rate and the monetary policy framework.[19]

What governs the choice of the policy rate?

In practice, the choice of the policy rate has often much to do with legacy and to some extent cross-country emulation. For instance, the ECB's choice of a 1-week (originally 2-week) tender rate is reminiscent of the choices of the German, French, Belgian and Austrian central

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[17] The Hong Kong dollar is anchored at HKD 7.80 per USD (with a ±HKD 0.05 tolerance band since May 2005), while the Macanese pataca is anchored at MOP 1.03 per HKD. Accordingly, the HKD and MOP short-term market interest rates are directly and indirectly influenced by USD interest rates via interest parity conditions.

[18] For example, in the October 2006 monetary policy statement, the MAS said it would "maintain the policy of a modest and gradual appreciation of the S$NEER policy band" and there would be "no re-centring of the policy band, or any change to its slope or width". The NEER series is published occasionally, but the exact composition of the basket and the exact centre, width and slope of the policy band are not published. But over time, many Singapore-based market economists have with some success reverse-engineered plausible versions of the S$NEER policy band. See Monetary Authority of Singapore (2001) for details on Singapore's policy regime.

[19] Tucker (2004, p 370) observes that even the evolution of the implementation framework (not just policy rate) bears no clear relationship with changes in the monetary regime at the Bank of England in the entire post-WWII era. He cites Swank and van Velden (1997, pp 1–12) for OECD country evidence on the same point.

banks in the pre-EMU era.[20] Elsewhere, the popularity of the overnight rate target may be in some ways influenced by the Federal Reserve. Similarly, the prevalence of Bank Rates and repo rates as policy rates among other central banks may reflect the influence of the Bank of England.

But history and peer emulation aside, functionality also matters. As a signal of the policy stance, the policy rate should ideally provide clarity and good controllability. This perhaps explains why so many central banks signal policy with their official operation or facility rates, which are naturally fully within their control. And to the extent that the policy rate, once properly implemented, is also the starting point of monetary transmission, it should ideally be something economically relevant. This may be the reason why some central banks prefer to target a market interest rate instead. Moreover, the relevant market rate to target may change over time with banking system and financial market development. The 2004 policy rate reform in Malaysia mentioned above is a good illustration of this point. The former policy rate, adopted in 1998, had been highly relevant in principle given its link by formula to the Base Lending Rate (BLR) ceiling. The BLR was then the benchmark for pricing retail and corporate interest rates. However, as more and more banks moved towards cost-based pricing, the BLR lost significance. Thus, the policy rate's relevance also diminished. This development eventually led Bank Negara Malaysia to adopt a new framework, with the overnight rate target as its new policy rate.[21]

Regardless of the exact choice of policy rate, any *decision* to raise the overnight rate target or to cut the official repo rate is of little significance unless the decision is *implemented* one way or another. The next section takes the first step into the operational sphere of monetary policy implementation by considering in more detail the relationship between the policy rate and the day-to-day objective of the central bank's operations desk.

3. The operational objectives of monetary policy implementation

Just as monetary policy-making at the strategic level has its goals, monetary policy implementation at the operational level also has its objectives. Such objectives that central bank operations desks pursue in their everyday work are often set in terms of their *operating targets*, which can be of three main types: interest rate, exchange rate and quantity (eg bank reserves).

3.1 Interest rate targets: the current mainstream

Drawing upon the information in Table 1 (columns 2 and 3), the figure below summarises the combination of policy rates and operating targets adopted by the central banks in the sample. Apart from the three central banks with explicitly exchange rate based regimes, most of the others tend to adopt some measure of short-term interest rate as their operating targets. Central banks that signal policy with an overnight rate target naturally give their operations desks instructions to keep the overnight *market* rate close to the targeted level. Central banks that signal their policy stance with other official interest rates, however, show some

[20] In fact, many other aspects of the ECB's operating framework and practices can also be traced back to its member central banks.

[21] Moreover, under the new framework, each banking institution would establish its own BLR based on cost and business considerations and would no longer be subject to any BLR ceiling (BNM Press Release dated 23 April 2004).

variation in operating objectives. But even there, overnight or short-term interest rates still represent the majority.

Combination of policy rate and operating target choices (as of March 2007)

Operating target \ Policy rate	Overnight rate target	Other official rate	Exchange rate
Overnight rate	Australia, Japan, Korea, Malaysia, New Zealand, United States	**	
Other short-term rate(s)		China†, Indonesia, Taiwan†, Thailand, United Kingdom, **	
Exchange rate			Hong Kong, Macao, Singapore
Quantity		China†, Taiwan†	

** The euro area, Indian and Philippine central banks do not have formal operating targets. But in practice they operate with some reference to the overnight rate and other short-term interest rates.
† While the formal operating target is a quantity target, in practice, attention is also paid to short-term money market interest rates.

It should be noted that some central banks do not adopt a formal operating target, but nonetheless keep an eye on the behaviour of the overnight and other short-term interest rates in their day-to-day operation. The ECB is in this category, as are the Indian and Philippine central banks. The Bank of England has traditionally watched short-term money market rates in general but in 2006 re-formulated its operating objective in more specific and innovative terms: "a flat money market yield curve, consistent with the official Bank Rate, out to the next MPC decision date, with very limited day-to-day or intraday volatility in market interest rates at maturities out to that horizon" (Bank of England (2007, p 3)).

Quantitative operating targets, in contrast, are now in the minority. In an earlier era, the focus on quantities such as bank reserves or monetary base was in part related to the popularity of monetary aggregates as intermediate targets. The prevalence in that era of heavily regulated banking systems and underdeveloped non-bank financial intermediation also meant that monetary transmission via market interest rates – something now almost taken for granted – used to be less prominent. But as banking deregulation got under way and as other channels of intermediation opened up, monetary aggregates' relevance for the ultimate objectives of monetary policy declined.[22] Bank reserves or monetary base targeting also came to be seen as less relevant, while market interest rates began to have more role to play.[23]

[22] Especially over the short to medium horizon and when the economy is not in extreme inflation or deflation.

[23] Bindseil (2004) discusses the rise and fall of the "reserve position doctrine" between the 1920s and 1980s, and how in his view this fallacious doctrine, which supported the focus on quantities in that era, especially in the United States, is still being perpetuated by some academic work even today. Disyatat (2008) discusses the gaps between the conventional academic exposition of monetary policy implementation and actual practice, and the possible impact this has on the proper understanding and analysis of various aspects of monetary economics.

3.2 Residual uses of quantity targets

Among the major industrial economy central banks, the reorientation from quantities back to interest rates was mostly complete by the early 1990s. Many emerging market central banks did the same from the 1990s onwards.[24] Barring the exceptional case of the Bank of Japan during the quantitative easing era (see Box 1), the Taiwanese and Chinese central banks are the only two in the sample that still consider bank reserves to be their formal operating targets.

In Taiwan, there is still official reference to the M2 growth target range as a guide to policy at the strategic level. The central bank therefore still accords some importance to the level and growth of reserve money at the operational level. However, judging by the other aspects of operation and the overall relative stability of short-term money market rates, the central bank in practice pays considerable attention to interest rates in its everyday operations.

In China, too, the central bank's emphasis on bank reserves is in part related to its use of monetary aggregates as intermediate targets. But it is also in part out of necessity. Laurens and Maino (2007) point out that, despite much progress with financial and institutional reform, China's interest rate transmission channel is at the current juncture still not yet fully functioning, posing an obstacle to solely relying on interest rates as an operating target. Furthermore, China's chronic excess liquidity in recent years makes keeping quantities under control a relatively high priority objective. That being said, the fact that the Chinese central bank also has in place a kind of de facto interest rate corridor (more on this in section 5) suggests that it is also increasingly paying attention to short-term interest rates at the operational level.

[24] For example, Korea made the transition gradually in 1998-99 (Bank of Korea (2002)). India began the transition in 2000 by de-emphasising the role of quantities with the introduction of the Liquidity Adjustment Facility. Indonesia formally exited from base money targeting (a legacy of the IMF adjustment programme) in 2005 with the adoption of the 1-month SBI auction rate as policy rate. Even before this formal adoption, market participants had already for some time perceived the 1-month SBI auction rate as a de facto policy rate (Borio and McCauley (2001)).

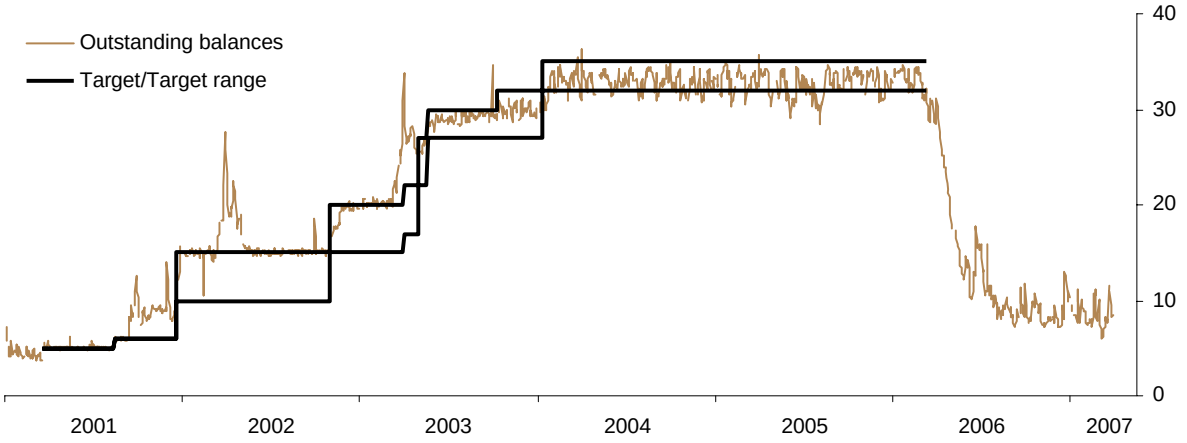
Box 1: Quantitative easing in Japan (March 2001–March 2006)

The "quantitative easing policy" episode in Japan offers an example of how quantitative operating targets may still play a role under extraordinary circumstances. Repeated rate cuts in Japan in the 1990s had brought the overnight call rate down to almost zero by February 1999. Amid sluggish activity and tenacious deflation, the move to bring interest rates back to positive territory in August 2000 had to be reversed in early 2001. With the interest rate channel pushed to its limit and effectively exhausted, the Bank of Japan resorted to the quantity channel in order to continue to signal policy easing.

Prior to resorting to quantitative easing, the monetary policy announcements gave guidelines for money market operation in interest rate terms. For example, the 9 February 2001 announcement read "The Bank of Japan will encourage the uncollateralized overnight call rate to move on average around 0.25%." Under quantitative easing, however, the guideline for operations was formulated in terms of the size of financial institutions' balances at the central bank. For example, the 19 March 2001 monetary policy decision read "The Bank of Japan will conduct money market operations, aiming the outstanding balance of the current accounts at the Bank at around 5 trillion yen."

Current account balances at the Bank of Japan

In trillions of yen



Source: National data.

Between March 2001 and January 2004, the target for current account balances was raised several times, from a level of around 5 trillion yen to a range of around 30-35 trillion yen. The main operational challenge during this period was to induce financial institutions to hold increasingly larger balances – well beyond the amount they need to fulfil reserve requirements and to facilitate settlements. Extending the maturity of operations and purchasing more government securities outright were among the measures taken by the central bank to supply more liquidity. At the same time, increased precautionary holdings by banks (given interbank market atrophy) and arbitrage-related holdings by foreign banks (given their ability to raise yen funds via foreign exchange swaps at negative interest rates) helped to sustain the demand for bank balances.

With the eventual revival of the economy and the return of inflation, five years of quantitative easing came to an end. The 9 March 2006 monetary policy decision readopted the overnight call rate as the operating target, but kept the target level at effectively zero. Over the following months, maturing operations allowed the current account balances to decline towards a level more in line with required reserves. In the July 2006 monetary policy meeting, the decision was made to raise the policy rate from effectively zero to 0.25%, drawing the zero interest rate policy era also to a close.

As unique and innovative as it may be, quantitative easing in Japan was born out of extreme and adverse circumstances. With its effectiveness in both macroeconomic and financial stability terms still open to debate (Oda and Ueda (2005)), quantitative easing is probably not a policy option to which other central banks may want to aspire.

3.3 Implications for overnight rate volatility

Regardless of whether the overnight interbank market rate *level* is of policy significance, central banks often have some interest in monitoring the overnight rate *volatility*. On the one hand, some volatility is seen as healthy since it creates trading opportunities, which in turn promotes interbank market activity. On the other, however, too much volatility may indicate that the interbank market is not functioning smoothly.[25] Moreover, large or persistent deviations from the policy target, especially if not explainable by purely technical factors, may risk being interpreted as either an unintended failure to achieve the announced policy stance or an intended deviation from it.[26]

The overnight rate volatility is in part affected by the choice of policy rate and operating target. Graph 1 shows the key official central bank interest rates and the overnight interbank market rates for the economies sampled in this paper. In economies where the central bank targets the overnight rate itself, the volatility of the actual overnight rate – both in terms of some measure of variability (eg standard deviation) and its deviation from the policy target – is likely to be relatively low. In Australia, in particular, where banks have over time developed a convention to deal with each other only at the Target Cash Rate, the actual cash rate has virtually no variation around its target.[27] This had also been the case in New Zealand until mid-2006, when a change in the liquidity management regime induced market participants to start trading at a small margin above the policy rate.[28]

In economies where the central bank does not formally target the overnight rate, there could in principle be more room for overnight rate volatility. It is apparent from Graph 1 that non-overnight rate targeters such as China, the euro area, Hong Kong, India, Indonesia,[29] Macao, the Philippines, Singapore and the United Kingdom have to different extents higher daily overnight rate volatilities than do the explicit overnight rate targeters. However, this characterisation does not seem to apply well to Taiwan and Thailand, where the overnight rates seem to be no more volatile than those in Korea or the United States.

