

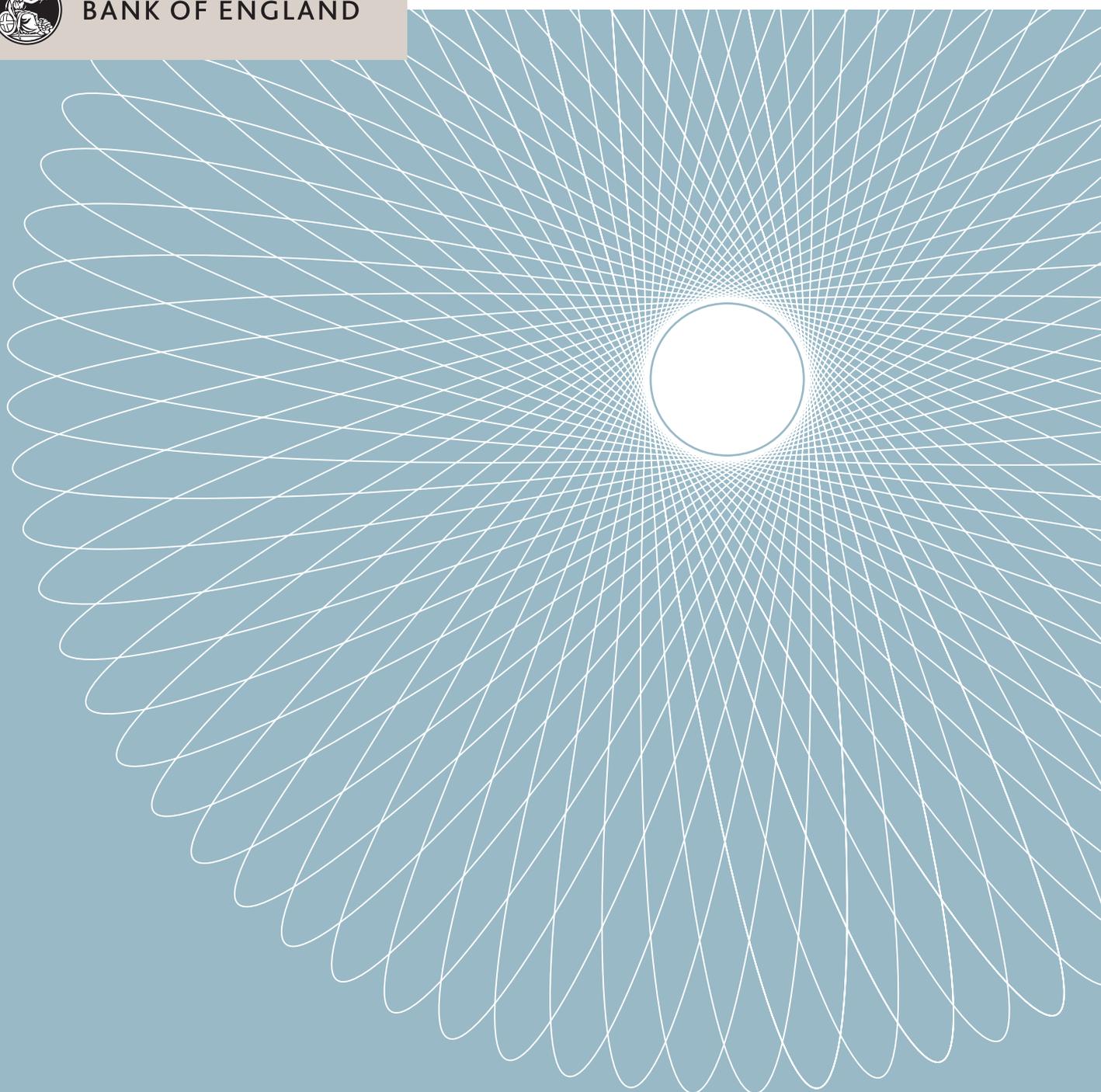
# Centre for Central Banking Studies

## Handbook – No. 27 Liquidity forecasting

Simon T Gray



**BANK OF ENGLAND**







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# Liquidity forecasting

Simon T Gray

When central banks enter into transactions to implement their monetary policy, they necessarily make use of their own balance sheets. Whether they are undertaking open market operations (OMO) to inject or drain funds from the banking system, or allowing the banks to use standing facilities to borrow or deposit funds, the central bank's balance sheet will be impacted: the funds in question are commercial bank balances held at the central bank.

Ideally, operations undertaken to implement policy should have a predictable impact on the economy, via the banking system. This means that the central bank needs to know the context in which it is operating: what is the current availability of commercial bank balances compared with the level of demand, and how is this expected to change in the near term? An accurate current picture and good forecast of the central bank's likely future balance sheet is required.

The same information on the central bank's balance sheet is also needed if the central bank wishes to manage liquidity pro-actively. Most central banks do, whether it is to avoid a shortage of liquidity impacting on the payment system, or an excess impacting short-term yields and/or the exchange rate.

This *Handbook* examines the issues involved in forecasting the central bank's balance sheet. This is normally referred to as 'liquidity forecasting' since the item on the balance sheet which central banks typically try to manage is commercial banks balances, a subset of high-powered liquidity.

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**The views expressed in this *Handbook* are those of the authors, and are not necessarily those of the Bank of England.**

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# Liquidity forecasting

## What is liquidity and why do central banks care?

Liquidity — in terms of a monetary aggregate rather than ease of trading an asset — can be defined as narrow (or high-powered or central bank) money at one extreme; or the widest definition of broad money aggregates at the other. Both are of interest to central banks, as they have implications for both monetary and financial stability.<sup>(1)</sup> Increasingly, cross-border linkages mean that liquidity imbalances in one country can lead to spillovers into another economy. This is most obviously the case with the broader definition of liquidity: investors facing a shortage of domestic assets (excess liquidity can also be viewed as a shortage of assets)<sup>(2)</sup> may try to access foreign assets; this will normally involve foreign exchange markets and cross-border transactions. To the extent central bank and commercial bank balances are interchangeable in the wholesale money markets, disequilibrium in high-powered money may also spillover cross-border — evidenced by market behaviour in the United States, the United Kingdom and the euro area in August–September 2007.

When this *Handbook* talks about 'liquidity', what is meant is the narrow definition — a subset of central bank liabilities — rather than a broader monetary aggregate. In particular, it is *the domestic-currency denominated, non-interest-bearing liabilities of the central bank held by the non-state sector*.

Central banks typically manage monetary policy by controlling the cost of this liquidity (whether indirectly, via the cost of commercial bank borrowing from the central bank to fund the liabilities, or directly via the cost at which its liabilities are remunerated) and thus, through arbitrage, the cost of interbank funds. But if there is either too much or too little of this liquidity in the market, the central bank will find it harder to manage monetary policy; and most central banks therefore try to manage market liquidity in a manner which will facilitate the implementation of monetary policy.

Central banks tend to forecast banks' free reserves, and estimate excess reserves (see definitions, below), because they believe:

(i) that a disequilibrium — whether too much or too little liquidity — tends to promote behaviour by banks which the central bank does not want; and therefore

(ii) that the central bank may need to react in order to continue implementing an appropriate monetary policy stance.

If there is a shortage of liquidity, then the central bank will (almost) always supply the need. There have been a few occasions where a central bank has not been able to supply sufficient cash to meet the economy's needs — notably when there is hyperinflation or civil unrest (or in one Latin American country, when the central bank printers went on strike) — and people may then resort to barter or increased dollarisation. But this is very unusual. As regards a shortage of commercial bank reserves held at the central bank, the risk is that a shortage would mean payments could not be cleared at the end of the day. It is to avoid this risk that central banks have in place credit standing facilities (SFs) — though they will normally aim to supply liquidity via open market operations (OMO) — to avoid spikes in market interest rates. Commercial banks might have sufficient balances for payments purposes, but be short of reserves balances in terms of meeting reserve requirements (RRs) or liquid asset ratios (LARs). Since the interest rate penalty of a shortfall is typically the same as for accessing the credit SF or higher, the impact on banks' behaviour will be similar, so that central banks will where possible supply the necessary liquidity via OMO. In any case, liquidity will nearly always be supplied, albeit possibly at a high price, so that *ex-post* liquidity shortages are unusual.

The consequences of a liquidity surplus are not the mirror-image of a shortage, and central bank structures are not therefore always symmetrical. There is no risk of payment system failure because of a surplus of liquidity, nor of a failure to meet reserve requirements. Arguably, there is therefore less need for a deposit SF. But there will be consequences of a surplus on the behaviour of commercial banks, which typically run counter to the policy goals of the central bank. The immediate consequence of excess liquidity is that short-term interest rates will fall, potentially close to zero. This is evident in a number of countries. Banks could try to offset this loss of income by making riskier loans in search of yield (with consequences for financial stability and possibly inflation, if there is excessive lending); or they might refuse to take customer deposits, especially interest-bearing deposits (with consequences for the development of financial intermediation, and possibly inflation if this encourages consumption rather

(1) See for instance 'What is global excess liquidity, and does it matter?', Ruffer, R and Stracca, L (2006), *ECB Working Paper no. 696*.