Indeed, the choice of policy rate and operating target is not the only determinant of overnight rate volatility. The other aspects of the operating framework arguably have just as much, if not more, influence.[30] A case in point is the traditionally more volatile overnight rate in the United Kingdom compared to the euro area. The higher volatility in UK overnight interest rate is attributable to some features of the Bank of England's operating framework, which had been until mid-2006 quite different from the ECB's. There was no reserve requirement in the

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[25] Market malfunctioning may result from technical glitches or other factors that prevent the efficient distribution of funds from institutions that are in surplus to those that are short. It may also result from gaming of the market by specific institutions. To the extent that some other markets (eg overnight index swaps) do rely on the overnight interbank rate as a benchmark, excessive overnight rate volatility may hamper their development.

[26] Borio and McCauley (2001) report one case in 1999 in which, against the background of abundant liquidity and subdued loan growth, Malaysian interbank rates were allowed to drift and stay substantially below the formal policy rate (see Graph 1). Domestic market participants understood it as a kind of de facto easing and came to see the regular money market tender yields as a de facto policy rate.

[27] Though ensuring an appropriate overall supply of reserves via central bank operations (see section 5) also plays an important role.

[28] The changes include a reduction in the frequency of open market operations, the phasing out of the intraday liquidity facility and the resetting of the overnight standing facility rates from a symmetric ±25 basis points to an asymmetric +50/–0 basis points around the policy rate. See Reserve Bank of New Zealand (2006).

[29] In its June 2008 policy statement, Bank Indonesia officially announced a change of its operating target from the one-month SBI rate to the overnight interbank rate.

[30] In a study of industrial economy central banks, Prati et al (2003) find that operating procedures and operation styles play a crucial role in shaping empirical features of short-term interest rates.

UK and therefore no averaging to smooth out banks' demand for reserves over time (more on this in section 4). Although the width of the interest rate corridor was the same as in the euro area, the access to the Bank of England's standing facilities was limited to settlement banks only and the supply of funds at the lending facility was also limited in quantity (more on this in section 5). These institutional characteristics made for a more volatile UK overnight rate and were modified in the May 2006 operating framework reform.[31] As can be noted from Graph 1, the volatility of UK overnight interest rates declined markedly after the reform.

Other central banks also offer examples of how operating framework features influence overnight rate volatility. Tracing the evolution of federal funds rate volatility between 1989 and the first half of 2005, Hilton (2005) notes that the increase in volatility in the 1990s was mainly associated with the decline in total reserve requirements, while the subsequent decrease in volatility coincided with a number of developments that help to reduce the impact of unexpected excess or shortfalls in reserves, including the increase in the "carry-over" limits, the switch from contemporaneous to lagged reserve accounting in 1998 and the increased sensitivity of the Fed's Trading Desk to daily patterns of reserve demand. In Singapore, the overnight rate volatility became more contained with the introduction of the end-of-day lending facility for banks in November 2000 and declined further after the introduction of reserves averaging in September 2001 (Monetary Authority of Singapore (2007)).

Furthermore, there is also a historical association between the overnight rate level and its volatility. In the United States, for example, the very low absolute level of fed funds rate between 2001 and 2004 may have contributed to some "rate compression", reducing movements at least on the down side (Hilton (2005)). A low interest rate environment also makes it less costly for banks to hold non-interest-bearing balances at the central bank, thereby reducing the likelihood of scrambles for liquidity and thus of upward spikes in the overnight rates. The experience in Japan during the quantitative easing era provides an extreme illustration of this point. With the short-term interest rate level at essentially zero, there was no incentive for banks to lend in the money market. With the central bank readily providing abundant liquidity to the system, there was also no incentive for banks to borrow from each other in the market. As a result, there was neither activity nor volatility. But as interest rate levels began to rise subsequently, money market activity and interest rate volatility also picked up.

In sum, central banks can to some extent choose the degree of acceptable overnight rate volatility by choosing some combination of operational framework features. Nonetheless, they may have to accept that there are limits to their control over the supply and demand factors that affect interest rate volatility. Indeed, the day-to-day implementation of monetary policy basically revolves around balancing the supply and demand of bank reserves with various instruments, so as to induce a price and/or a quantity of bank reserves that is consistent with the central bank's operating objective, as well as with the smooth functioning of the settlement system. The next two sections will discuss these "nuts and bolts" of monetary implementation with reference to the demand for and the supply of reserves.

[31] Tucker (2004) outlines this and other problems under the previous framework and previews the basic design principles for the new framework. Clews (2005) explains the new system and notes that while the individual elements are not new, this particular combination of elements is novel.

4. Demand for reserves

There are two main reasons for banks (and other financial institutions with similar functions) to hold reserves. One reason is to facilitate everyday interbank payments and settlement. The other is to fulfil reserve requirements, if such requirements exist and are binding.

4.1 Settlement balances

Although quite common around the world, reserve requirements are by no means universal. Banks in, for example, Australia, Hong Kong and New Zealand are not subject to such requirements.[32] In these economies, banks only need to hold settlement balances (or working balances). Since holding balances that are unremunerated (or remunerated at less than the prevailing market rate) incurs an opportunity cost, banks would normally tend to keep their settlement balances to the minimum necessary.[33] However, responding to this incentive to economise does carry some risk. In the event of unexpectedly large settlement needs, a bank would have to borrow funds from others at a market-determined rate or from the central bank's lending facility, which usually charges a penalty rate. Banks must therefore balance the opportunity cost of holding unnecessarily large balances against the risk of having to borrow dear in case they fall short. All these also imply that the demand for settlement balances on any given day tends to be inelastic, depending mainly on settlement needs (both expected and precautionary) and responding relatively little to small changes in interest rate levels.

Graph 2 shows the settlement balances in the three economies that do not currently have reserve requirements. Australia's experience, in particular, provides a clear illustration of how the level of balances responds to perceived and actual settlement needs. Anticipation of the changeover to real-time gross settlement (RTGS) in June 1998 prompted uncertainty over how much settlement balances banks would need under the new regime. Banks raised their reserve holdings substantially as a result.[34] But as banks later became accustomed to functioning under RTGS, their demand for balances also declined.[35] By contrast, the large rise in settlement balances in Hong Kong between late 2003 and early 2004 and in New Zealand after early 2006 reflect predominantly supply factors (more on this in section 5).

4.2 Reserve requirements: design, usage and functions

In the other economies surveyed in this paper, reserve requirements do apply, exerting an influence over the demand for reserves. Table 2 presents the main features of such requirements and the reserve ratios as of early 2007. Several key observations are worth

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[32] Until the introduction of the voluntary reserves-averaging scheme in May 2006, there was also no reserve requirement in the United Kingdom. Freedman (2000) points out that non-binding or eliminated reserve requirements are not uncommon in the global context (eg Canada, Sweden also) and provides a concise explanation of how the central bank can exert leverage over the policy rate even in the absence of binding reserve requirements. Other studies (eg Borio (1997), Woodford (2000)) also discuss how the central bank's influence need not depend on imposing requirements on banks to hold unremunerated reserves.

[33] An example to the contrary is Japan at the time of virtually zero interest rates (March 2001 to March 2006). The opportunity cost then was so low that financial institutions were basically indifferent between holding reserves and lending the funds out in the market. This indifference in part made it possible for the central bank to induce financial institutions to hold increasingly large amounts of excess reserves under quantitative easing.

[34] Given that banks had recourse to the overnight deposit facility at only 25 basis points below the cash rate target, the opportunity cost of holding more precautionary reserves was alleviated to some extent.

[35] See Reserve Bank of Australia (2003). The article also notes that there is no relationship between the size of settlement balances and the interest rate level.

highlighting, as they provide an indication of the current functions served by reserve requirements and their recent evolution.

How reserve requirements are calculated and fulfilled

With regards to *how* the requirements are calculated and fulfilled, an important feature that now applies in most economies is the *averaging provision* (column 1). By allowing financial institutions to fulfil their reserve requirements on an average basis over the maintenance period, averaging makes the demand for reserve more elastic (or sensitive to small changes in interest rates), which in turn helps to buffer the impact of any instability in the supply of reserves on the interbank market interest rates.[36] This smoothing effect in principle works better with a higher level of requirements (a thicker cushion) and a longer maintenance period.[37] Among the economies in the sample, two-week maintenance is a typical choice, although there are also a number of systems with one-month maintenance periods (column 4). An interesting innovation on this front is the ECB's adoption of a variable length maintenance period, which is set to be aligned with the monetary policy meeting schedule so as to avoid having a policy rate change in the middle of a maintenance period (see Box 2). In doing so, it reduces the incentive for banks to drastically change their reserve holding pattern in anticipation of monetary policy changes.

Another notable feature is the widespread adoption of a *lagged reserve accounting* framework (column 3). With the calculation period having ended before the maintenance period begins, the amount of reserves required is thus known with certainty. This certainty helps banks plan their reserve holding pattern. It also helps the central bank anticipate reserve demand in the period ahead. However, there is some diversity in practice on this front. Japan and Korea[38] have half-lagged reserve accounting frameworks, while Taiwan has an almost contemporaneous set-up (with only four days lag for a one-month maintenance period), which is reminiscent of the practice in the United States between 1984 and 1998.[39]

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[36] For reserves averaging to perform this buffering function, reserve requirements must first be a binding factor affecting the marginal demand for reserves. Two preconditions apply: banks must be able to use their holdings of required reserves to meet settlement needs, and the required level of reserves must exceed the level of working balances (see Borio (1997, pp 17–19)). The alternative of no averaging (eg in China and Indonesia) means that banks are required to hold a fixed amount everyday throughout the maintenance period, resulting in an inelastic demand for reserves. This implication for demand elasticity is similar to that in the case of no reserve requirement: the demand for reserves is determined mainly by settlement needs and not so much by small changes in money market interest rates.

[37] The smoothing of reserve demand across time can be taken further if financial institutions are allowed to "carry over" at least some (excess) reserve holdings in one maintenance period to count towards fulfilling the requirement in the following maintenance period (see column 2 of Table).

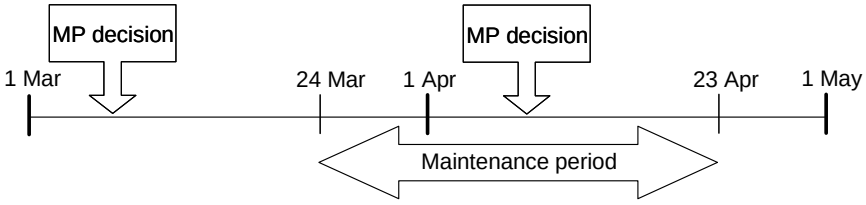
[38] Korea also moved from half-lagged to fully lagged in the March 2008 reform (see Annex).

[39] Contemporaneous reserve requirement was once seen as a way to keep banks on their toes so as to heighten the influence of the central bank as the ultimate source of liquidity (see Patrawimolpon (2002)). The fact that most central banks now do not favour this arrangement suggests that they reckon that they do not really need this arrangement to have an influence and that they prefer to see a more predictable demand for reserves. See Borio (1997, p 47) for an explanation of contemporaneous, semi-lagged and lagged arrangements.

Box 2: The maintenance period and the monetary policy decision cycle

Apart from the length of the maintenance period, the timing thereof in relation to the monetary policy decision schedule has also emerged as an issue for some central banks. The gist of this timing issue can be illustrated by a simplified version of the ECB's experience in the first three years of its operation (see European Central Bank (2003) for details). The ECB is the first among the central banks surveyed in this paper to address this concern.

The ECB used to have a one-month maintenance period that ran from the 24th day of a calendar month to the 23rd day of the following month. Since the Governing Council normally made monetary policy decisions in the first of the two meetings in each month, there was always a chance that the policy rate, thus the cost of obtaining liquidity from the central bank (and the remuneration on required reserves), could change during a maintenance period.



Given the possibility to average their reserve holdings over the maintenance period, banks would seek to obtain and hold more reserves on days with lower perceived costs. If a policy rate hike were expected during a maintenance period, banks would want to hold more reserves up front, when the cost would be seen as relatively low. This was the case facing the ECB in 1999 and the first half of 2000. Conversely, if a policy rate cut were expected, banks would want to defer their holdings to after the monetary policy decision. This was the situation facing the ECB in early 2001 when market participants began to expect rate cuts. Such incentives to "front-load" or "back-load" on reserves introduced instability to the demand for reserves and could lead to higher volatility in the short-term interbank market interest rates.①

To eliminate this intertemporal gaming over policy changes and the potential side-effect on money market interest rates, the ECB reset the maintenance period from March 2004 on, so that it would always start on the settlement day of the first weekly main refinancing operation *after* the monetary policy decision day. This way, no policy rate change could be anticipated to occur in the middle of a maintenance period. Accordingly, instead of being fixed at one calendar month, the new maintenance period would vary in length with the Governing Council's meeting schedule.②

The ECB's experience and eventual solution have potential relevance for central banks with pre-set monetary policy announcement dates, particularly if the frequency of policy announcements is relatively high (eg monthly).③ The Bank of England adopted a similar design when it introduced de novo a voluntary reserves-averaging scheme in May 2006. The maintenance period was set to start on the Monetary Policy Committee (MPC) date and end one day before the next MPC date (typically four, sometimes five, weeks later). In its operating framework reform in 2007, the Bank of Thailand applied the same principle to synchronise the maintenance period with the MPC cycle. Since the MPC meetings were usually scheduled on Wednesdays at six-week intervals, the two-week maintenance period was reset to always end on a Tuesday so as to avoid having an MPC date in the middle of a maintenance period. The Bank of Korea also used a similar approach in its operating framework reform in 2008 (see Annex).

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① Carpenter and Demiralp (2006) document the "anticipation effect" for the case of the US.

② See http://www.ecb.int/events/calendar/reserve/html/index.en.html.

③ An alternative solution that does not require realigning the maintenance period is to stabilise the opportunity cost during the maintenance period, irrespective of the change in the policy rate. See Borio's discussion in Bank for International Settlements (2001).

How much reserves are required

With regards to *how much* reserves are required, the broad trend over the past decade or so has been a general reduction in the reserve ratios and a consolidation of the various classes of requirements. In the earlier era with mainly bank intermediation, reserve requirements were an important lever of monetary control and served a prudential function as well. Reserve ratios were as a normal course of policy implementation raised or lowered to affect liquidity conditions, and in turn other variables such as monetary aggregates. Different ratios were often applied to different types of bank liabilities to influence their composition, among other things. However, with the evolution of the financial system and the reduced role of monetary aggregates as intermediate targets, high ratios, differentiated ratios and the active manipulation thereof have also declined in significance.

That said, there is still a lot of diversity in this regard among the economies in the sample. The reserve ratios range from the very low levels in Japan to the 10% or higher (applied to at least some categories of deposits) in China, the Philippines, Taiwan and the United States.[40] In a few economies, differentiated ratios still exist. In Japan, for example, the reserve ratios are highly differentiated by the type of institution and the type and size of deposits.[41] In Taiwan, requirements vary according to the type of deposits (eg checking, savings, time deposits, foreign currency, etc).[42] In Korea, there are three levels of requirement, based on whether the liabilities are short-term (highest requirement), medium-term or long-term (lowest requirement). In the United States, the differentiation is based on the size of the liabilities.[43]

An interesting recent development on this front is the Bank of England's voluntary reserves-averaging scheme, introduced as part of the money market operations framework reform in May 2006. Scheme members are free to choose their own (positive) targets for reserve holdings, to be fulfilled on average over the maintenance period.[44] With the introduction of the scheme, the reserve balances held at the Bank of England rose from typically less than GBP 1 billion to over GBP 16 billion, providing a substantially larger cushion.[45]

It is interesting to note that although the active manipulation of the reserve ratio is no longer a typical means to implement monetary policy for many central banks, one can nonetheless find some recent examples.[46] For instance, in the face of excess liquidity associated with persistent capital inflows, the reserve ratio in China has been raised over a dozen times

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[40] For the Philippines, 10% is the regular statutory reserve requirement only. There is also a liquidity requirement of 11%. In Taiwan, the 10.75% is applied to checking accounts only. Other types of liabilities are subject to lower ratios. In the United States, the 10% ratio is applied to reservable liabilities in excess of the exemption amount (0% requirement) and the low reserve tranche (3% requirement).

[41] See http://www.boj.or.jp/en/type/stat/boj_stat/junbi.htm.

[42] See http://www.cbc.gov.tw/EngHome/ebanking/Statistics/RESERVE_REQUIREMENTS_E.asp. The general trend of declining reserve ratios over time is also apparent in the cited table.

[43] See http://www.federalreserve.gov/monetarypolicy/reservereq.htm.

[44] Scheme members that manage to meet their own targets (within a specified tolerance range, normally ±1%) will have their reserve holdings remunerated at the official Bank Rate. A penalty applies in case of failure to meet the target. See Bank of England (2007) for details.

[45] A similar voluntary reserve scheme in fact also exists in the United States, alongside the regular reserve requirements. Originally introduced in the early 1980s for another purpose, contractual clearing balances have since also served to help to stabilise the overall demand for reserves. The use of contractual clearing balances was small in the 1980s since required reserve balances were sufficiently high. As reserve requirements declined in the 1990s, the demand for contractual clearing balances rose in order to help maintain a sufficient cushion. See Board of Governors (2005, chapter 3).

[46] An illustration of the active use of reserve requirements in former times as a lever of monetary control can be found in Bank of Korea (2002), pp 67–70 and 141–148. A more general description of how reserve requirements were used in a number of Southeast Asian economies in the past can be found in Dasri (1990).

since September 2003. Compared to issuing central bank bills to mop up the excess liquidity, hiking reserve requirements has the advantage of being more permanent in nature and lower in cost (required reserves are remunerated at 1.89%, central bank bills pay around 3% at the time of writing). Facing a similar situation, the cash reserve ratio in India has also been raised multiple times since September 2004, partly reversing the trend reduction in the reserve ratio over the past decade. Reserve requirements on short-term deposits in Korea were raised for the first time in 16 years in December 2006 to influence the mix of short-term versus long-term deposits and to check the rapid growth in bank lending.[47]

Also of note is that reserve requirements in the 2000s have partially shed their reputation as a "tax" on banks or a source of seigniorage revenue. Over half of the sampled central banks that impose reserve requirements do explicitly remunerate reserves in part or in full (Table 2, last column). While some central banks offer remuneration at rates that are clearly below the prevailing market interest rates, thereby still implying a "tax", some others such as the ECB and the Bank of England have designed their remuneration scheme on purpose to avoid this tax burden.[48] In contrast, there is no explicit remuneration in any form in Japan, Korea, Malaysia and Singapore. However, these economies tend to have relatively low reserve requirements on average.[49] In the United States, where interest payments on reserves are currently not allowed, new legislation was passed in October 2006 to amend section 19 of the Federal Reserve Act, which will allow explicit remuneration of reserve balances "at a rate or rates not to exceed the general level of short-term interest rates" and will lower the statutory minimum reserve requirement to zero, both with effect from October 2011.[50] This change in legislation opens up an opportunity for the Federal Reserve to review and possibly to update its reserve requirement framework.

Taken all together, the "how" and "how much" features of reserve requirements in the early 2000s suggest that while the liquidity management and interest rate buffer functions have become more prevalent, the use of reserve requirements as an active tool of monetary control has remained relevant in some instances. Moreover, in light of the considerable number of new developments, it is clear that the design and use of reserve requirements is still very much a live issue in central banking.

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[47] Reserve requirements have also been used for other purposes. In Taiwan, reserve requirements on foreign currency deposit were introduced in December 2000 to put foreign currency and domestic currency deposits on equal footing. The authorities have since on occasion used this WTO-compliant alternative to counter abrupt short-term capital movements and exchange rate pressures (Central Bank of China (2006), p 33). In the Philippines, the authorities hiked liquidity reserve requirement as well as the statutory reserve requirement to help contain exchange rate pressures in 2004 and 2005. Similarly in Indonesia, currency weakness in 2004 prompted the central bank to impose an additional (but remunerated) requirement that increases with the size of short-term liabilities. In September 2005, the additional requirement was raised further according to the loan-to-deposit ratios of banks, with the more actively lending banks being subject to less additional requirement. This latter move was meant to encourage the "lazier" banks to lend more.

[48] Both the ECB and the Bank of England remunerate reserves at their respective policy rates, which in practice represent the levels around which very short-term money market rates fluctuate. This means that banks are on average not "taxed" for holding reserves – consistent with reserve requirements serving mainly a reserve demand smoothing and interest rate buffering function in these two systems.

[49] The Bank of Korea used to remunerate reserves, but discontinued the practice in 1987 on the grounds that since banks could use reserves for settlement purposes and the central bank's settlement services are provided for free, the "tax" on reserves could be seen as a means to finance this service. Moreover, since the central bank offers a loan facility (Aggregate Credit Ceiling Loans) from which banks could obtain funding at subsidised rates, banks are potentially compensated (Bank of Korea (2002), p 72).

[50] See http://www.federalreserve.gov/generalinfo/fract/sect19.htm.

5. Supply of reserves

The overall supply of reserves in the system is the net result of two types of influences. One is the influence of *autonomous factors*, which refer to changes on the central bank's balance sheet that are not a result of its domestic liquidity operations. The other is the influence from *policy factors*, which basically reflect the impact of central bank operations. In this section, the term "liquidity" is used interchangeably with "bank reserves".

5.1 Autonomous factors

The stylised central bank balance sheet below illustrates the relationship among autonomous factors, policy factors and the resulting quantity of bank reserves. In the context of a modern central bank, there are typically three main types of autonomous factors: net foreign currency assets, currency in circulation and net liabilities to the government. All else being equal, increases in net foreign currency assets (eg as a result of foreign exchange intervention[51]) would increase the quantity of bank reserves, while increases in currency in circulation or net liabilities to the government (eg government deposits at the central bank) would imply a decrease in the quantity of bank reserves.

Stylised central bank balance sheet

ASSETS	LIABILITIES
Δ Net foreign assets	Δ Currency in circulation
Δ Net securities	Δ Bank reserves
outright	required reserves
under repo	excess reserves
Δ Net credit to banks	Δ Net liabilities to Government

The system is said to be in *surplus* if the net contribution of autonomous factors to liquidity exceeds the change in the demand for liquidity. In this case, central bank operations to mop up the excess may be called for. Conversely, the system is in *deficit* if the net contribution of autonomous factors falls short of the change in demand, leaving scope for the central bank to inject liquidity.

While the demand for reserves can be made more stable and predictable with measures such as averaging or lagged reserve accounting (see section 4), the autonomous factors are mostly beyond the immediate control of the central bank. In particular, the movement of the government's funds in and out of its account with the central bank is often cited as the most volatile and unpredictable item, especially over longer horizons.[52] Graph 3 shows that government deposits at some central banks do fluctuate quite strongly even at a monthly frequency. The fluctuations are especially apparent in, for instance, Australia and New Zealand. Moreover, consecutive years of fiscal surpluses in these two economies have to

[51] Even though usually conducted by the central bank itself, intervention is considered an autonomous factor from the domestic liquidity management point of view. Interventions and domestic liquidity operations are often implemented by different units, each operating according to its own mandate.

[52] However, central banks can establish certain coordination arrangements with the government so as to reduce uncertainty over government flows, and thus the impact on liquidity, at least over shorter time horizons.

varying extents led to a trend rise in government deposits, implying a trend drain on system-wide liquidity. This development has increased the burden on the two central banks to supply liquidity to the system (more on this below).

Currency in circulation also tends to be a volatile item, but to the extent that the volatility often reflects seasonal factors (eg higher demand around holiday periods), it is not entirely unpredictable. In Japan and the United States, in particular, currency issue is a relatively large component that has historically grown in tandem with the central bank's balance sheet (Graph 3). Currency issue also used to be a large component on the books of the Chinese and Indian central banks, but its contribution to central bank balance sheet expansion was overtaken by net foreign currency assets at the beginning of this century. In other Asian economies, currency issue tends to be a small and relatively stable item on the central bank's balance sheet.

The liquidity impact of foreign exchange transactions by the central bank (eg intervention) is in principle predictable over a short horizon, given the T+2 settlement convention. However, such transactions are less predictable over a longer horizon. Moreover, a trend rise in net foreign currency assets could imply structural liquidity surpluses.[53] In non-Japan Asia, many central banks' balance sheets essentially grow with their foreign currency asset holdings. This has been the case in Hong Kong, Macao, Malaysia, Singapore and Taiwan since at least the 1980s, and in Indonesia, Korea, the Philippines and Thailand since the 1990s. In China and India, foreign currency assets have also become a key driving component but only since 2000. As a result, the baseline liquidity scenario in non-Japan Asia tends to be a structural surplus. Accordingly, these central banks tend to be mostly concerned about absorbing excess liquidity. This stands in stark contrast to industrial economy central banks, which tend to face structural liquidity deficits and thus mainly focus on injecting liquidity into the system. This fundamental difference in structural liquidity position in part explains the difference in the two groups' choices of liquidity management instruments. The chronic need to either absorb or inject liquidity has also seen some central banks in both groups "run out" of their traditional instruments, prompting them to search for alternatives (see below).

5.2 Policy factors

There are many instruments with which a central bank can provide or withdraw liquidity. One can classify these into two broad categories: standing facilities and discretionary operations. Standing facilities are accessed at the initiative of eligible financial institutions. In contrast, discretionary operations are conducted at the initiative of the central bank itself. Most central banks have both categories of instruments at their disposal.

Standing facilities: evolving roles

Standing facilities, like reserve requirements, used to play a key role in monetary policy implementation. There was a time when it was quite common for a central bank to signal its policy stance and guide bank interest rates via standing facilities rates.[54] It was then also quite common to offer multiple types of lending facilities, some of which were meant to provide loans for strategic or developmental purposes. Lending at subsidised rates was also

[53] A trend decline in net foreign assets could thus imply a chronic drain on liquidity.

[54] Bindseil (2004) and Bindseil and Nyborg (2007) point out that in the pre-1914 world, monetary policy implementation meant controlling short-term interest rates, mainly via the use of standing lending facilities. Tucker (2004) describes the "classical system" (ca 1890s–1970s) in which lending at the penal Bank Rate was the Bank of England's main weapon for controlling market interest rates. Open market operations were merely a tool for adjusting the scale or probability of market borrowing at the Bank Rate and had no rate-setting functions per se.

widespread. However, with the general trend towards banking deregulation and the reduction in (or even prohibition of) policy lending by central banks, the character of standing facilities has evolved accordingly. Overall, standing facilities have tended to become simpler. Facilities that have in one way or another become irrelevant relative to the central bank's mandate have been abolished, suspended, consolidated or taken over by the fiscal authorities.[55]

Table 3 summarises the types of standing facilities that are offered by the sampled central banks for short-term liquidity management purposes as of early 2007.[56] Essentially all central banks have facilities for providing liquidity (by lending) to financial institutions, typically at penal interest rates (column 1). Over half of the central banks also have facilities for absorbing liquidity (by borrowing or deposit-taking) from financial institutions, usually at below-market interest rates, thereby forming an interest rate corridor (column 2).[57] Some of these explicit two-sided corridors were put in place only quite recently. For example, Malaysia's was set up in April 2004, when the overnight policy rate was introduced. Singapore's new corridor was put in place in June 2006 and Thailand's in January 2007. Both Singapore and Thailand used to have only lending facilities – as had been the United Kingdom before a deposit facility was added in June 2001.[58] By contrast, Bank Indonesia used to offer only a deposit facility (FASBI), but introduced a lending facility in 2005.

One notable development is that the provision of short-term liquidity at subsidised, below-market rates is no longer practised among the sampled central banks. The Bank of Japan's discount rate used to be a below-market lending rate, but became de facto above-market in 1998, as market interest rate declined further. This new reality was formalised with the introduction of the Complementary Lending Facility in February 2001.[59] The Federal Reserve's Discount Window, the classic textbook example of below-market lending facilities, was also replaced in 2003 by the Primary and Secondary Credit Facilities, with lending rates set at policy rate plus 100bp and 150bp, respectively.[60] In Taiwan, the central bank's Discount Rate also went from below market to above market at around the same time.