(2) See for instance, taking the broad definition, 'On the macroeconomics of asset shortages', Caballero, R (2006), *NBER Working Paper no. 12753*.

than saving); or they might try to move into foreign exchange where some return on balances is available (with consequences for either the exchange rate or the central bank's foreign exchange reserves, or both; and possibly for inflation if the exchange rate depreciates).

Some central banks eg in the Far East have observed that when the market has a large structural surplus of liquidity, the interest-rate transmission mechanism of monetary policy weakens. This again points to an impact on monetary policy implementation.

If the market swings from a surplus to a shortage from day to day — so that even the direction of the disequilibrium is unpredictable — short-term interest rates will be more volatile than would otherwise be the case (this will tend to impede development of the longer-term end of the market) and banks will be more reluctant to take positions because of the risks involved.

In other words, liquidity forecasting and management is part of the central bank's goal of stabilising the value of money — whether this means, in a given context, stabilising the domestic value by keeping inflation low, or stabilising the external value by keeping the exchange rate<sup>(1)</sup> at a particular level. And it supports the broader goal of financial market stability, by reducing the risks which can arise from short-term price volatility.

The *ECB Monthly Bulletin* (May 2002) noted, in the context of liquidity management:

*'Central bank liquidity management comprises assessing the liquidity needs of the banking system and supplying or absorbing the appropriate amount of liquidity through open market operations.'*

This implies that liquidity management, at least for the ECB, is essentially accommodative. With such an approach, the central bank does not pre-determine a path for liquidity (reserve money) growth, it simply aims to supply the net requirements of the market, whatever the requirement is.

This approach may be easier when the market is characterised by a structural deficit of liquidity (eg the United Kingdom, the United States, the euro area and Japan), since there is a marginal cost to banks in obtaining liquidity — they need to borrow from the central bank — and excess reserves are typically not remunerated. Banks have an incentive to hold the right amount — enough for payments purposes but minimal costly excess. Where there is a structural surplus of liquidity, however, the incentive structure may be less obvious. In principle, there may be no difference: banks will still want enough for payments purposes and minimal costly excess. But if the central bank leaves some excess liquidity in the market,

so that short-term market rates are very low, the opportunity cost of holding excess balances at the central bank may be seen as small. Banks might then exhibit only a sluggish response to excess holdings of liquidity, and it can be harder to determine, behaviourally, where the boundary lies between desired and excess reserves.

It follows from the purpose of the liquidity forecast, that the forecast should be seen in the context of the central bank's liquidity management policy and operations. If liquidity is to be managed using OMO — ie transactions where the central bank takes the initiative — the central bank must have a good forecast.

## Definitions of liquidity

The task of forecasting liquidity involves a forecast of the balance sheet of the central bank, so that, by residual, the central bank can judge the scope of its market interventions in order to maintain the appropriate level of liquidity in the economy.

It is important to differentiate between the various liabilities on the central bank's balance sheet (**Table A**).

**Table A** The central bank's balance sheet

Assets	Liabilities
Foreign exchange (net)	Cash
Credit to government	Government balances
OMO: credit to banks	OMO: liquidity drain
Standing facility: credit to banks	Standing facility: liquidity drain
Other	Banks' free reserves
	Banks' required reserves
	Capital and reserves

Not all central bank liabilities are fully liquid, and not all are held by the non-state sector. For instance:

- government deposits with the central bank are liquid, but the government will not necessarily respond to 'excess' deposits in the same way as a private sector bank;<sup>(2)</sup>
- term deposits or central bank bills, normally a form of OMO used to drain excess liquidity, are interest-bearing and are a response to excess liquidity;
- required or contractual reserves may represent free liquidity from day to day if there is a system of reserve averaging, but cannot be freely used over the maintenance period as a whole;

(1) Nominal, real or trade weighted.

(2) Some central and regional government treasuries do hold surplus funds with commercial banks (whether private or state sector) if balances at the central bank are not remunerated.

- foreign debt is interest-bearing and is not in domestic currency; and
- capital and reserves of the central bank are not held by the non-state sector.<sup>(1)</sup>

Cash is clearly non-interest bearing, held by the non-state sector, and liquid; there could be an excess or a deficit of it in the economy. Commercial bank current account balances constitute 'free' reserves which may or may not be 'excess'.

As a final point here, it is often far from clear just how to move from a published central bank balance sheet to the pro-forma structure used above. Central bank staff may need to do some work with their accounts department in order to be able to produce a balance sheet — at least broken down into the major items — that is operationally useful for liquidity management.

### What are free and excess reserves?

All funds in banks' current accounts could be defined as free reserves, to the extent that banks are free to use the funds on any given day. Where there is (i) an required reserves (RR) regime and reserve averaging is practiced, or (ii) a voluntary contractual reserves (VCR) regime, these reserves are likely to be maintained in the commercial banks' current accounts at the central bank. This means that balance sheet data are not sufficient to indicate whether a bank has free or excess reserves: the liquidity forecaster needs to know in addition what the RR/VCR target levels are.

It is important in this case to distinguish between what might be 'free' balances — ie can be used freely — on a given day, and what are free for the reserve maintenance period as a whole. On any given day, a bank can run its balance at the central bank down to zero (or whatever lower bound is set), even if at that point it holds less than the reserve target, whether for that day or for the maintenance period up to that point. But over the reserve maintenance period as a whole, it is not free to do so. A bank may of course end a period with reserves lower than its target; but this is not a 'free' option — there will be an interest rate penalty — and central banks will normally work on the assumption that each bank aims at least to meet its reserves target, and manages liquidity accordingly.

The central bank could, in general terms, define 'excess' reserves as anything above the level desired by commercial banks. This begs the question: what level do commercial banks want to hold?

Some banks will always want to hold a certain amount of reserves voluntarily, for payments system liquidity and perhaps for precautionary motives. Where there is a regime of RR with no averaging,<sup>(2)</sup> banks hold voluntary (or 'demanded') reserves on top of the required level for transactions purposes. Where

averaging is allowed, banks typically have to hold higher balances — on average — than they would voluntarily chose. Since the averaging mechanism provides them with scope for liquidity management, one might expect *a priori* that any balances held above the reserve requirement level would be excess to demand. Indeed, some commentators define any reserves held on top of required reserves as 'excess'. But this may not be correct, for various reasons, either on any given day, or for the maintenance period as a whole.

In some countries, liquidity forecasters can assume that the banking system as a whole will target reserves of marginally more than the RR target — perhaps between 0.25%–0.5% above the RR level in the euro area, for instance. If the combination of the central bank's OMO and reserve averaging provides ample scope for liquidity management, then banks will tend to target marginally above the RR target. As there is some stigma associated with a shortfall (the interest rate cost of a shortfall or an excess is normally symmetrical), banks have a small incentive to err on the side of a surplus. But in some countries, where the use of OMO is less predictable and access to the credit SF is seen as very expensive, some banks will hold a larger, but less predictable, buffer above the RR target. The size of the targeted buffer will be a function of the uncertainty of the central bank's operations; the operational structure and its relationship to the setting of monetary policy; possibly of exchange rate speculation; and of the reliability of the payment system and commercial banks' internal treasury systems. Changes in any of these will affect the size of the targeted buffer, making it harder to estimate the level of desired reserves, and thus by residual of excess reserves.

Similar forecasting problems can arise if the level of RR is not high enough to provide all banks with enough scope for liquidity management — as in the United States at present — or if reserves are held on a purely voluntary basis — as in Australia. In both cases, the central bank has to estimate the desired level of voluntarily-held reserves before it can decide whether the forecast actual level of reserves is on target or not. To some extent, the central bank may have to be guided by the behaviour of the market. It may observe that if the level of free reserves is within a certain band (this may be thought of as a 'comfort zone'), short-term market rates will reflect the policy rate; whereas if reserves are above or below that band, market behaviour responds by moving interest rates or changing demand for foreign exchange.

This handbook takes the view that it is important to distinguish between free reserves — whether or not they are on top of required reserves — and reserves which exceed the commercial banks' demand for them. Thus excess reserves are a subset of

(1) There are rare exceptions, where the central bank's capital is held by the private sector; but this is normally for historical reasons, and this capital could not behave in the same way as excess liquidity.

(2) Reserve requirement averaging is discussed in detail in *Handbook No. 24*.

free reserves: it is not an alternative term for the same thing. Commercial banks' behaviour will be different, depending on whether balances held at the central bank are (i) held voluntarily (desired, or demanded, reserves), in which case the banks will want to keep them; or (ii) in excess of the desired level, in which case the banks will seek to convert them into an asset which carries some form of return. What matters to the central bank is the behaviour of commercial banks seeking to get rid of excess reserves,<sup>(1)</sup> or avoiding the risk of a shortfall.