The definitions of standing facility rates are of two main types (columns 3 and 4), reflecting two main functions of these facilities. One type is represented by India and the Philippines, where the key standing facility rates are in fact the formal policy rates. Thus, the standing facilities at these two central banks by definition still perform a policy signalling function. The other type is represented by most of the other central banks, where their standing facility rates are set at a margin relative to their policy rates. For these central banks, standing

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[55] An illustration of the relatively complex setup in the past of central bank lending facilities and the eventual consolidation thereof can be found in Bank of Korea (2002), pp 45–48 and 129–140. A liberalisation of the rediscount window, implying the elimination of directed credit for selected sectors, also occurred in the Philippines (see Tuaño-Amador (2003), p 226). A brief account of a similar evolution in Japan and how the former "official discount rate" was renamed "basic discount rate and basic loan rate" to reflect its new role can be found at http://www.boj.or.jp/en/type/release/zuiji_new/nt_cr_new/ntdis01.htm.

[56] These are the key facilities for mainly short-term liquidity management purposes. Many central banks offer other longer term facilities as well.

[57] A borrowing/deposit facility helps to defray part of the opportunity cost of holding unremunerated reserves, especially when the interest paid is set not too much lower than the normally expected level of market rate.

[58] The Bank of Korea, which used to have only lending facilities, also adopted an interest rate corridor setup in the March 2008 reform (see Annex).

[59] At the same time, a number of facilities that had already lost significance with respect to monetary policy implementation were also abolished. See http://www.boj.or.jp/en/type/release/zuiji/kako02/k010228b.htm.

[60] See http://www.ny.frb.org/aboutthefed/fedpoint/fed18.html for a description and a brief history of the Federal Reserve's lending facilities. In response to unusual money market tensions, the Federal Reserve reduced the spreads of the credit facility rates in August 2007 and again in March 2008 (see Annex). The current standing facility rates are posted on the Discount Window website http://www.frbdiscountwindow.org.

facilities are no longer a policy signal per se but are a supporting device to help keep short-term market interest rates in line with the formal signal of the policy stance. There are also some special cases. For example, in China the lending facility rate is not related to the formal policy rates (which have little to do with money market interest rates), while the de facto market floor is defined by the remuneration rate on excess reserves. In Singapore, since the Monetary Authority is not an interest rate targeter, there is no formal policy interest rate to serve as the reference for setting the standing facility rates. Instead, the standing facilities are priced at a ±50 basis point margin around a market-determined interest rate (the weighted average of successful bids at the daily morning auction for uncollateralised overnight borrowing by the MAS from primary dealers), which changes daily..[61]

The width of the interest rate corridor also speaks to the standing facilities' role. As noted in section 3, the width of the corridor, as well as the terms of access to these facilities, have implications for the overnight market interest rate volatility. One can see from Graph 1 that wider corridors (eg in the euro area, the United Kingdom, the Philippines and, most of all, Indonesia) would in principle allow more room for the overnight rate to fluctuate than would narrower corridors (eg in Australia, Malaysia and New Zealand). However, whether or not overnight rate fluctuations would indeed take up the full width of the corridor depends on the other aspects of the operating framework, such as whether there is averaging of reserve requirements and whether the central bank regulates the overall supply of liquidity proactively via discretionary operations (see below)..[62] But all else being equal, a narrow corridor defined around the formal policy rate would serve to dampen short-term market rate volatility around the policy rate (a "rate setting" or "rate stabilising" function). In contrast, a wider corridor would serve mainly to reduce the chance of market rates wandering too high or too low in the event of unusual market pressures (a "safety valve" or "back-stop" function).

The Bank of England's variable-width corridor, introduced in May 2006 as part of its operational framework reform, attempts to balance these two functions. Instead of setting the ceiling and the floor at the same fixed margin at all times, the margin stays wide (±100 basis points) during most of the maintenance period, emphasising the safety valve function, but narrows to only ±25 basis points on the last day of the maintenance period to enforce the rate stabilising function. To further enhance these two functions, the access to the standing facilities was also broadened to include even financial institutions that are not members of the reserves-averaging scheme. Moreover, the quantity of liquidity on offer at the lending facility is no longer rationed by the central bank's forecast of liquidity shortage. The ability to borrow from the lending facility is now only limited by the availability of eligible collateral.

It is notable from Graph 1 that some ceilings/floors appear to be binding while others are apparently not, thus allowing the overnight market rate to over- or under-shoot these boundaries at times. Whether a ceiling/floor is "hard" or "soft" depends in part on the relevant facility's access conditions (eg counterparty and collateral eligibility criteria). For example, in Indonesia, the overnight deposit facility is accessible without limit to all banks. The deposit facility rate thus forms a "hard" floor for the overnight market rate. However, a bank's ability to

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[61] See http://www.mas.gov.sg/news_room/press_releases/2006/MAS_Launches_Electronic_Trading_Platform_for_SGS.html.

[62] For example, in Australia, even though the corridor is narrow (and there is no reserves averaging), the overnight rate seldom ventures towards the boundaries. This has to do with the proactive stance of the central bank in providing the right amount of liquidity via discretionary operations and the convention developed among banks to trade overnight liquidity with each other at precisely the policy rate under normal circumstances. In contrast, in the euro area, where the central bank's main refinancing operation takes place only once a week, there is potentially more scope for the overnight rate to touch the corridor boundaries. But even there, the amplitude of overnight rate fluctuation has shrunk over time as a result of the refinements made to the operating framework (eg realigning the maintenance period with the monetary policy decision schedule, doing more fine-tuning operations, etc).

obtain funds from the lending facility is subject to a limit equal to only 50% of the bank's holdings of eligible collateral (SBIs). Accordingly, the lending facility rate only serves as a soft ceiling, since banks in need of more funds than allowed by the limit (and those that do not have enough eligible collateral) must still borrow from the market, potentially driving up market rates. This "hard floor, soft ceiling" setting is also apparent in China and to a lesser extent India and the Philippines.[63] Less tangibly, though no less importantly, the willingness of counterparties to access the standing facilities also matters. If eligible counterparties are for some reason reluctant to use a standing facility (eg due to certain actual or perceived non-price costs), then the relevant ceiling/floor may also be rendered non-binding.[64]

Finally, it should be noted that the discussion thus far has focused mainly on the standing facilities for satisfying the day-to-day demand for liquidity. With the general migration towards real-time gross settlement (RTGS) over the last decade or so, the demand for liquidity is no longer concentrated at the end of the trading day, but exists essentially throughout the day. Almost all the central banks in the sample offer some kind of intraday liquidity facility, in the form of either lending or overdraft (Table 3, last column).[65] A notable exception in this regard is the Reserve Bank of New Zealand (RBNZ), which opted in 2006 to discontinue its intraday facility as part of its new liquidity management regime.[66]

Discretionary operations

With standing facilities now playing mostly a supporting role, discretionary operations have become the main tool that central banks use to regulate the overall supply of liquidity. Central banks' discretionary operations can be of six main types:

1. outright purchases or sales of domestic currency assets in the secondary market,
2. issuance of central bank paper in the primary market,
3. reversed purchases or sales of domestic currency assets (repos and reverse repos),
4. reversed purchases or sales of foreign currency assets (eg FX swaps),
5. direct borrowing or lending in the interbank market
6. transfer of public entity deposits at the central bank to or from the banking system

Most central banks would typically have more than one of these at their disposal. However, not all available instruments are necessarily actively in use under normal circumstances.[67]

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[63] The market floors in both India and the Philippines are based on reverse repos. Thus, banks' ability to lend excess funds to the central bank is in principle limited by the central bank's command of eligible collateral. In this sense, the floor is not unconditionally "hard". In addition, the Philippine central bank can at times adjust the market floor (but without changing the official policy stance) by "tiering" the floor rate such that it declines with the amount of funds banks wish to park at the central bank. Tiering allows the market rate to fall below the Reverse Repo rate and is a mechanism to discourage banks from holding too much excess liquidity.

[64] A familiar example of such non-price costs is "stigma": a bank borrowing from the central bank (usually at a penalty rate) instead of from its peers may inspire negative inferences about the standing of this bank in the market. Stigma can also be internal: if access to central bank credit requires additional administrative procedures (eg authorisation from management, special reporting) because it is seen as a deviation from the normal routine (possibly implying a mistake in cash management), it may also create a disincentive.

[65] Since intra-day liquidity is mainly for the purpose of facilitating settlement, it is often provided interest-free against eligible collateral or at a service charge.

[66] The new regime basically seeks to supply the system with sufficient liquidity up front, so that there will be less need for banks to resort to central bank lending. See Reserve Bank of New Zealand (2006). The rise in the settlement cash level in 2006 (Graph 2) reflects this change in liquidity management approach.

[67] An extreme example is Hong Kong, where the monetary authority is technically capable of conducting most types of operations, but chooses to eschew discretionary operations in order to comply with the ideal of a rule-

Table 4 outlines the key and supporting discretionary operations that are typically in use by the central banks in the sample as of early 2007.[68] Three observations are in order.

First, operations based on marketable assets (types 1 to 4) are currently more widely used for day-to-day liquidity management than is direct interbank borrowing/lending (type 5). This is the case even for central banks that target the overnight interbank market rate. In particular, reversed transactions (typically based on public sector securities) are quite popular, given the greater flexibility they offer and the smaller impact they have on the prices of the underlying securities compared to outright transactions. The transfer of public sector deposits (type 6), though still an available option for some central banks, is currently not a typical operation.

Second, as briefly mentioned earlier in this section, the baseline liquidity scenario facing a central bank is an important determinant governing the choice of the modal operation. Central banks that tend to face liquidity deficits in the system would typically need to inject liquidity by purchasing assets, either outright or under repo agreement. This is the case in, for example, Australia, the euro area, Japan, New Zealand (prior to the liquidity management regime reform in June 2006), the United Kingdom and the United States. In contrast, central banks that tend to face structural liquidity surpluses would typically need to absorb liquidity by selling assets. This is the case in most of non-Japan Asia.

On this second observation, it is worth noting that central banks facing chronic surpluses or deficits could eventually exhaust their typical instrument and need to look for alternatives. For example, if a central bank is not in possession of a lot of readily sellable assets, its capacity to handle a chronic structural liquidity surplus could be constrained. There are several alternatives. One is to have the central bank issue its own securities in the primary market as a different means to absorb liquidity. This has been the situation in much of non-Japan Asia, where traditionally small fiscal deficits have meant small outstanding stocks of government securities in general, even less in at the disposal of the central banks.[69] Regular auctions of central bank paper have long been the key operation in Indonesia, Korea and Taiwan. China joined this group in 2003, when the central bank resumed issuing bills and bonds. In Malaysia, while daily money market tenders (ie direct interbank borrowing, uncollateralised) have so far remained the key operation, central bank paper issuance has gained importance with the amendment of the central bank law in 2006.[70] Singapore and India represent two exceptions to the prevalence of central bank paper issuance in non-Japan Asia. In both

based currency board regime. That means there is no active off-setting of autonomous factors. The sixty-fold increase in the aggregate balance in late 2003 and early 2004 (Graph 2) was the natural result of the official US dollar purchases triggered by the intense market speculation at the time for Hong Kong dollar revaluation. The subsequent shrinking of the aggregate balance back to more normal levels resulted from the official US dollar sales in response to a subsiding of speculative pressure.

[68] Under some circumstances, central banks can resort to operations that are atypical relative to what they normally do. The episode of money market tensions in 2007–08 provides a recent example (see Annex).

[69] Notwithstanding the stepped-up efforts after the Asian crisis to develop the local bond markets, the availability of government securities in emerging Asia is still nowhere comparable to that in Japan or the United States, where operations based on government securities have been the standard fare.

[70] Prior to the amendment of the Central Bank Act, the Malaysian central bank had limited scope to use Bank Negara Bills as a key instrument because of the rather strict issuance limit (linked to the level of central bank capital). The amendment (effective October 2006) allows the central bank to issue a new type of securities, Bank Negara Monetary Notes (BNMN), which are usable in both the conventional and Islamic financial markets and are subject to a more flexible issuance limit (linked to the level of international reserves instead).

cases, it was the government that took up the responsibility of issuing more eligible securities.[71] Such an approach essentially amounts to fiscal overfunding.[72]

The possibility of "running out" of instruments and the need to find alternatives are also a theme among some central banks that are chronic net injectors of liquidity. For example, in Australia and New Zealand, fiscal surpluses since the late 1990s have not only tended to see a net drain of liquidity from the system but also a decline in the outstanding stock of government securities. Absent any initiative for the fiscal authorities to overfund and issue more debt securities, it would not be sustainable to continue to rely on purchasing central government securities as a main means to inject liquidity.[73] In response, the Australian central bank has chosen to accept other high-quality securities so as to extend its ability to conduct reversed purchases.[74] At the same time, it has supplemented reversed purchases of securities with more foreign exchange swap operations. Less willing to expand the range of acceptable securities than its Australian counterpart, the New Zealand central bank has preferred to use mainly foreign exchange swaps to supply the bulk of needed liquidity.[75] The sharp rise in the central bank's foreign currency assets in 2006 (Graph 3) reflects the increased use of foreign exchange swaps to inject domestic currency liquidity.

Third, there is a link between the choice of instruments and the state of financial market development. As mentioned above, an underdeveloped government securities market (or even a developed but shrinking one) has impinged upon some central banks' ability to conduct operations with government securities, thus requiring them to seek alternatives. But that said, financial market sophistication does not always have to be a binding constraint on instrument choice.[76] Among the central banks surveyed, there are examples of innovations on the operations front that were undertaken with the expressed intention of furthering the development of domestic financial markets.

Two cases in point are the introduction of Exchange Fund bills and notes in Hong Kong in the early 1990s and the decision for the surplus-running Singaporean government to overfund and issue government securities in the late 1990s. Both actions served to create new eligible paper for monetary operations as well as to kick-start the public-sector securities market.

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[71] When the proceeds of securities issuance are deposited with the central bank, private sector liquidity is reduced (ie becomes "locked up" as government deposits). The additional government securities in private sector hands can potentially also serve as collateral for subsequent repurchase transactions.

[72] See McCauley (2003 and 2006).

[73] The United States faced the prospect of a similar problem at the turn of this century when fiscal surpluses led to a decline in the stock of Treasury securities. The problem eventually faded with the return of fiscal deficits. Nonetheless, the efforts made at the time to identify alternative instruments and to study their implications did result in subsequent initiatives to modify the Federal Reserve's operating procedures (eg redesign of the lending facility in 2003). See Federal Reserve System Study Group on Alternative Instruments for System Operations (2002). The study arguably also helped lay the groundwork for the Federal Reserve's response to the emergence of money market tensions in 2007 (see Annex).

[74] The list of eligible paper was expanded in March 2004 to include state government securities, Australian dollar securities issued by certain foreign entities, bank bills and certificate of deposits. Broadbent (2008) provides a discussion of this development. Subsequently, in response to the emergence of money market tensions (see Annex), the list of eligible collateral for repo operations was further expanded in September/October 2007 (see http://www.rba.gov.au/MediaReleases/2007/mr_07_14.html).

[75] The RBNZ also decided in August 2007 to accept, as a temporary measure, registered certificates of deposit at its overnight lending facility, though at a higher cost of 100 (instead of 50) basis points over policy rate. The RBNZ's relatively conservative stance with regards to accepting bank-issued paper is in part related to its supervisory duties (a responsibility that its Australian counterpart no longer has). Accepting paper issued by banks that it supervises may risk conflict of interest.

[76] McCauley (2008) explores the reciprocal relationship between financial market development and monetary operations. Archer (2006) makes a similar point about the connection between banking system development and choice of monetary operations.

India's approach of having the government issue more bonds under the Monetary Stabilisation Scheme, rather than changing the law to allow the central bank to issue its own paper, has the advantage of adding size and liquidity to the government bond market, especially at the short end of the curve. In Thailand, the initiative to shift operations away from "BOT repos" to "bilateral repos" and ultimately to phase out the central bank operated BOT repo market in 2003-2007 was intended to pave the way to develop a genuine private repo market.[77] In addition, a securities position adjustment facility was introduced in 2004 to allow primary dealers to borrow specific bonds on a temporary basis, helping to support market-making activity and market liquidity. Other central banks (eg in Australia, Japan, Malaysia, New Zealand and the United States) also operate securities lending facilities to recycle in-demand issues back to market participants, so as to help maintain liquidity in the government bond market. More proactively, the Malaysian central bank even introduced a programme to borrow securities from the typically buy-and-hold institutional investors. With the freed up securities, the central bank could conduct liquidity absorption operations by reversed sales of these securities.

5.3 Putting the pieces together

While it is interesting and instructive to compare individual features across central banks, it is also important to make sense of how the various features fit together within a framework. For example, with respect to the relative importance of discretionary operations versus other instruments, there can be different approaches. For a central bank that is very active in managing liquidity with discretionary operations (eg operating daily), there may be relatively less need to rely on standing facilities as a safety valve or on reserve requirement as a buffer against interest rate volatility. This approach characterises the Federal Reserve or Bank of Japan style framework. However, if a less frequent operation schedule (eg weekly) is preferred, then it would make sense to have user-friendly standing facilities and a robust reserves-averaging scheme to help buffer imbalances in between operation dates. This approach characterises the Bank of England or ECB style framework. Both styles of combining the different central bank instruments could in principle achieve the same operating objectives equally well.

There are also different approaches with respect to the range of operations in active use, and of eligible counterparties and collateral. A narrow set of operations (eg repos with mainly government securities vis-à-vis primary dealers only) may be quite sufficient if the relevant collateral is always available and the counterparties are always reliable as agents for propagating the impact of operations to the broader market. Otherwise, using a wider set of operations involving more diversified collateral and counterparty types may be more practical. A number of emerging Asia central banks in the sample have been relying primarily on issuing central bank paper as their main (or only) discretionary operation. As discussed above, the prevalence of central bank paper in emerging Asia is in part a solution for the lack of other eligible collateral. However, heavy reliance on central bank paper has at times raised questions about the snowballing interest cost and the possible impact on market liquidity of having more than one public sector issuer.[78] In contrast, some other central banks (notably Malaysia, Singapore, Thailand) have opted for a mix of discretionary operations. While this diversified approach may have its origins also in market underdevelopment or legal

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[77] In the BOT repo market, the central bank acted as the central counterparty in every transaction. The pricing thus did not reflect the true credit risks of the ultimate lenders and borrowers. It also left market participants with little incentive to directly deal with each other, as in a genuine private repo market. See http://www.bot.or.th/English/FinancialMarkets/Fin_Mkt_Development/Related%20Articles/Private%20repurchase%20market.pdf.

[78] See McCauley (2003 and 2006).

constraints,[79] it nonetheless has the advantage of reducing the risk of putting any one particular operation or collateral type under excessive strain.

All in all, each of the possible approaches of monetary policy implementation represented by the central banks surveyed in this paper has its benefits as well as costs. The suitability of any given approach is always a function of factors such as the state of financial development, institutional characteristics, legal and regulatory constraints, objectives and even preferences of the central bank. Indeed, it is difficult, or even inappropriate, to talk of "best practices" in monetary policy implementation without giving reference to these factors.

6. Concluding remarks

This paper documents the main features of 17 central banks' operating frameworks as of early 2007 and highlights the notable changes that took place in the late 1990s and early 2000s. On the one hand, it confirms a number of broad themes across central banks with respect to the main features of policy implementation: focusing on short-term money market interest rates as operating objectives, favouring averaging of reserve requirements, using interest rate corridors with penalty rates and searching for alternative instruments. On the other hand, however, the variety of circumstances represented by the central banks in the sample clearly demonstrates that there is still a lot of diversity with respect to how the different operational elements fit together. Moreover, the differences are not just between industrial and emerging economies – a lot of diversity exists even just among the four major central banks. In short, there is no unique "best" combination of features that suits all central banks, even if they happen to pursue similar operating objectives.

Another perhaps even more striking finding of this paper is that even within just the last couple of years, there have been many changes and new developments in virtually all aspects of monetary policy implementation – from the redefinition of policy rates and operating targets, to the adoption of new instruments, to a complete overhaul of the reserve requirement framework. It is therefore also clear that no operating framework can be the "right" one for all times. Central banks everywhere – in industrial and emerging economies alike – have continued to refine their frameworks and procedures and to innovate where necessary, responding to changing needs in changing times.

[79] The relatively late development of government securities markets in emerging Asia has delayed the popular use of repo operations. Other historically more important instruments (eg foreign exchange swaps, direct interbank transactions) have remained significant. In Malaysia and Thailand, the relatively tight legal constraints on central bank issuance have contributed to the need to supplement central bank paper with other instruments.

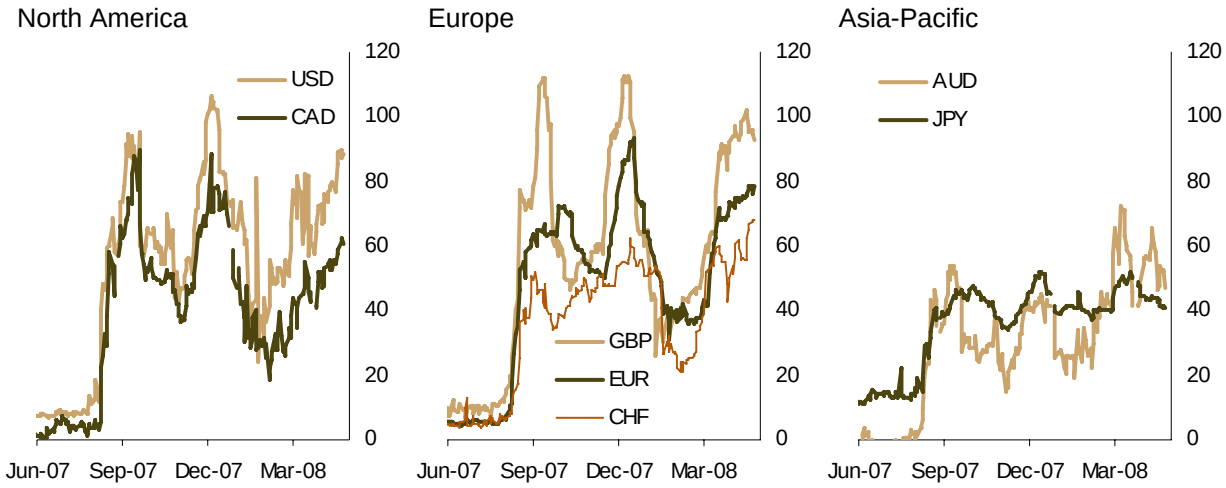
Annex: An update of major developments

Since the March 2007 sample date, a number of central banks have made significant operational changes. This annex outlines two major developments in this regard. The first pertains to the various special operational measures taken by central banks since August 2007 in response to the unusual tensions in major currency interbank markets. The second is the operating framework reform at the Bank of Korea in March 2008. Both developments reinforce the theme of this paper that central banks continue to respond to changing needs in changing times – both in normal times and in times of stress.

A.1 Central bank measures in response to interbank market tensions

The operating frameworks for a number of major central banks were put to the test, when the turmoil in major financial markets, which had originated in the US subprime mortgage market, spread to the interbank market in early August 2007.[80] With the collapse in investor confidence in and thus demand for asset-backed securities, banks that had previously relied on securitisation for funding had to resort more to the interbank market and the bond market. Growing concerns over liquidity and solvency also constrained the willingness and ability of banks to supply funds in this market. As a result, the overnight interbank market rates of major currencies became more volatile. Term interbank market rates also traded at sizeable premia, reflecting difficulties to borrow unsecured funds at maturities longer than overnight. The spread between term Libor and the overnight index swap (OIS) rate, an indicator for interbank market tensions, became much wider than normal.

Three-month Libor-OIS spreads (in basis points)



Source: Bloomberg.

The industrial economy central banks responded to the funding market tensions with a series of operational measures. The responses varied across central banks, reflecting in part the different intensities of market tensions encountered and in part the different characteristics of

[80] For more information on the origins and evolution of the financial market turmoil, see the Overview sections of the September 2007, December 2007, March 2008 and June 2008 issues of the *BIS Quarterly Review*. For a more detailed description of the onset of interbank market tensions and central bank responses (up to late February), see Borio and Nelson (2008).

their existing frameworks. Overall, the Federal Reserve effected more operational changes than others. This was because pressures on the US dollar funding market was relatively severe, and the Federal Reserve's existing framework was comparatively restrictive, giving rise to more scope to make adjustments at times of market stress.[81]

Special operational responses during the financial turmoil[1]

	AU	CA	EA	JP	CH	GB	US
Exceptional fine-tuning operations	✓	✓	✓	✓	✓	✓	✓
Exceptional long-term open market operations	✓	✓	✓	✓	✓	✓	✓
Change in standing lending facility terms							✓
Broadening of eligible collateral	✓	✓			✓[2]	✓	✓
Broadening of eligible counterparties						✓[3]	✓
Introducing or increasing securities lending						✓	✓
Change in reserve requirements/target	n.a.	n.a.				✓	

AU = Australia; CA = Canada; EA = euro area; JP = Japan; CH = Switzerland; GB = United Kingdom; US = United States. [1] Table reflects information up to end-April 2008. [2] A planned broadening of collateral (ie not triggered by market turmoil) as from 1 October 2007. [3] For four special auctions of term funding announced in September 2007, for which, however, there were no bids.

Source: Central banks; adapted from Borio and Nelson (2008)

- **Increased frequency of operations** to respond with greater sensitivity to shifts in the demand for reserves. All affected central banks conducted fine-tuning operations in addition to their regular operations at one point or another.
- **More favourable standing lending facility pricing terms** to help cap short-term market interest rates. The main example was in the United States, where the spread between the primary credit facility rate and the policy rate was narrowed from 100 basis points to 50 basis points in August 2007, and to 25 basis points in mid-March 2008. The maximum loan term was also increased from overnight to 30 days, and subsequently to 90 days.[82]
- **Increased supply of longer-term funds via discretionary operations** to accommodate the demand for term funds. The Federal Reserve added to its capacity to supply term funds (one-month maturity) with the introduction of the Term Auction Facility[83] in December 2007 and the Single-Tranche OMO programme in March 2008. The Bank of England expanded the amount of three-month funds on offer at its scheduled longer-term operations. The ECB conducted supplementary three-month operations and in April 2008 began to offer six-month funds. The

[81] See http://www.newyorkfed.org/markets/Understanding_Fed_Lending.html for a summary of the major changes. See also http://www.newyorkfed.org/markets/Forms_of_Fed_Lending.pdf for a comparison of all – existing as well as new – discretionary operations and lending facilities.

[82] The Reserve Bank of New Zealand also announced in early May that the maximum term of its overnight lending facility would be extended to 30 days, effective 3 June.

[83] By providing collateralised loans through competitive auctions, the Facility offered depository institutions a less stigma-prone channel (compared to the Discount Window) to obtain central bank funds.

Reserve Bank of Australia even conducted operations with one-year maturity in April and May 2008.

- **Wider range of collateral** to improve the access to and the distribution of central bank funds. Most of the central banks expanded to varying degrees their eligible collateral lists, in some cases to include securities that had been adversely affected by the credit market turmoil (eg asset-back securities, mortgage-backed securities).[84] The ECB was a notable exception, but only because it already accepted a very wide range of collateral.

- **Wider range of counterparties** to improve access to and distribution of central bank funds. The most prominent example was the Federal Reserve's Primary Dealer Credit Facility introduced in mid-March 2008 following the near collapse of Bear Stearns, a non-bank primary dealer. This innovation extended discount window access, until then a privilege for banks only, to non-banks. Other central banks with counterparties that could already both participate in market operations and access lending facilities had less scope to broaden further the range of counterparties.[85]

- **Increased securities lending** to underpin financial sector liquidity. The Federal Reserve introduced the Term Securities Lending Facility in March 2008 to allow primary dealers to swap certain assets, including some that had been rendered illiquid by the credit market turmoil, for safe and liquid US Treasury securities for 28-day terms.[86] Primary dealers could then pledge the borrowed securities to obtain funds in the market. The Bank of England's Special Liquidity Scheme launched in late April 2008 was a similar mechanism for banks, though it offered a longer term (one year, extendable to three) and accepted only "legacy" assets that existed as of end-2007. The Scheme thus aimed at improving the liquidity position of the banking system, not at financing new assets.[87]

- **Increased reserves cushion** to help dampen fluctuations in the demand for reserves. The main example was the Bank of England's voluntary reserves scheme, which has a built-in capacity to this effect (see section 4). Scheme participants did increase their chosen reserves targets after the onset of market tensions. To accommodate the uncertainty over reserve needs, the central bank also widened considerably the tolerance range around the target, within which reserve holdings were remunerated.