### Can there be excess cash?

In most countries, cash is supplied on demand; and because there is a cost to holding cash, the economy as a whole does not make excessive demands. Central banks will therefore tend to assume that supply of cash equals demand, and that — by contrast with commercial banks balances at the central bank — there is never an 'excess' of cash which might affect behaviour. This should be true as long as commercial banks are free to return excess cash holdings to the central bank; and that there are efficient and cost-effective means for any (temporarily) surplus cash to flow from the economy via the commercial banks back to the central bank.

But there are exceptions to this. In a few countries with less developed financial systems — 'cash economies' — there can be excess cash in circulation. This normally arises when a government pays salaries (and perhaps pensions) in cash; and is often associated with monetary financing (the central bank's balance sheet expands as the government borrows from it to withdraw cash). The cash may find its way back to the central bank via the banking system, or could be left in the economy with potentially inflationary consequences. The latter scenario is more likely to happen where a large part of the economy is unbanked (one reason for salaries being paid in cash in the first place), and the mechanisms for returning surplus cash to the central bank are inadequate or non-existent.<sup>(2)</sup>

The task of forecasting this form of excess liquidity — excess cash in circulation — may be harder than simply forecasting demand for cash when it is only supplied on demand, as there may be no normal, base level to compare with; but in such a case it may be more important.

### Should account be taken of non-domestic currencies?

Having defined the task of liquidity forecasting as estimating (i) the future level of domestic-currency, non-interest-bearing central bank liabilities held by the non-state sector and (ii) the demand for such liabilities, it is worth considering the impact of non-domestic currencies in a (semi) dollarised economy.

It is impossible for a central bank to know how much foreign currency cash is circulating in its economy. Data for domestic currency in issue can be taken from the central bank's own balance sheet, and data for domestic currency in circulation by adjusting this for reported vault cash held by banks. But there

is no such record of foreign currency in circulation, and no prospect of obtaining accurate reporting of such holdings.

It can nevertheless be useful for a central bank to know whether the level of dollarisation is changing. This will help it to understand what is driving the growth in domestic currency in circulation and whether it might be excessive, inflationary etc. For instance, if there is substantial de-dollarisation, then as the population switches from foreign to domestic currency, the volume of domestic currency will increase faster than the growth rate of/demand for total transactional cash in the economy. Rapid growth in domestic currency in circulation may not be a problem. It might be possible periodically to undertake surveys<sup>(3)</sup> to get an idea of the level, and more importantly changes in the level, of dollarisation in order to be able to form a judgement on this. A few central banks do so.

If a central bank finds that substantial use is made of its currency in other countries — notably the US dollar and the euro — it may be useful to estimate such holding for the purposes of analysing currency demand; and to forecast it separately, as it may behave differently to cash demanded domestically.

It is reasonable to assume in most cases that there is unlikely to be an excess of foreign exchange in circulation, except perhaps for short transitional periods, since it can normally be invested abroad for a return. An excess or shortage may result in banks selling/buying foreign exchange from the central bank, which will in turn affect domestic currency liquidity, and possibly also the exchange rate. However, to the extent the financial sector is inefficient, the transactional costs of investing foreign exchange abroad may be excessive, encouraging — at the margin — any excess holdings to be spent domestically. They would then have much the same impact as excess holdings of domestic currency.

Some countries have found that, if the exchange rate appreciates and is expected to continue appreciating, then demand for domestic currency, non-interest-bearing liabilities of the central bank will increase temporarily, as people expect to benefit the exchange rate gain; but once the exchange rate is perceived to have stabilised, this will unwind. In an under-banked economy, the easiest (or only) way of

(1) If banks judge that it will be impossible to get rid of the excess, their behaviour will be affected in a different way — this will be explored later.

(2) It will also impact the transmission mechanism. Changes in interest rates may affect the balance between consumption (transactions money) and saving (bank deposits) if enough people hold bank deposits; but cannot influence directly those who use only cash. The level of savings held in the form of cash under the mattress (as opposed to bank deposit) should be influenced by the level of inflation or strength of the exchange rate (high inflation encourages more hoarding of physical goods); but this is less under the central bank's direct control.

(3) It is unlikely to be worthwhile asking individuals how much foreign currency cash they hold, as they would be suspicious and have incentives to lie. But shopkeepers might be prepared to say what percentage of their purchases (from suppliers) and sales are denominated and/or paid for in foreign currency. Changes over time in the responses would give an indication of changing levels of dollarisation.

taking a speculative position on the domestic currency may be via holdings of physical cash.

## Autonomous factors: levels and changes

The factors which the central bank needs to forecast — those which are not under its direct control — are often referred to as ‘autonomous factors’. For most central banks, the main items are:

- cash in circulation;
- net government balances; and
- net foreign assets (for some this will mean simply foreign exchange reserves).

There may be others, such as the ‘float’ in the payment system, which are important for some countries but not for others. Some items may be irregular. For instance, profit remittance to the government may happen twice a year; or foreign exchange inflows relating to a privatisation may affect a few days around the time of the privatisation only; but their size means that account needs to be taken of them when they happen; and the forecast model should allow for their inclusion as necessary.

As indicated earlier, excess reserves are a subset of free reserves (and cash). These are normally the residual in the forecast; it is necessary to forecast the other items of the balance sheet, both assets and liabilities, in order to generate a forecast for free reserves. On the assumption that the central bank has a reasonably accurate picture of its balance sheet for a recent date (ideally close of business the previous day), it will know the balances in commercial banks’ current accounts for a date in the past. This being the case, the central bank can in practice forecast the changes to the main items, rather than the levels themselves, since that will produce a forecast for changes to free reserves. The central bank can therefore concentrate on forecasting the items which show the largest fluctuations in value.

Clearly, if the central bank forecasts the levels, then changes for the given period are a residual; and if changes to the latest balance sheet are forecast, the forecast future balance sheet is a residual. One implies the other. Both approaches have merit, and at different times, both may need to be used. Assume that cash in circulation today is 100, and is forecast to increase by 0.5% tomorrow, to 100.5. If the figure for today is revised to 100.3, does this mean that some of the increase in demand for tomorrow has happened early, in which case the forecast level is not altered but the change is? Or should the forecast level be increased on the basis of a higher base number and unchanged forecast increase? Depending on the circumstances, either could be right. Similarly, assume that the level of government balances is revised up for today. That might increase the level forecast for tomorrow, for a given

income and expenditure forecast; or it might imply a different change, if the government targets a particular balance held at the central bank.

These factors may be stated in terms of levels (eg the level of foreign exchange reserves) or in terms of flows (changes to the level of net foreign exchange reserves). In practice, the latter may be more useful, since the central bank normally wants to forecast changes in the residual item, commercial banks’ free reserves. It is important to remember that the forecast needs to cover items which affect commercial bank liquidity. A change in the exchange rate will lead to a revaluation of foreign exchange reserves, with a counterpart in a ‘revaluation reserve’; but these offset each other, and do not impact on commercial bank liquidity.

## What period should be forecast?

For the purposes of liquidity management, the central bank ideally needs to undertake a daily forecast for coming few weeks — certainly until the end of the current reserve maintenance period. If daily data is not available — as is the case in a number of central banks — a weekly forecast might need to be used instead, until data availability can be improved. But if the central bank’s monetary instruments include longer-term operations — with a maturity of several months, perhaps — then there is a good case for producing a rough forecast of the central bank’s balance sheet for the next few months, in order to provide a context for those longer-term operations. And for some central banks, there is merit in occasionally projecting the balance sheet out for several years, for instance to help answer the question: if the current structure of operations continues for the next five years, what will the balance sheet look like based on assumptions for the yield curve and the exchange rate? Is the current stance sustainable?<sup>(1)</sup>

A central bank must undertake a short-term forecast, if its monetary operations are to be undertaken in a pro-active way: otherwise, it would simply be guessing what to do in volume terms. But it should also make a longer-term forecast. This is in part as a check (if the long-term forecast and the short-term forecast appear regularly and substantially out of line with each other, is one wrong? Are the same assumptions being used?); and for different aspects of operational planning.

### The short-term forecast

There may be some interaction between the length of the maintenance period, and the central bank’s ability to produce an accurate forecast. Some central banks find that they can produce a reasonably accurate forecast for the two weeks or

(1) One Eastern European central bank defined these as: for liquidity purposes, daily and monthly; for financial planning purposes, quarterly and annual; and long term, occasional eg looking forward seven years to estimate possible impact on the balance sheet if/when it joins the euro.

month ahead, but cannot accurately split the forecast by each day, or even week. If this is the case, the maintenance period could be set to match the period which the central bank can best forecast. A longer period than five weeks would be very unusual, and might give the market too much freedom; but if extending from one or two weeks to four-five weeks would allow for a significant improvement in liquidity management, it should be considered. That said, the central bank should still aim to improve data and forecast quality to provide a more accurate short-term picture of financial market developments.

The short-term forecast needs to take account of the commercial banks' time horizon. If there is a daily liquidity constraint — as was the case in the United Kingdom prior to May 2006, for instance — then an accurate forecast is needed for the current day. Most central banks will want to have some idea of the forecast for the current day, if only to be reasonably sure that reserve balances held by the commercial banks are sufficient to be able to cope with expected cash movements in the economy.

The next time horizon would normally be the period until the next planned OMO. For some central banks, this will be the next day, and therefore a one-day forecast is sufficient (this is also the period used by the Reserve Bank of Australia, where there is no reserve maintenance period, though operations are not necessarily undertaken every day). For others, it may be a one-week period — eg the Bank of England since May 2006,<sup>(1)</sup> and the euro system. The central bank might assume that the commercial banks as a whole would like to end the system with average reserves for the maintenance period roughly at the target level, and to stay at that level for the remainder of the maintenance period. If this can be achieved, so that at the start of a seven-day period the system has roughly the right level of reserves, the question is: what volume of liquidity adjustment is needed to keep the banks on track for the coming seven days? Although in theory banks could move substantially away from the target level for a few days, in practice it is unlikely that they would want to do so. If there are one-off events, such as a securitisation or large payment due to or from the government, which might lead the banks to want to vary from the target average level, the central bank will need to be aware of this and take it into account.

The third time horizon to consider is the period between today and the end of the current maintenance period, which might be one day, or could be up to one month. The Bank of England and the ECB publish daily information which shows the average level of reserves held in the maintenance period to date, and the average level required for the remainder of the period if the banks are to hit the target (or mid-point of the target, in the case of the United Kingdom) exactly. This is factual information rather than a forecast; but taken together with the forecast changes in autonomous factors indicates the

expected volume of OMO to be undertaken during the remainder of the maintenance period.

Most central banks find it useful to end a reserves maintenance period in the middle of the working week (typically Wednesday or Thursday). Certain of the autonomous items — notably cash in circulation, and the float (where relevant) are more volatile at the start and the end of the working week, and therefore harder to forecast. Ending the maintenance period on a day which is easier to forecast makes it more likely that the right amount of liquidity will be provided. If this is done, it also implies that maintenance periods should be a whole number of weeks, rather than eg a calendar month long.

For policy consistency purposes, it may also make sense to align the start and end of maintenance periods with the day on which the central bank reviews monetary policy (provided this is on a regular schedule). In the United Kingdom, the maintenance period starts on the day the Monetary Policy Committee announces its decision, and ends the day before the next MPC meeting. In the euro area, a similar alignment is made between those Governing Council meetings which review monetary policy, and the end of the maintenance period.

### Timeframe for long-term forecast

Beyond the current maintenance period, which constitutes a constraint for banks' liquidity management, a liquidity forecast is used more for planning purposes than for specific operations.

The longer-term forecasts may be useful in planning the maturity structure of longer-term, price-taking OMOs. Many central banks, whether injecting or draining liquidity from the economy, opt to place some of the transactions/part of their balance sheet on a — maturity (up to fourteen days to maturity), where they operate as price maker; and other transactions/part of their balance sheet at a much longer-term maturity (possibly several years, but perhaps just several months), where they operate as price taker. When deciding how much of the balance sheet should be placed at longer-term maturities, and how long those maturities should be, it will help to have some idea of how the balance sheet is expected to develop in the future.

A longer-term forecast may also be useful if the central bank is uncertain whether its current policy stance is sustainable. This is notably in the case with an exchange-rate target. But this form of forecast will be different to the short-term balance sheet forecasting. The central bank may want to estimate:

(1) The Bank of England's Red Book, which describes the framework for monetary operations, can be found at: [www.bankofengland.co.uk/markets/money/publications/redbookjan08.pdf](http://www.bankofengland.co.uk/markets/money/publications/redbookjan08.pdf).

- Likely growth in demand for domestic currency in coming years: this will be a function of GDP growth (including the grey/black economy which may be a major user of cash rather than formal banking channels), expected inflation, any expected (de-)dollarisation, payment system developments etc.
- Likely pressures on its foreign exchange reserves and the exchange rate: this will be a function of GDP growth, world demand for the country's exports, changes in competitiveness, future repayments of foreign currency borrowings etc.
- Possible changes in government behaviour eg if the government has committed to ending monetary financing, or is moving to a budget surplus, or moving cash balances from commercial banks to the central bank as part of an enhanced treasury-management function, or a change from foreign currency to domestic borrowing.

This sort of forecast will use quarterly or even annual data, and will not be concerned by within month, or maybe even within year seasonality; and it may benefit from a level of economic analysis that cannot be used with some elements of the very short-term forecast.

If the forecast is being used for monetary policy, rather than liquidity management purposes — for instance, if the central bank is using a monetary aggregate as its intermediate monetary policy target — it will probably need to extend to at least twelve months. The central bank will normally only take 'corrective' action if the growth path of the targeted aggregate is off-track over several months and this is expected to cause problems for the final target of monetary policy.

## Forecasting the autonomous factors

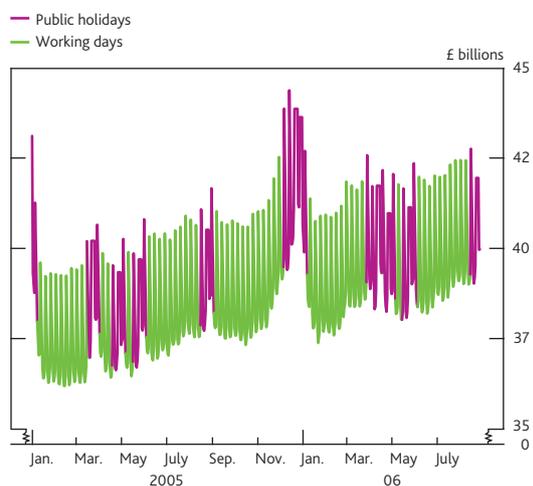
The items on the central bank balance sheet which need to be forecast are often referred to as the 'autonomous factors'. These are the items normally understood to be beyond the central bank's direct control. OMO clearly are within the central bank's control; and use of SFs is normally forecast as zero — though see discussion below. Commercial banks' current account balances is the residual item; the forecast needs to encompass everything else, though in practice it could ignore items that lead to offsetting changes and which do not impact banking sector liquidity (eg property revaluation might change an asset item and 'capital and reserves' on the liability side, but would make no difference to liquidity). More emphasis should, of course, be placed on forecasting items which are likely to show large changes. A large balance sheet item which never changes will not impact liquidity; and a very small item which changes by small amounts will not have much impact (though if there are a lot of such items, the cumulative effect could be significant).

For most central banks, the main three autonomous items which need to be forecast are cash (= currency in issue); net government transactions; and net foreign exchange transactions. These are explored in more detail below.

## Cash

There is normally a strong seasonal component to cash in circulation, even in countries with a developed financial system, where most savings and most transactions — by value, and in some cases by number — do not use cash (**Chart 1** illustrates strong seasonal pattern for the United Kingdom). In most countries, supply always equals demand, as cash is issued on demand, and central banks take back cash, via the banking system, if there ever is a surplus due to seasonal factors.<sup>(1)</sup>

**Chart 1** Daily data for notes in circulation in the United Kingdom, showing seasonal patterns



Source: Bank of England.

In a country with a developed financial system, the government will make little direct use of cash. Salaries for civil servants, pensions etc are paid by direct credit to a banking account. Any subsequent demand for cash — as people withdraw part of their salary (in some countries predominantly via ATMs if in cash, though most expenditure may be in a non-cash form) — will be subsumed into the cash demand management of the commercial banks. There is therefore no direct link in the forecast between government salary disbursements and cash in circulation; there will instead be a net government expenditure with a counterpart in commercial bank accounts at the central bank (covered in a later section here). If a significant part of the population is finance-constrained, then a peak in cash withdrawals may coincide with the payment of government salaries and pensions. The central bank would then need to monitor whether this happened; and if such a link changed over time eg with a move to non-cash means of payment, or with a reduction (or growth) in the finance-constrained proportion of the population.

(1) By contrast, coins are not normally taken back even if there is a seasonal surplus.

In countries with a less developed financial system, the government may pay salaries, pensions etc predominantly in cash. The exact route may vary for the cash flows: does the government collect cash from the central bank and deliver it to ministries etc? Or is cash sent to commercial banks around the country for disbursement? In general, there will be a close relationship between net government expenditure and cash in circulation; and no direct impact on commercial bank balances at the central bank, to the extent the government uses cash from the central bank, rather than bank accounts, to make payments. If the government starts to make use of direct credits to bank accounts, the relationship will change; but it may happen in stages over several months or even years (the banking system needs to be given time to gear up to a large increase in customers). And there may be changes in individuals' behaviour. In some countries, the first time a salary is paid into an account rather than in cash, all of the cash is withdrawn on day one. The next month, the beneficiary may only withdraw enough for a week or two. Over time, the individual may start to make use of non-cash payment services, or savings accounts at the bank. The transitional phase, which may last for quite a long period, will make forecasting harder.

In some countries, the government (and other groups) make payment by cheque; but the recipient encashes the cheque immediately — in some cases at central bank counters. Cash flow management might be easier if the central bank did not encash such cheques, but instead they had to be paid into accounts at a commercial bank. This might also encourage the beneficiary to leave some of the cash in the bank (where they can hold an account), whereas encashment at the central bank requires the full amount to be taken in cash. However, quick results should not be expected. For example, Ghana's Cocoa board has for some time made payments by cheque, but finds that these are encashed very quickly.