- **Increased international cooperation** to facilitate the cross-border distribution of liquidity. This was exemplified by the temporary swap lines established between the Federal Reserve on the one hand and the ECB and Swiss National Bank on the

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[84] Notwithstanding its relatively more conservative stance towards collateral eligibility, the Reserve Bank of New Zealand (RBNZ) also temporarily accepted certain types of bank-issued certificates of deposit at its overnight lending facility starting late August 2007. In early May 2008, the RBNZ announced that it would begin to accept in June domestic AAA-rated securities, including residential mortgage-backed securities and AA-rated New Zealand government sector debt. See http://www.rbnz.govt.nz/news/2008/3310253.html.

[85] The Australian, euro area and Swiss central banks, for example, have the same counterparty eligibility for discretionary operations and for standing facilities. The Bank of England has a large though incomplete overlap. In September 2007, it offered to broaden the range of counterparties in four special auctions. However, since the auctions coincided with a period of subsiding market pressures, they received no bids.

[86] See http://www.newyorkfed.org/markets/tslf.html for more information.

[87] See http://www.bankofengland.co.uk/markets/sls/index.htm for more information.

other in December 2007.[88] This allowed the two central banks in continental Europe to conduct operations to supply US dollar funds to European banks during European trading hours.

As of May 2008, the unusual tensions in funding markets were still persisting. The central banks of the affected currency areas could yet respond with further operational measures.

A.2 Operating framework reform in Korea

The Bank of Korea announced in July 2007 plans to update its operating framework. Preparations began later in the year and the new framework came into effect in early March 2008. Broadly, the reform could be characterised as a shift from a framework that is akin to that of the Federal Reserve and the Bank of Japan, to one that is similar to that of the ECB and the Bank of England. The key changes are summarised as follows:

Bank of Korea operating framework reform (effective 8 March 2008)

	Old framework	New framework
Policy rate	Overnight call rate target	BOK Base Rate (= reference rate for BOK operations and facilities)
Operating target	Overnight call rate	Overnight call rate
Reserve maintenance period	Half month	2-3 weeks
	Based on days of the month (8th–22nd; 23rd–7th)	Based on days of the week (2nd Thu–4th Wed; 4th Thu–2nd Wed)
	Partly lags calculation period	Fully lags calculation period
Remuneration	No	No
Standing facilities	Loans to meet temporary shortage of funds at policy rate + 200bp; liquidity adjustment loans at fixed rate (facilities not in active use)	Abolish loans to meet temporary shortage of funds and liquidity adjustment loans
		Introduce overnight liquidity adjustment loan facility at Base Rate + 100 bp, and deposit facility at Base Rate – 100 bp
		Corridor narrows to ±50 bp on the last day of maintenance period
Discretionary operations	Weekly MBS auctions	Weekly MBS auctions
	Non-regular reverse transactions	Weekly 7-day reverse transactions
		Exceptional fine-tuning reverse transactions as needed

Source: Bank of Korea

[88] First announced in the context of the joint announcement of coordinated central bank actions on 12 December 2007, the swap lines were increased in size in March 2008 and again in May 2008. The term of the swap lines was also extended.

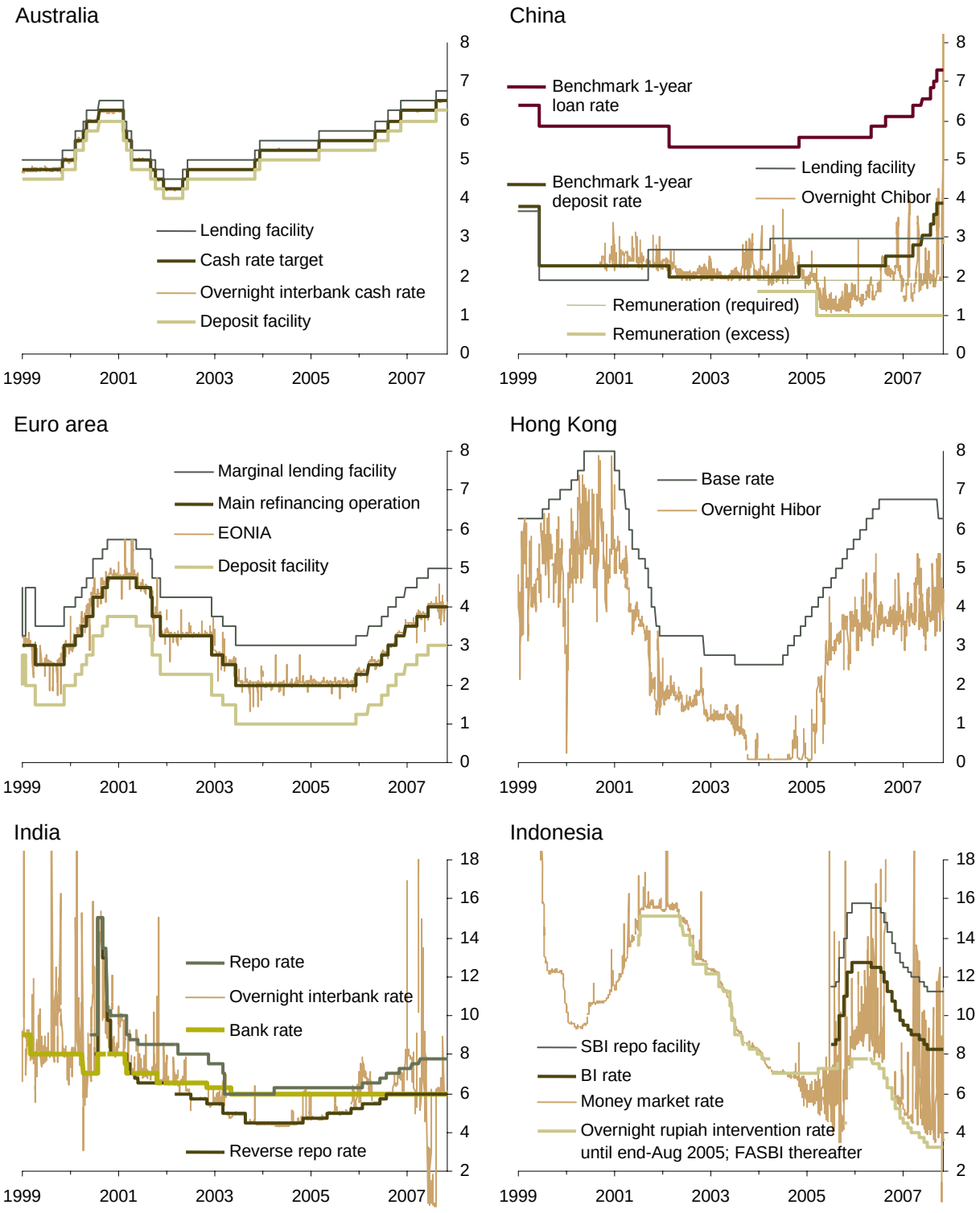
According to the Bank of Korea announcement, the reform was in part an attempt to address certain problems observed under the previous call rate targeting framework, including the over-concentration of money market activity in the overnight maturity and the lack of activity in other maturities.[89] The realignment of the reserve maintenance period should have the same stabilising effect that motivated the adoption of this design by a number of other central banks (see section 4.2, Box 2). The modernisation of the lending facilities, which had fallen into disuse, and the addition of a deposit facility should also help contain overnight rate volatility, especially on the last day on the maintenance period.

[89] http://www.bok.or.kr/contents_admin/info_admin/eng/home/press/pressre/info/Reform_Policy_Framework.pdf

Graphs and tables

Graph 1: Central bank official interest rates and overnight market rate

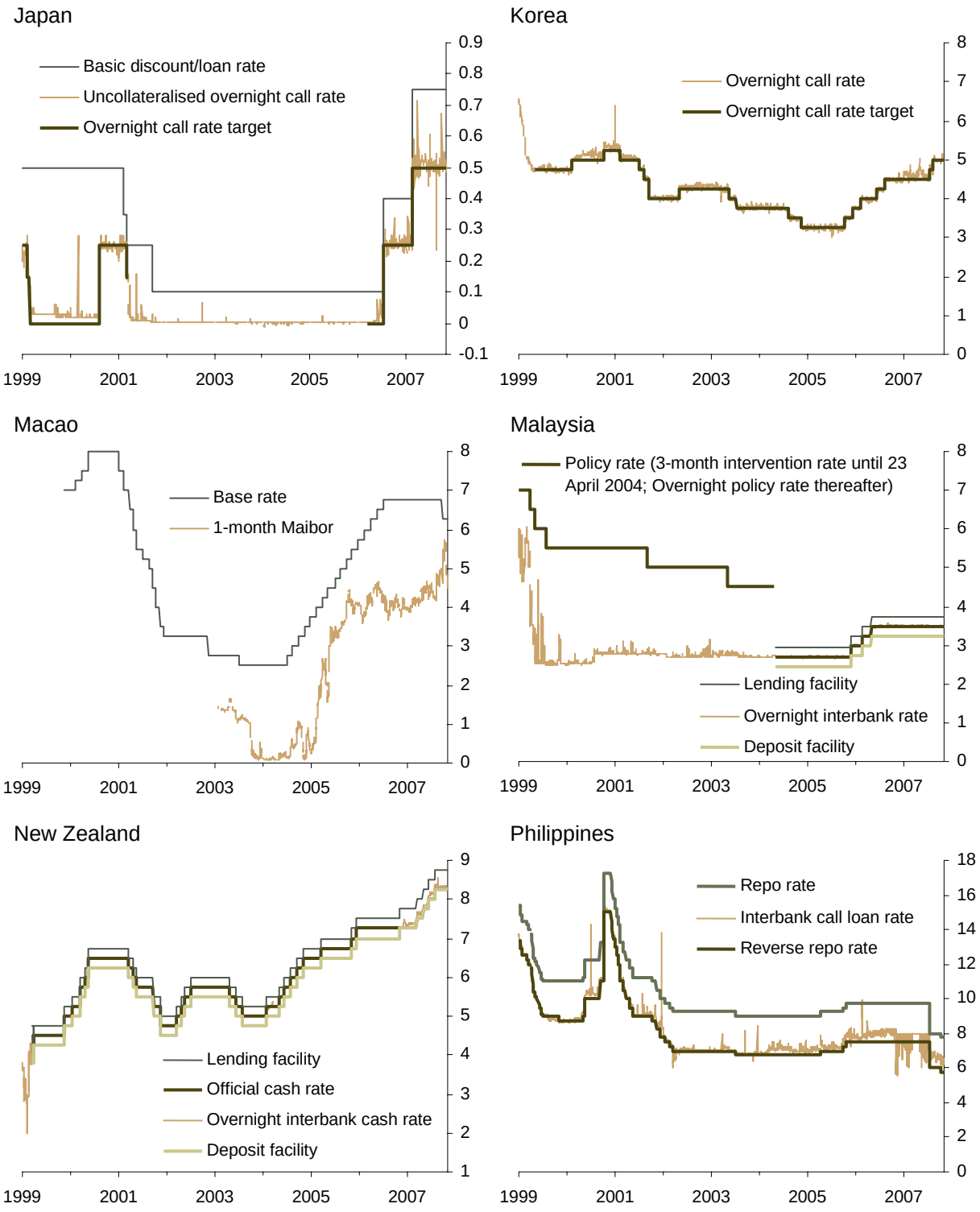
In percent



Sources: Central banks; CEIC.

Graph 1: Central bank official interest rates and overnight market rate (cont.)

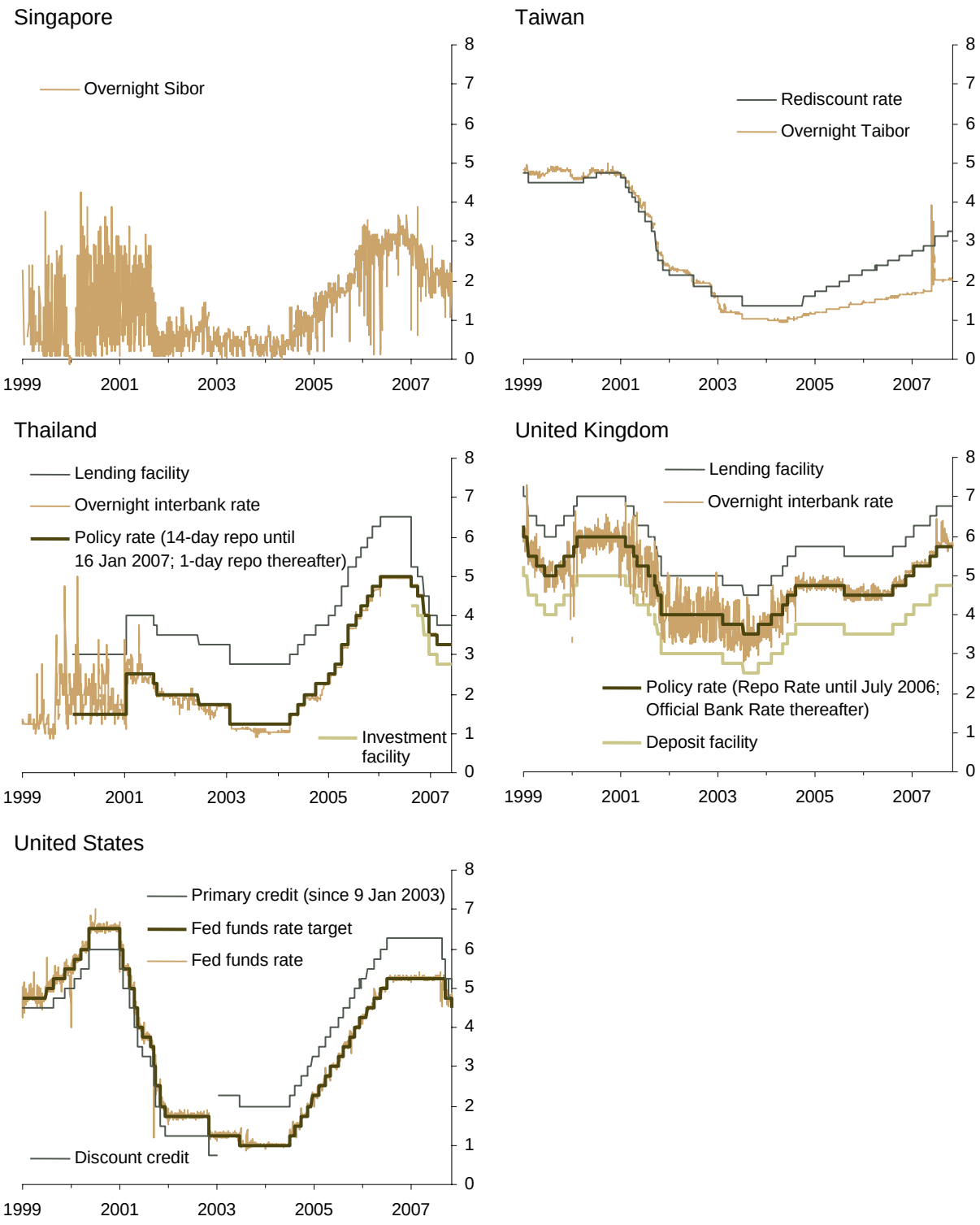
In percent



Sources: Central banks; CEIC.