In some countries, forecasting cash demand will be affected by the level of dollarisation. 'Dollarisation' does not mean exclusively the use of US dollars outside the United States; it encompasses use of any non-domestic currency for transactional purposes. In some countries, there may be more than one such currency. The deutschemark, and subsequently the euro, have been widely used at times in central European countries which are not part of the euro area; the South African rand may be used in neighbouring countries. Afghanistan currently sees use of the US dollar as well as the Pakistani rupee and other currencies.<sup>(1)</sup>

Where a non-domestic currency is used as a substitute for the domestic one, the demand for transactional cash will clearly not be the same as the demand for domestic currency transactional cash. As long as the relationship between use of domestic and foreign currency is stable, this may not be a major problem. But if the relationship changes, then it will be

harder to forecast demand for domestic currency. The relationship may change if there is de-dollarisation, for instance if there is a growing level of confidence in the domestic currency, or if it is expected to appreciate against the dollar (or whatever the alternative currency is) in the near future; or it may change if there is an increase in the level of dollarisation, for instance if there is a perception that central bank behaviour may lead to an increase in inflation and consequently a weakening of the exchange rate. A process which accurately forecasts the total demand for transactional cash would not then give the right result for the domestic currency component. There is no simple answer to this problem. But it may make sense for the central bank to run periodical surveys to try to estimate how much domestic and foreign currency is being used — for instance, asking a sample group of shop-keepers every month or quarter roughly what percentage of transactions are denominated in which currency.

Multiple seasonalities may also be a major issue in forecasting a daily path for currency demand. The four main factors which need to be considered are:

#### Trend and cyclical growth

This may be in line with nominal GDP growth: a neutral assumption, in the absence of any other information, might be that demand for cash would be a stable ratio of nominal GDP. Or there might be a trend movement in the relationship observable over time. Increasing use of non-cash alternatives for payments will affect the relationship. Similarly, more widespread availability of ATMs may reduce cash holdings, by making it easier for users to replenish cash when needed.

#### Annual seasonality eg key festivals

Many countries find that there is increased demand for currency around key festivals, as people typically spend more money then. Some may be picked up quite easily: Christmas always falls on 25 December (except in some Orthodox countries), although it may be classed as a moving holiday because it falls on a different day of the week each year. Easter may be in March or April; and Ramadan is always earlier than in the previous year because of the use of a lunar calendar for its calculation. Moveable feasts will require some manipulation, as standard statistical programmes may not cope well with them.

In other countries, there will be a strong seasonality related to holiday periods: tourists, or spending related to seasonal remittances from abroad, may substantially increase the demand for cash at peak times.

(1) Use of non-domestic currencies also adds a layer of complexity to the forecast for note demand for those central banks who issue the notes used abroad, though not normally on a very short-term basis. The US Federal Reserve Bank has to take account of demand for US banknotes (including by denomination) in many countries around the world.

### Monthly seasonality

If government salaries, pensions etc are paid in cash, this may lead to a monthly pattern for cash demand. In some countries, for instance, cash in circulation rises towards the end of each month when salaries and/or pensions are paid, and then falls gradually until the same point in the following month.

### Weekly seasonality

Many countries find a clear weekly seasonality. More cash is withdrawn ahead of weekends, and returned to the central bank — via shop tills and commercial banks — on the first working day of the following week. This is sometimes known as the trading-day effect. In some countries the pattern is very strong; and it will be influenced by public holidays. Where wages are paid weekly — typically on a Thursday or Friday — this will also cause a weekly pattern in cash holding. Again, standard statistical analysis tools may not be able to cope well with weekly patterns, which run across month and year ends. But the central bank needs to forecast them.

### Forecast judgement and adjustment

As well as this analytical approach to cash demand, the central bank can also liaise with the major cash demanders (normally commercial banks, or maybe cash-handling security firm intermediaries) on their expected demand for cash over the next few days. The analytical forecast may indicate that there will be no net demand for cash over the next two-three days, but if all the major banks say they are sending lorries to collect more, the forecast team needs to be aware of this. A pooled forecast — combining the statistical forecast with information from note sorting and distribution centres — should be expected on average to generate a more accurate forecast than either of the individual inputs.

### Denomination forecasting

The demand for cash forecast will clearly be of use not only to the liquidity forecasting team, but to those responsible within the central bank for the printing of currency in circulation. They will need to ensure that sufficient notes of the correct denomination are printed and available to meet demand. The forecast for total demand, and the aggregation of the forecasts for individual denominations, are likely to differ to some extent.

Since this involves an industrial process, and for perhaps the majority of central banks worldwide involves shipping in notes from producers in other countries, some advance notice is required. But there is a cost to holding excess notes — storage costs, security, the risk that a particular series may be withdrawn from circulation before all stocks have been used — so central banks cannot simply over-order massively in order to avoid the risk of running short of notes.

### Government transactions

Most central banks say that 'net government transactions' is the hardest part of the forecast. One central bank noted that

its Ministry of Finance published forecast income and expenditure data on its website; but the numbers were simply unreliable. Others say that their Ministry of Finance is reluctant to release some data, claiming it to be confidential (though in some cases at least this appears to be code for 'We don't know either!').

In some cases, what the central bank needs to know, and the way in which the Ministry of Finance views data, may be rather different. The Ministry cares most about the budget balance, while the central bank cares about its liquidity impact (and of course any impact on demand and thus inflation). The Ministry of Finance may make use of commercial banks — whether state-owned or private sector — for substantial parts of its net transactions. This mixes transactions across the books of the central bank, which do impact liquidity, with other transactions which do not. If this is the case, then the central bank will need to persuade the Ministry of Finance that it is worth making some effort to obtain data in the form useful to the central bank. It might argue, for instance, that improvements in cash management by the Ministry of Finance will not only help to stabilise short-term interest rates and support financial market development (with spin-off benefits for the government if it borrows in domestic markets), but that it should also allow direct savings to the Ministry of Finance as it can then manage its funds more effectively.

Economic models may be useful in helping to forecast the government's budget flows on an annual basis, but cannot provide the short-term cash-flow forecasts needed for liquidity management.<sup>(1)</sup> However, the short-term projections of cash flow should be compared against the annual profile: they should give broadly the same picture over time.<sup>(2)</sup>

In general, expenditure is often easier to forecast than income, as it relies more on official decisions. A government department may decide on a particular expenditure and negotiate prices and payment dates — for instance, for a fleet of new ambulances, or for upgraded IT equipment, or additional teachers — and should have a good idea about how much will be spent, and when. But receipts against corporate income tax or duties on tobacco will reflect the aggregate total of company profits in the relevant period, or of the spending (or smoking) decisions of large numbers of people.

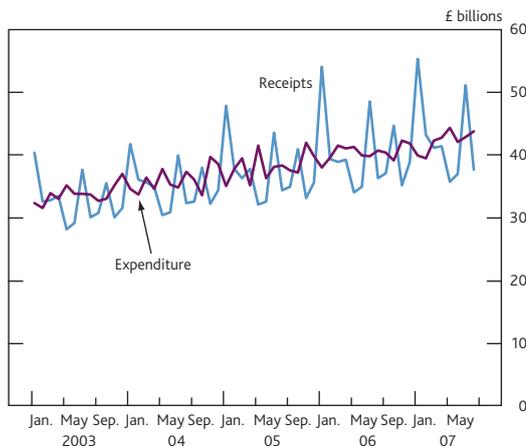
It may also be the case that the path for expenditure is smoother (less volatile) than that for income, and so easier to forecast.

(1) Even on an annual basis, some elements may prove hard to model. For instance, companies paying corporation tax may be able to offset past profits and interest payments against their taxable profits, reducing the aggregate tax yield; and the impact of these factors will vary through the economic cycle.

(2) These issues are covered in an article by Mike Williams which can be found at [www.mj-w.net/pdfs/ForecastingUKCashFlows.pdf](http://www.mj-w.net/pdfs/ForecastingUKCashFlows.pdf). His site also contains a useful note on government cash management, [www.mj-w.net/pdfs/williams\\_technote.pdf](http://www.mj-w.net/pdfs/williams_technote.pdf).

**Chart 2** tracks, on a monthly basis, UK government income and expenditure over a 4.5 year period. It is clear that the expenditure path is much smoother than that for income; though the seasonality of income items is probably easier to spot, with regular troughs and peaks. A central bank will want data with a higher frequency than monthly; but monthly is much better than nothing, and it may be possible to estimate a reasonable monthly pattern based on published data alone, or using data of transactions across accounts at the central bank.

**Chart 2** UK government flows, 2002–06



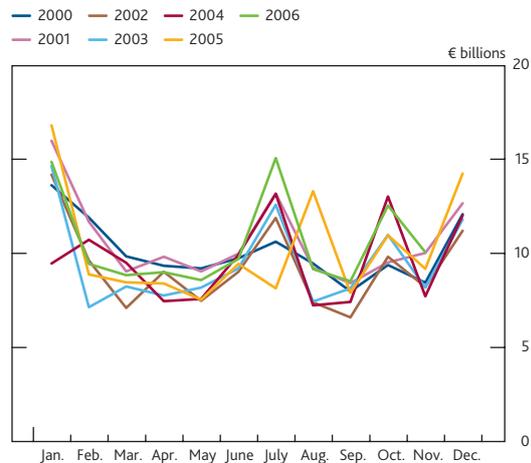
Source: ONS.

The pattern of a smoother expenditure path than that for income holds is probably fairly general, though not universal. **Charts 3** and **4** show much more volatile income patterns, but also a strong — and so reasonably predictable — seasonality.

In some cases, the pattern of expenditure and income appears less stable, but the net figure may nevertheless be relatively stable and predictable (see for example **Chart 5**). If it is the net figure that impacts the central bank's balance sheet — this will depend on whether all flows go through the central bank's books, and how the government manages the cash flow differences — then the central bank may be able to obtain useful information to support its liquidity forecast even in the absence of a precise forecast for the components of government transactions.

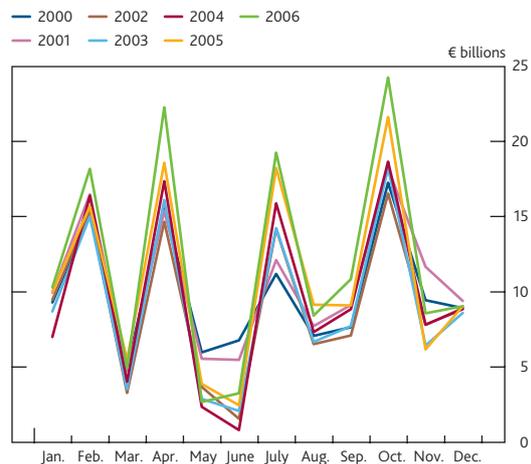
On the expenditure side, some items should be quite easy for the government to forecast. This is notably the case with staffing and pensions, since each department ought to have good records of how many staff it employs and at what salary levels; and the day of the month of salary payments are normally pre-determined.<sup>(1)</sup> Information on normal salary payment dates will allow a within month pattern to be imposed on monthly payment flows.

**Chart 3** Spain — seasonal patterns in government flows



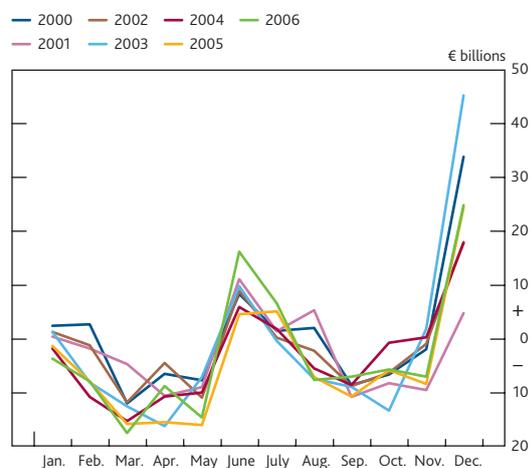
Source: Thomson Datastream.

**Chart 4** Spain — seasonal patterns in government revenue



Source: Thomson Datastream.

**Chart 5** Italy — seasonal patterns in net government income



Source: Thomson Datastream.

(1) Though one West African central bank suggested that many staff would be happy to be paid in the right month, let alone on the correct date.

Expenditure on major one-off items should also be known reasonably accurately some weeks in advance, and accurately at least a few days in advance. It should be possible to instruct ministers and senior civil servants that authorisation of any payment above a certain level (X million currency units, or Y% of the budget) must be pre-notified to the Ministry of Finance treasury management unit. It may even be that such pre-notification is already required for budget management purposes, and what is needed is simply to copy the information to the Ministry of Finance treasury/cash management unit.

If, for example, wages and salaries (including civil servants, hospital staff, military, pensioners and teachers) account for 60% of expected payments; and large one-off payments on known dates are expected to account for another 10%, then the forecast could start with the total monthly expenditure (using a known seasonal pattern<sup>(1)</sup> and budget data); input estimates for salaries and one-off payments on the known dates; and spread the remaining payments evenly — eg around 1.5% of total monthly expenditure on each working day of the month. For a given two or four week reserves maintenance period, this may be reasonably accurate.

On the income side, accurate forecasts may be harder. But as indicated above, there may be some key dates and/or strong seasonality that can be used to help. For instance, corporate tax in many countries is due on a certain date each quarter. Income tax due from individuals may be received (or at least due) on a particular day of the month. The central bank might observe from examination of the relevant government accounts held at the central bank that X% of the expected income is usually paid on those dates, and that Y% is normally spread over the following few days. Economic development since the last budget might lead the central bank to adjust the total expected tax payments for the relevant period. This will assist it in converting a budget forecast for quarterly corporate tax income into a cash flow forecast for specific days in the future.

As with expenditure items, large income flows expected on particular dates can be entered into the forecast, and other flows spread evenly through the forecast period.

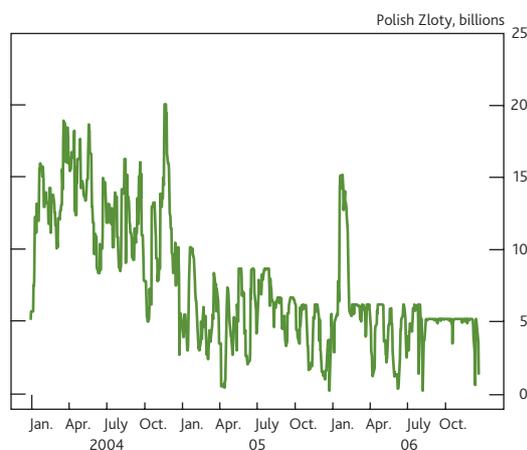
The ECB publishes on its website some institutional arrangements by country — see Annex 3 for an example of this. This indicates that in some countries government net flows across the books of the central bank do not cause any forecast problems,<sup>(2)</sup> while in others they can be both large and hard to forecast. To a large extent this will depend on institutional arrangements. For instance, if the government uses commercial banks for the majority of its banking transactions, both for holding cash balances and for making payments, these flows will not impact market liquidity and so do not need to be captured by the forecast. Such a practice

does give rise to potentially tricky issues for the government, but can make the liquidity forecast easier. Issues include:

- Should the government use all commercial banks, or just a few? How does it choose? If it stopped using a particular bank because of concerns about creditworthiness, could this cause the bank to collapse?
- If there are state-owned banks, or dominant banks in general, should the government use the state-owned and/or large banks, which are possibly the strongest and have the largest branch network; or would this preserve their dominance and so prevent a growth in competition?
- Should the government ask for collateral if it is keeping large balances with commercial banks; and if it does so, how might this impact secondary market liquidity for eligible assets?

Some central banks set a limit either on the government's balance with the central bank, or on short-term fluctuations in the balance eg France and Poland (**Chart 6**).

**Chart 6** Poland — government deposits at the central bank



Source: National Bank of Poland.

The UK government tasked its Debt Management Office with cash management as well, from 2000 (see Annex 4). Cash management is distinct from (longer-term) debt management, in that the former is necessary even if the government has a balanced budget and no debt (since income and expenditure will not be matched on a daily basis); while the latter need not be affected by short-term uncertainties in cash flow, but instead is driven by longer-term budget planning. Cash management is a treasury function, and still requires an accurate and timely forecast of government flows to be

(1) The seasonality for salaries and pensions may be different to that for other items. If the two can be split out, this should allow for a more accurate forecast.

(2) In some cases this is because the flows are small, with most government transactions going through commercial banks rather than the central bank.

produced, as well as some form of dealing-room transactions to manage cash on both a very short-term and on a medium-term basis. But when conducted effectively, it means that the government net transactions across the books of the central bank are very small on a day-by-day basis. This substantially facilitates the central bank's task of liquidity management.

### Government guarantees

Some governments find it hard to forecast cash flows relating to guarantees given to local government, state-owned enterprises or other state-supported bodies. This raises three issues:

- If the government is fully guaranteeing a loan by another state body, it may make more sense for the government to borrow from the markets, and on-lend as necessary to that state body. By reducing the number of issuers, and bringing the borrowing into the ambit of the government's overall debt management strategy, total borrowing costs should be reduced and market liquidity improved.
- If central government, or government departments, do give guarantees, it is essential that proper procedures are followed. This would include: guarantees only to be given by duly authorised bodies, and following agreed procedures; and information on such guarantees to be reported to the Ministry of Finance so that central government has unified and complete data on the amounts and timing of any payments guaranteed.
- On an ongoing basis, regular (eg quarterly) reporting should be provided on financial developments by any body which has received a guarantee, so that central government is not caught by surprise if a guarantee is called; and *ad hoc* reporting by any body in receipt of a guarantee if there is a deterioration in its financial position which might lead to the guarantee being called.

In some countries where government guarantees are given, none of the above holds true. The Ministry of Finance may need to be pro-active in seeking out information, in establishing proper procedures, and possibly in refusing to cover any 'guarantee' which has not been properly authorised (this would give an incentive to lenders to be more cautious, and to ensure that central government was kept informed).