Graph 1: Central bank official interest rates and overnight market rate (cont.)

In percent

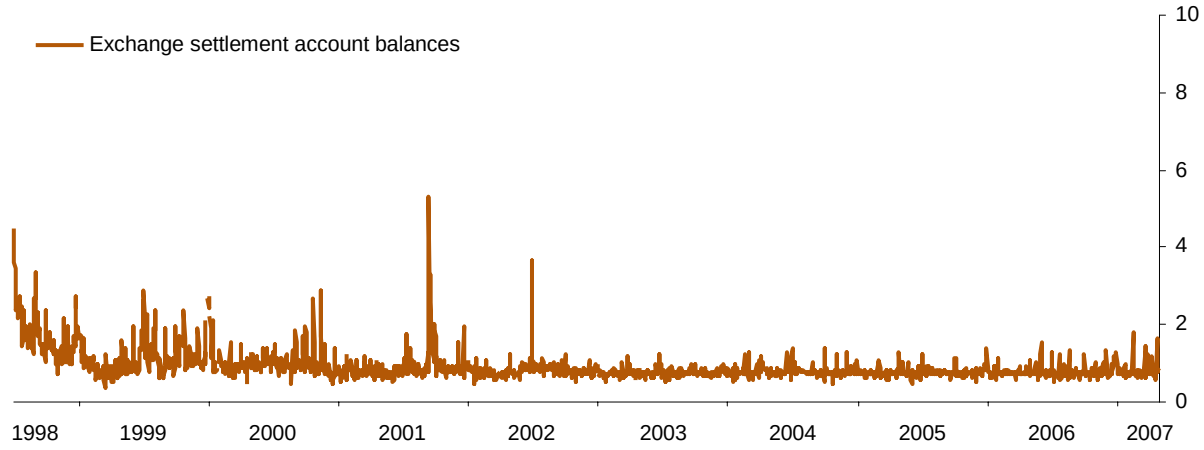


Sources: Central banks; CEIC.

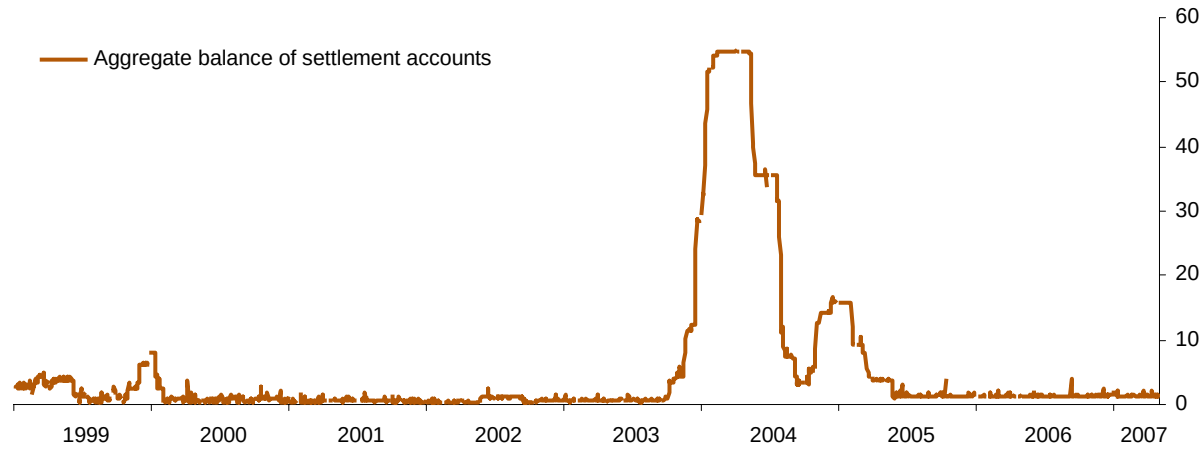
Graph 2: Settlement balances where there is no reserve requirement

In billions of local currency units

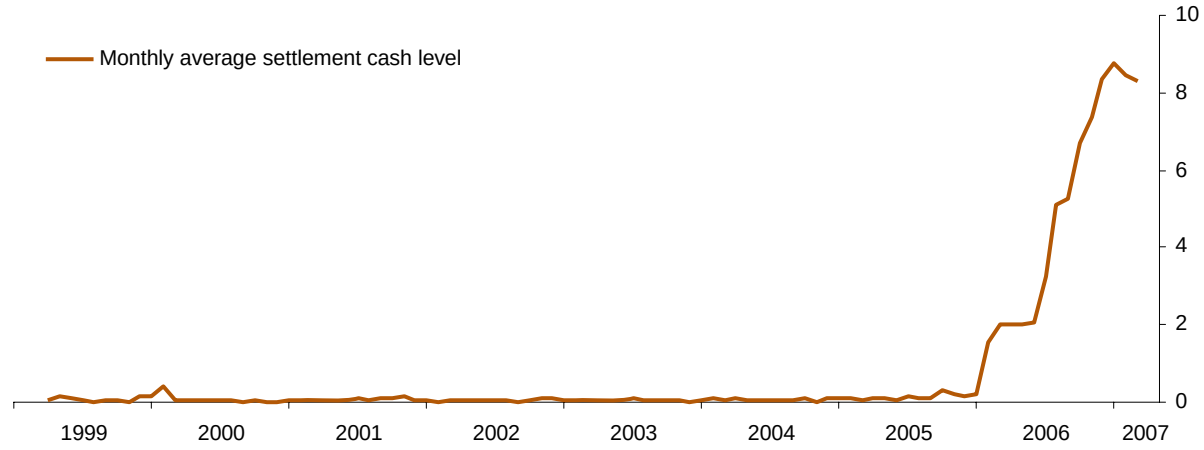
Australia



Hong Kong



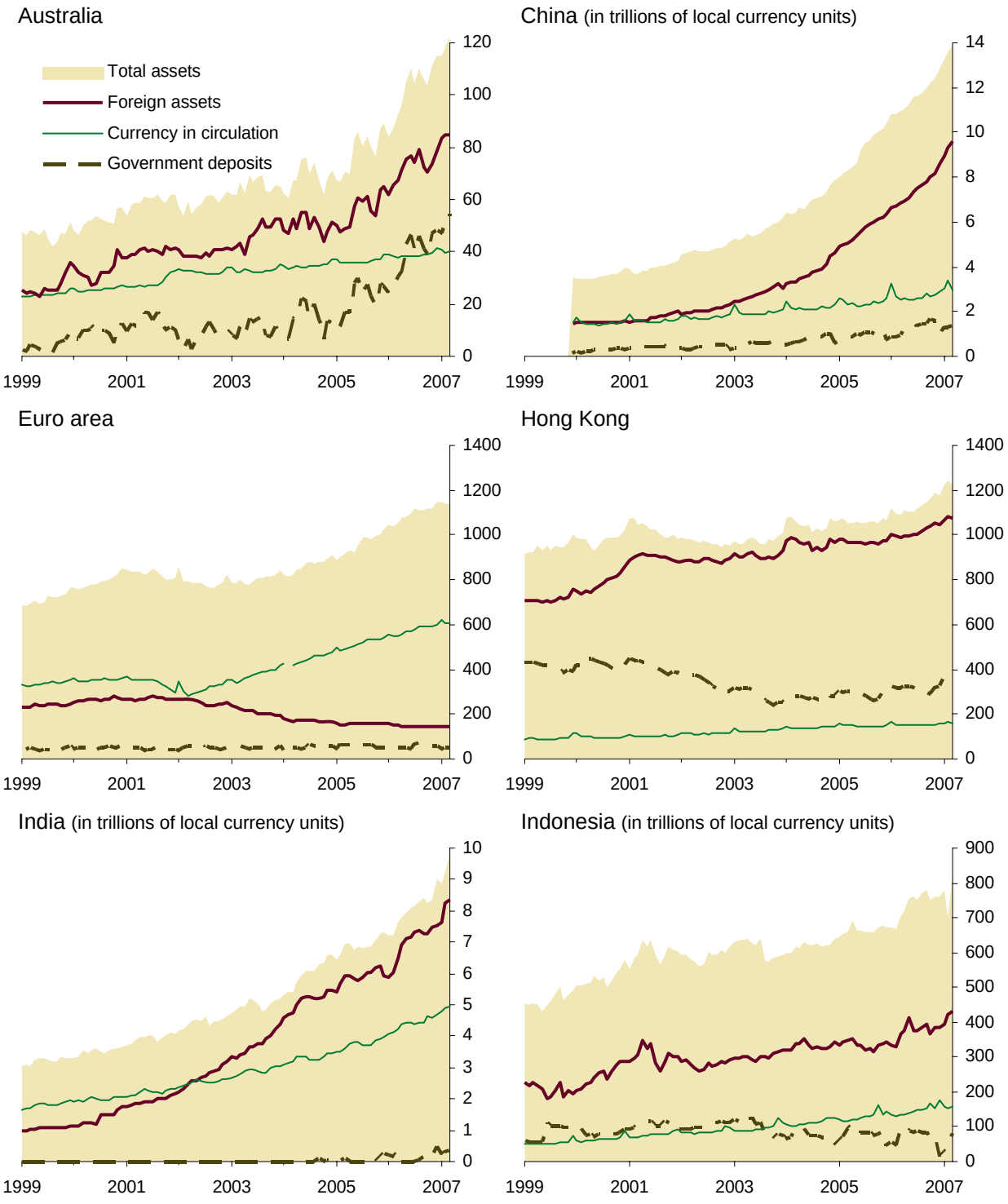
New Zealand



Sources: Central banks.

Graph 3: Central bank balance sheet: Total assets and key autonomous factors

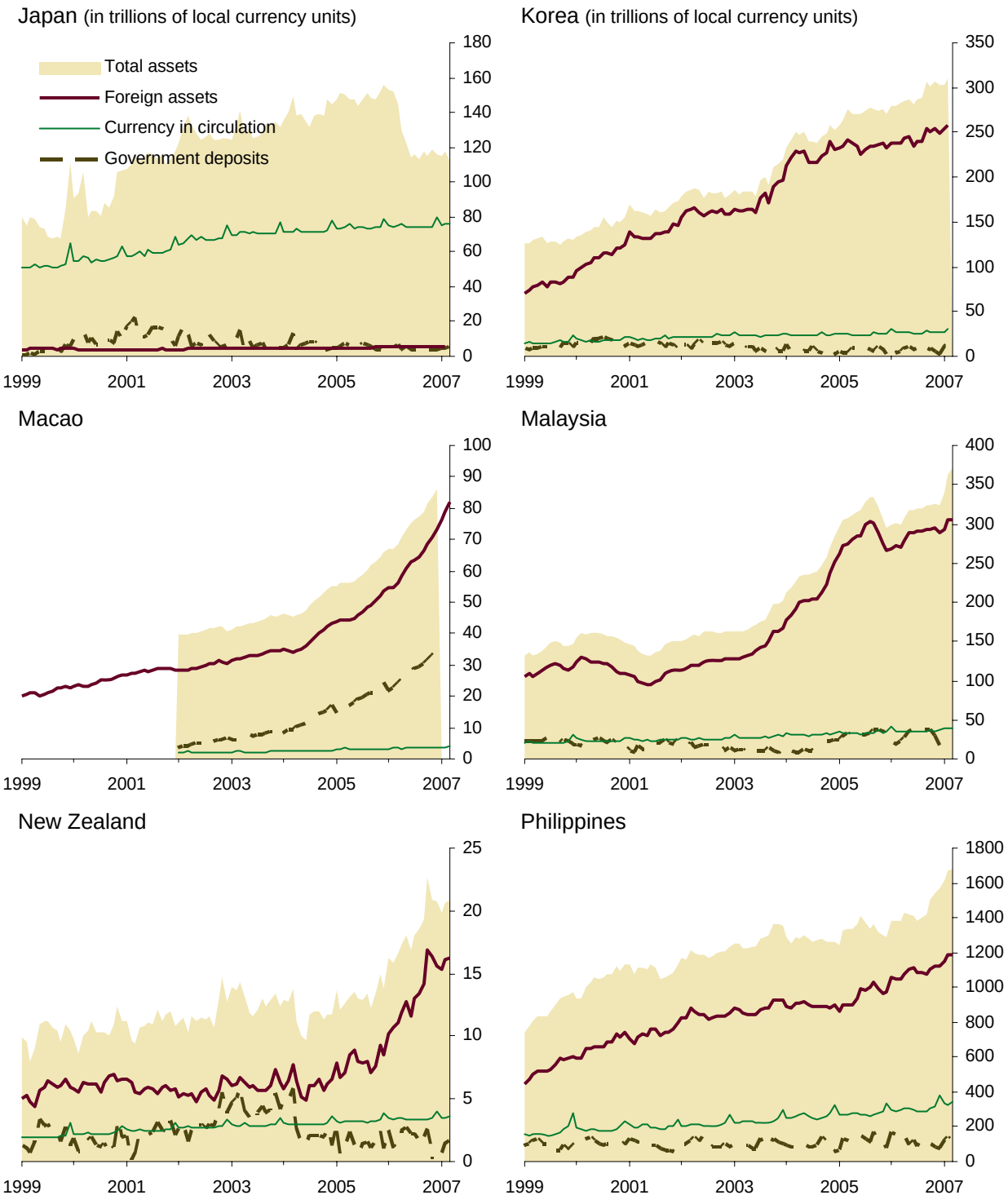
In billions of local currency units, unless otherwise indicated



Sources: Central banks; CEIC.

Graph 3: Central bank balance sheet: Total assets and key autonomous factors (cont.)

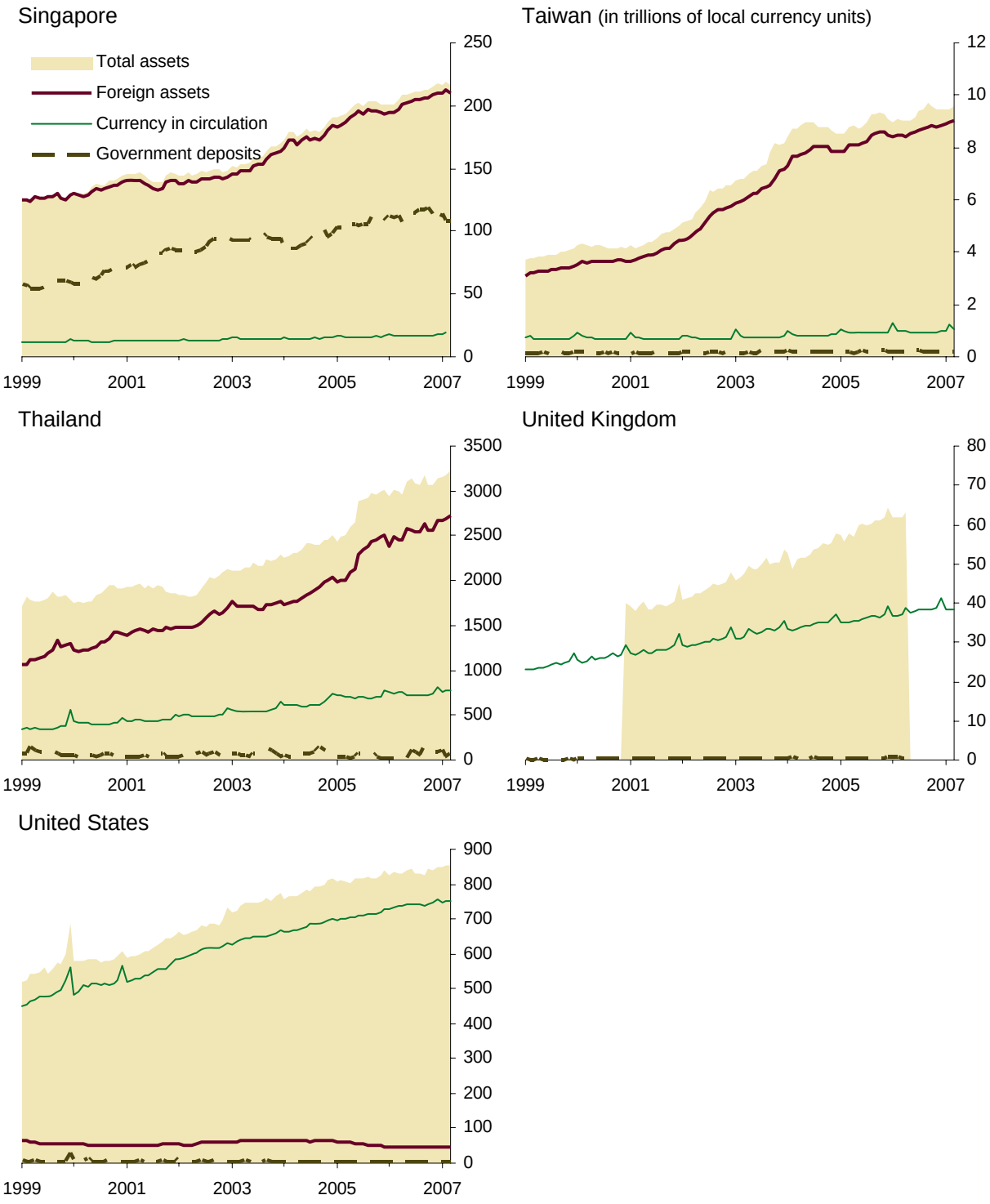
In billions of local currency units, unless otherwise indicated



Sources: Central banks; CEIC.

Graph 3: Central bank balance sheet: Total assets and key autonomous factors (cont.)

In billions of local currency units, unless otherwise indicated



Sources: Central banks; CEIC; IMF, International Financial Statistics.

Table 1: Institutional setup of monetary policy decision and operation (as of March 2007)

	Basic frequency of policy announcement	Formal policy rate	Formal operating target	Memo
Australia	Monthly	Target Cash Rate (=O/N rate target)	O/N cash rate	Inflation targeting
China	As and when required	1-year deposit and loan reference rates	Excess reserves	Ref. to M-growth targets
Eurosystem	Monthly	Minimum bid rate for the Main Refinancing Operation (1-week maturity)	No formal target	
Hong Kong[1]	–	–	USD/HKD spot rate	Currency board
India	Quarterly	1-day Repo and Reverse Repo Rates	No formal target	
Indonesia	Monthly	BI Rate (= target rate for 1-month SBI)	1-month SBI rate	Inflation targeting
Japan	Up to twice a month	Uncollateralized O/N call rate target	O/N call rate	
Korea	Monthly	O/N call rate target	O/N call rate	Inflation targeting
Macao[2]	–	–	HKD/MOP spot rate	Currency board
Malaysia	8 times a year	Overnight Policy Rate (=O/N rate target)	Average O/N interbank rate	
New Zealand	8 times a year	Official Cash Rate (=O/N rate target)	O/N cash rate	Inflation targeting
Philippines	Every 6 weeks	O/N Repo and Reverse Repo Rates	No formal target	Inflation targeting
Singapore	Semi-annually	Policy band for Singapore dollar NEER	Singapore dollar NEER	NEER-based regime[3]
Taiwan	Quarterly	Discount Rate	Reserve money	Ref. to M-growth targets
Thailand	Every 6 weeks	1-day Repo Rate	1-day Repo rate	Inflation targeting
United Kingdom	Monthly	Official Bank Rate	Short-term money market rates	Inflation targeting
United States	8 times a year	Fed funds rate target (=O/N rate target)	O/N interbank rate	

[1] Currency board regime with a US dollar anchor, thus no independent monetary policy. The central bank's lending facility rate (Base Rate) is linked to the US Fed funds rate target by formula and changes whenever the US policy rate is changed. [2] Currency board regime with a Hong Kong dollar anchor. The central bank's lending facility rate (Base Rate) is linked to Hong Kong's Base Rate. [3] The NEER band is set with reference to inflation and growth objectives.

Sources: Central banks.

Table 2: Reserve Requirements – main features and key ratios (as of March 2007)

	Averaging	Carry-over	Accounting	Maintenance period	Requirements on domestic currency	Requirements on foreign currency	Remuneration
Australia							
China	No	No	Lagged	10 days	10%	4%	Yes
Eurosystem	Yes	No	Lagged	28-35 days[1]	2%	2%	Yes
Hong Kong							
India	Yes	No	Lagged	2 weeks	6%	6%	Yes (on amounts > 3%)
Indonesia	No	No	Lagged	Daily	5%+additional[2]	3%	Yes (on amounts > 5%)
Japan	Yes	No	Half-lagged	1 month	0.05-1.3%	0.15-0.25%	No
Korea	Yes	No	Half-lagged	Half a month	0-7%	0-7%	No
Macao	Yes	No	Lagged	1 week	1-3%	1-3%	Yes
Malaysia	Yes[3]	No	Lagged	2 weeks	4%	4%	No
New Zealand							
Philippines	Yes	Yes	Lagged	1 week	10%[4]		Yes (up to a limit)
Singapore	Yes	No	Lagged	2 weeks	3%		No
Taiwan	Yes	Yes	Half-lagged	1 month	4-10.75%	0.125%	Yes
Thailand	Yes	Yes	Lagged	2 weeks	6%[5]	6%[5]	No (on the 1% held at CB)
United Kingdom	Yes	No	Lagged	1 MPC month	Voluntary[6]		Yes[7]
United States	Yes	Yes	Lagged	2 weeks	0-10%		No

[1] Varies with the monetary policy meeting schedule. [2] Additional requirement is linked to size of domestic currency liabilities and loan-to-deposit ratio (LDR): higher requirement for banks with higher liabilities or lower LDR. [3] Daily shortfall or excess limited to 20% of required reserves. [4] Refers to statutory reserves only, excludes 11% liquidity reserve requirement. [5] Of which, 1% is held as non-remunerated reserves; 5% can be held in eligible public securities. [6] Each reserves scheme participant chooses a targeted level of reserves for maintenance period. [7] For reserves successfully maintained within a range (normally ±1%) around the target.

Sources: Central banks.

Table 3: Standing facilities for short-term liquidity management (as of March 2007)

	Lending facility type[1]	Borrowing/deposit facility type[1]	Ceiling	Floor	Intra-day lending facility[2]
Australia	Repo	Deposit	Policy rate + 25bp	Policy rate - 25bp	Yes
China	Fixed rate loan[3]	Deposit	Rediscount Rate	Remuneration rate	Yes
Eurosystem	Repo or collateralised credit	Deposit	Policy rate + 100bp	Policy rate - 100bp	Yes[4]
Hong Kong	Repo		Base Rate[5]		Yes
India	Repo	Reverse Repo	Repo Rate	Reverse Repo Rate	Yes
Indonesia	Repo	Deposit	Policy rate + 300bp	Policy rate - 500bp	Yes
Japan	Fixed-term loan		Basic Loan Rate[6]		Yes[7]
Korea	Loan (not in use)		Policy rate + 200bp		Yes[7]
Macao	Repo		Base Rate		
Malaysia	Repo, sometimes collateralised loans	Direct borrowing	Policy rate + 25bp	Policy rate - 25bp	Yes[8]
New Zealand	Repo	Deposit	Policy rate + 50bp	Policy rate	Discontinued[9]
Philippines	Repo[10]	Reverse Repo[10]	Repo Rate	Reverse Repo Rate	Yes
Singapore	Collateralised lending	Deposit	O/N cash rate + 50bp	O/N cash rate - 50bp	Yes
Taiwan	Fixed rate loan[11]		Discount rate + 37.5bp		Yes
Thailand	Repo	Borrowing (collateralised)	Policy rate + 50bp	Policy rate - 50bp	Yes
United Kingdom	Repo	Deposit	Policy rate + 100bp (25bp last day of maintenance)	Policy rate + 100bp (25bp last day of maintenance)	Yes
United States	Fixed rate loan[12]		Policy rate + 100bp		Yes[6]

[1] Overnight or 1-day maturity unless otherwise stated. [2] Repos unless otherwise stated. [3] Vairous maturities. [4] Repo or overdraft depending on country. [5] Defined as max(Fed funds rate target +150bps, 5-day moving averages of the average of overnight Hibor and 1-month Hibor). [6] Back to 25 basis points above the policy rate, since the 21 February 2007 monetary policy meeting. [7] Overdraft. [8] Collateralised loans. [9] Since the liquidity management regime change in mid-2006. [10] Overnight, 2-week and 1-month maturities. [11] Various maturities, up to 360 days. [12] Small institutions lacking access to wholesale funding markets may get somewhat longer term loans.

Sources: Central banks.

Table 4: Main and other discretionary operations (as of March 2007)

	Main or keynote operation(s)			Other operation(s) in use	
	Type	**Typical maturity**	**Typical frequency**	**Type**	**Typical maturity**
Australia	RT	1 day to 3 months	Daily	OT, FXS	1 day to 3 months
China	CBP (PBC bills)	Up to 3 years	2 x week	RT	7–182 days
Eurosystem	RP or CL	1 week/ 3 months	Weekly/ monthly	RP (Quick tenders)	Varies
Hong Kong					
India	RT	1 day	2 x day	OT (Market Stabilisation Scheme)	From 91 days
Indonesia	CBP (SBIs)	28 days	Weekly		
Japan	CL, RT	O/N up to ~3 months	2–3 x day	OT	
Korea	CBP (MSBs)	Up to 2 years	Weekly	RT	Up to 91 days, mainly 1 to 14 days
Macao	CBP (MBs)	1 to 365 days	Daily	FXS, OT	1–365 days
Malaysia	DB	O/N to 3 months	Daily	RP, RS, securities lending CBP	2–4 months 3–12 months
New Zealand	FXS	1 week to 18 months	Varies (≤ daily)	Bond lending facilities	O/N to 1 week
Philippines				FXS	Varies
Singapore	RP, FXS, DB, DL	Up to 1 year	Discretionary		
Taiwan	CBP (CDs/NCDs)	Up to 3 years	Daily	FXS, RP, OT	Up to 3 months
Thailand	RP, FXS, OT, CBP		Varies by type	Securities lending, bilateral RP	
United Kingdom	RP	1 week/ longer term	Weekly/ monthly	Fine-tuning at end of maintenance	O/N
United States	RP	O/N to 14 days	Daily/ weekly	OT (purchase)	

Key: CBP = issuance of central bank paper, CL = collateralised lending, DB = direct borrowing, DL = direct lending, RP = Reversed purchases ("repo"), RS = RRP = Reversed sales ("reverse repo"), RT = Reversed transactions (= RP and/or RS), FXS = FX swaps, OT = outright transactions (purchases and/or sales)

Sources: Central banks.

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