Guarantees may be given for foreign exchange loans rather than domestic currency. This could lead to unexpected changes in net foreign exchange assets as well as government balances; but may mean there is no impact on domestic currency liquidity held by commercial banks (the fall in net foreign exchange assets could be offset by a reduction in the government's deposit at the central bank).

### Net foreign assets

If the central bank's exchange rate policy is genuinely for a free floating rate, the forecast for net foreign exchange transactions may be close to zero. The central bank will make occasional foreign exchange transactions on behalf of the government and other customers, but otherwise may not need to buy or sell foreign exchange. However, this situation is relatively unusual in practice.

If the central bank operates a T + 2 settlement for foreign exchange transactions, at least the very short-term forecast should be easy, since it will have two days' notice of a transaction before it impacts on domestic currency liquidity. Some differentiation may be possible: the central bank could adopt a policy of T + 2 settlement as a rule; but allow or insist on T + 0 (if settlement issues do not prevent) for SFs using foreign exchange, or fine-tuning OMO (where the central bank particularly wants to impact liquidity conditions today).

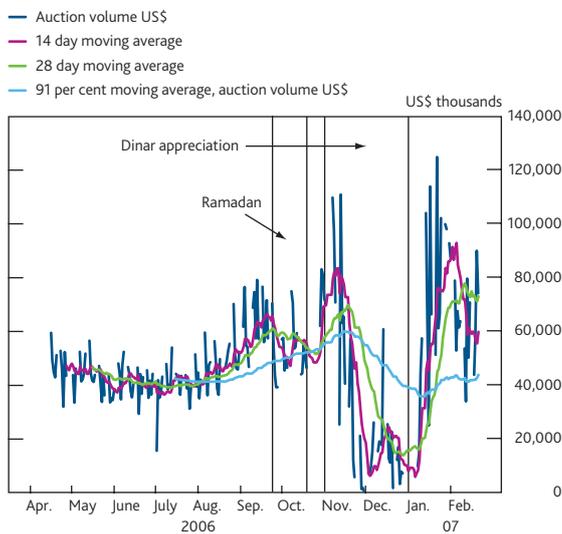
If the central bank has an exchange rate target, it may have little control over foreign exchange transactions, at least in the short term, although it may be able to forecast a trend. This relates to an important difference, from the point of view of liquidity management, between using an interest rate and an exchange rate tactical target. In the former case, the central bank can change the price/interest rate without needing to vary the volume of injection/withdrawal of domestic liquidity; but in the latter case it may need to vary the volume bought/sold in order to achieve the price target. This point is illustrated in **Chart 7**, showing the volume of US dollars sold by the Central Bank of Iraq in its daily foreign exchange auction.<sup>(1)</sup> There is clearly some seasonality in demand eg ahead of Ramadan. Increased consumption during Ramadan has an impact on net imports (to the extent consumption goods are imported) and thus on demand for foreign exchange. (There will also be an associated seasonality in cash demand.)

More strikingly, in the last two months of 2006, when the central bank tightened monetary policy by appreciating the dinar by around 10% against the US dollars, the volume of sales reacted very strongly. The broad direction of the reaction was predictable: while the currency was appreciating, banks and their customers would want to hold on to dinar balances for as long as possible, in the expectation of buying US dollars more cheaply later on; and once the expected appreciation was largely complete, they would unwind their positions — so the volume of net sales fell sharply until the appreciation was largely complete, and then rose above longer-term trend levels for a period. But it seems unlikely that the central bank could have maintained the exchange rate ahead of Ramadan without varying the volume of its sales in line with market

(1) The origins of the CBI's foreign exchange auction are described in 'A new currency for Iraq', published by Central Banking Publications in 2005.

demand, or that it could have engineered an appreciation of the exchange rate without prompting a change in the volume of market demand.

**Chart 7** Iraq — FX auction volumes



Source: Central Bank of Iraq website.

From the point of view of liquidity management, this meant that the policy of currency appreciation resulted in large changes in domestic currency liquidity; whereas a parallel policy of increasing official interest rates would not necessarily have any impact on liquidity.

In the short term, this need not be a problem. While domestic currency liquidity may increase in a way that is not fully predictable, if it is increasing because of a change in demand, it may be reasonable to assume that the two offset each other. The change in domestic currency balances does not necessarily imply a change in the volume of excess liquidity. Even if in general the central bank's balance sheet is asset driven, the particular case described above reflects a liability-driven change. In the short term at least, this may not require a central bank response.

If there is strong exchange rate pressure, it will be impossible for the central bank to forecast future purchases or sales accurately: the market is too unpredictable in times of stress. But under normal conditions — for instance, the first four months transactions in **Chart 7** — the central bank may be able to forecast reasonably accurately the market's net demand for foreign exchange. It will not be able to do so on a daily basis, since there are too many factors that affect very short-term demand. But it may observe trends in market demand. For instance, it may find that there are regular seasonal patterns. In some countries, imports rise ahead of key festivals, and this will impact the timing of demand. In others, export receipts for major items may be remitted on certain known days; or there may be a seasonal pattern to

sales.<sup>(1)</sup> If the central bank can detect seasonal patterns, and impose these on underlying trends in demand, it may obtain a reasonably accurate monthly forecast for net foreign exchange demand. In some cases, liaison with commodity exporting bodies (in many countries, commodity exports are handled by a centralised institution) may provide the central bank with useful information on the likely timing of future flows.

It will also be useful for the central bank to understand what drives imports. To the extent that marginal imports are a response to changes in export earnings, then whether exports increase or decrease, the net demand for foreign exchange may be stable over time. The central bank will need to understand the lags involved — for instance, 75% of an increase in export revenues may feed through to import demand from one to three months later. Timely information on exports will help to forecast changes in net foreign exchange assets in coming months. But it is also possible that imports may be funded by bank borrowing. In this case, changes in bank lending may be a lead indicator of changes in imports, and thus in the market's demand for foreign exchange.

One might conclude that if foreign exchange operations are intended to influence the exchange rate, the price is (more or less) under the control of the central bank, but the volume will be determined by the market. They should therefore be treated as an autonomous item in the liquidity forecast. But if the transaction is not expected to influence the exchange rate, the volume is more likely to be controllable by the central bank, and should therefore be grouped with monetary operations — whether OMO or SF — in the liquidity forecast. Examples of this type of operation would include:

- The Bank of Mexico regularly sells foreign exchange, in order to reduce the rate of growth of its foreign exchange reserves and the counterpart increase in domestic liquidity. The volume of sales is determined by net purchases of foreign exchange in preceding quarters, and the daily volume to be sold over the coming month is pre-announced. As the policy is clear and the volumes pre-announced, and because the market is deep, the actual sales do not impact the market exchange rate; and the volume is fully controlled by the central bank.
- Foreign exchange swaps are used by a number of central banks. Their usefulness will vary depending on whether there is a surplus or a deficit of liquidity in the market, and on the level (if any) of dollarisation in the economy. But since they do not affect the underlying exposure of the market to foreign exchange, they should not affect the market exchange rate.

(1) Weather will affect seasonal demand for oil and gas, and thus revenue for export/expenditure on import. Some crops have a clear season eg coffee beans; while others do not eg bananas.

## Float

*'Households and businesses make a significant portion of their payments by writing checks on their accounts at (banks). The Federal Reserve's national check clearing system facilitates the movement of these checks around the country. The Reserve Banks credit a bank's reserve account at the Fed for checks deposited — presented for collection — by the bank and debit its account for checks drawn on it and presented by other banks. When a presenting bank's reserve account is credited before a corresponding debit is made to the account of the bank on which the check is drawn, two banks have credit simultaneously for the same reserves, creating reserve float. This float arises because Reserve Banks credit checks presented for collection, under a preset schedule, to a bank's reserve account ..., while it sometimes takes (longer) to process those checks and collect funds from the banks on which they are drawn.'*<sup>(1)</sup>

For some central banks, the size of the float is important; and it may vary because of seasonal factors:

- More cheques will be written at times of higher expenditure eg ahead of key festivals, notably Christmas; and higher volumes can increase processing delays.
- More cheques are likely to be banked on the first or second working day of the week (it may take a day for cheques to be paid in to commercial bank branches and then passed on to the cheque clearing centre): higher volumes can increase processing delays.
- Where cheque clearing involves the physical transportation of pieces of paper, bad weather may cause transport delays and so increase the float.

The Fed has introduced certain incentives to discourage banks from increasing the float deliberately; more information can be found on the Fed's website.

For a given size of float, it is possible that unexpected payments towards the end of the day could cause problems for individual banks in managing their liquidity, with an impact on the assessment of the overall position of the market. In the United Kingdom and many other countries, cheques (and ACH type<sup>(2)</sup> payment) transfers involve a large number of relatively low-value payments. The net daily debit or credit position is normally small compared to the overall payment flows managed by banks. Large payments are made via the Real Time Gross Settlement (RTGS) system. But if banks are allowed to, or do, make large-value payments by cheque; and if cheques can be paid in late in the day; then a small bank may find itself the recipient of a large credit on its central bank account too late in the day to re-channel the money to the market. One central bank noted that a small bank can find that the size of credits from late, large cheque payments can

lead to a commercial bank exceeding its reserve target the whole maintenance period well before the end of that period.<sup>(3)</sup> The central bank has to take account of this when forecasting the overall demand for reserves.

The question of the float does not arise in all countries: the structure of the payment system may make it irrelevant. For example, in the United Kingdom, cheque clearing is handled by the commercial banks, and the clearing system reports net debit and credit positions to the Bank of England each day. Since these always sum to zero (one bank's credit is another bank's debit), no float is created when the net payments are effected across the central bank's books.

## Taking account of known transactions

Some transactions are known in advance, and do not need to be forecast; but they do impact liquidity and so must be included. These are:

- The unwinding of any past OMO or SF transactions. If the central bank lends funds to the market for two weeks, it knows exactly when the repayment is due, and how much it will be. Or it drains liquidity by issuing a 182 day bill, it knows exactly what the repayment will be. These should be included separately to future OMO — that is, OMO undertaken in response to the current forecast — in order to avoid any confusion.
- Repayments of interest and principal on any government securities held by the central bank. These will appear twice in the forecast: they will (or at least should) be part of the forecast of government net transactions, where they will reduce the balance in the government's account at the central bank. Principal repayments will also reduce central bank assets (the balance sheet shrinks), while interest payments will increase P&L, on the liability side (the balance sheet does not shrink).
- Any dividends or other profit remittance to the government. These will be infrequent, but could be substantial when they happen. The forecast must include them; and a mechanism may need to be in place to ensure that irregular, infrequent payments such as these are not forgotten.

## Forecasting demand for liquidity

It was suggested earlier that if banks hold either too much or too little liquidity, they will respond in a way which may be detrimental to the central bank's goals. The definition of the 'right' level of liquidity needs to take account of any reserve

(1) Taken from a US Federal Reserve Bank paper on reserves management. More information on the float in the United States can be found on the New York Federal Reserve Bank website at: [www.newyorkfed.org](http://www.newyorkfed.org).

(2) ACH: Automated Clearing House — a system used to clear bulk retail payments.

(3) Sometimes these are referred to as 'burnt' reserves.

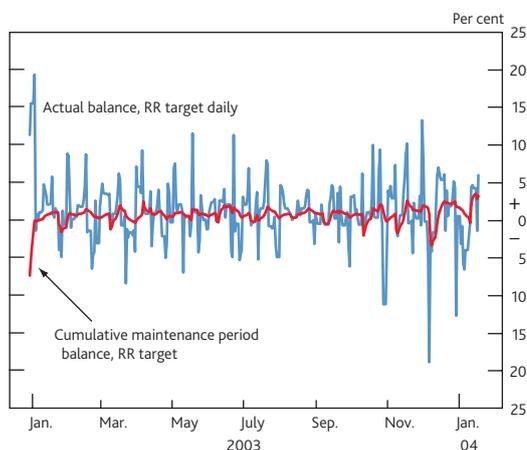
requirement set by the central bank (and perhaps also of any liquidity ratios imposed by banking supervisors, which may be a different part of the central bank, or a different institution altogether as in the United Kingdom); and also of the banks' demand for liquidity. One African central bank (with a reserve money target) noted that while their calculations showed the banking system to have excess liquidity, the banks themselves said they were short. If the central bank wishes to avoid spikes in interest rates which result from short-term fluctuations in demand, it is in most cases essential that bank *demand* for liquidity be understood and forecasted, as well as the autonomous ('supply') factors.

It is important to bear in mind that the trade-off which banks may make between the cost of holding liquidity and the benefits of having it (less risk of paying penal rates for emergency borrowing etc) may not be the same as that of the central bank.

In the euro area, banks have to meet a reserve requirement of 2% of liabilities, on average over a one-month period. This represents far more liquidity than the banking system needs for payments purposes, and the ECB can therefore assume that on virtually all occasions banks will want to meet the requirement (because there are penalties for failing to do so), but will not demand additional liquidity.

**Chart 8** shows the daily level of reserves in the euro system compared with the target level, for 2004. The vertical lines indicate new maintenance periods. It can be seen that the actual level of reserves on any day rarely diverges by more than 10% (ie 20 basis points of the 200 basis point target) from the target average level. The red line is a moving average of reserve holdings, and illustrates that average reserves are always very close to target by the end of each maintenance period.<sup>(1)</sup>

**Chart 8** Euro area — RR compared with target (2 per cent)



Source: European Central Bank website.

If the level of reserves held voluntarily exceeds any reserve requirement, then it will clearly not be sufficient to provide enough liquidity to meet the requirement exactly: demand has to be forecast. This is true of the United States, where reserve requirements are not a binding constraint on many banks; and of Australia and Canada, where there are no reserve requirements. In the United States, reserve requirements and additional working balances are not remunerated<sup>(2)</sup> (this may change from 2011), and banks have an incentive to hold balances as low as possible, an incentive which increases as official rates rise and *vice versa*:

*'Historically, both reserve requirements and clearing balance requirements have tended to move inversely with short-term interest rates... A decline in total requirements challenges banks by limiting their flexibility in distributing balance holdings over a maintenance period consistent with meeting their total requirements over a maintenance period. Experience suggests that there is some level of aggregate balances necessary to maintain liquidity in the reserves markets. As the amount of available balances falls below this level, the risks of a spike in fed funds rates in late-day trading and sizable borrowing from the discount window increases significantly.'* (Domestic open market operations during 2006, FRB, New York February 2007.)

Note that 'as low as possible' will have a different meaning for commercial banks and the central bank. For the former, the goal is to minimise the cost of holding sufficient balances to meet payment orders. For the latter, the goal is to provide sufficient liquidity to avoid disruption to the payment system and to keep short-term rates stable at or close to the policy rate (where this exists).

There may be an average amount of liquidity demanded by the market, which will be influenced by seasonal factors. But there will also be certain individual days when more liquidity is demanded, for instance if there are large tax payments due, or a large transaction (a securitisation, or a bond launch), or around certain month ends when banks want to be able to present larger liquid balances on their balance sheets; or simply a large volume of payments — eg around Christmas — when payments flow uncertainty is higher for individual banks. There is some evidence that the so-called 'martingale' property, which assumes that arbitrage will make banks indifferent between a holding of reserves on any given

(1) Reserve balances in the euro area are normally a fraction of a per cent above target, as many small banks in particular find it more cost effective to hold some excess reserves, than to set up the systems that would be required to manage them more exactly. The same phenomenon is observable in the United States, where excess reserves, held mostly by small banks, run at around US\$1.5 billion.

(2) Working balances above reserve requirements ('contractual clearing balances') gain credits which can be used to pay for services provided by the Federal Reserve system; but this is significantly less than the cost of holding such funds, especially if official rates rise.

day of a reserve maintenance period, does not hold in practice.<sup>(1)</sup>

In Australia, as (voluntarily held) reserves balances are remunerated at 25 basis points below the policy rate, banks are willing to hold a certain level of reserves — the cost of holding is much lower than in the United States — and on most days, the voluntarily held level of liquidity is sufficient. But there are some days when demand increases — for the same reasons as in the United States — and the Reserve Bank needs to be aware of these in order to supply the additional liquidity and avoid spikes in rates. This sort of forecast requires some general knowledge — it may be observed that at certain times of year the demand for reserves is higher/lower than average; but also specific information from the market about its needs on particular days, some of which may be one-off. The central bank needs to talk to the market to obtain this information.

Where there is excess liquidity, and the central bank does not drain it all — so that very short-term market rates tend to hover around the deposit SF rate (or zero, if there is no deposit SF) — it may be tempting to assume that the banks will always have enough liquidity. This may be correct on most occasions, but not on all. There is a benefit to the central bank in trying to forecast the occasions of shortage, especially when the credit SF is viewed as expensive (in some markets it is several percentage points above the 'policy' rate, and even further above short-term market rates). If some banks try to avoid any need of access to the SF, they may hold on to excess, precautionary reserves rather than lending them to other banks even when there is demand. This would particularly be the case for banks which do not hold a substantial volume of assets eligible for use in the central bank's credit SF (perhaps because the list of eligible assets is narrow; or liquid asset requirements mean banks cannot dispose of them freely). This will inhibit proper functioning of the market and can damage financial sector development, and points to a benefit of forecasting peak liquidity demand even under conditions of generalised surplus.

In both cases — a shortage of liquidity and non-binding reserves; or a surplus of liquidity — the banks could presumably choose to target higher levels of liquidity holdings overall. But they may judge that the overall cost of holding extra balances which would rarely be needed exceeds the cost of having to access the market or SF borrowing on the rare occasions of need. If the central bank wishes to avoid spikes in market rates around these — often very short-lived — occasions of higher need, they have to be able to forecast them, and also to have the tools to respond to them.

## Improving the quality of forecasts

### Good data

Central banks are continuously striving to improve the quality of their forecasts. Depending on the starting point, this may involve:

- Obtaining accurate base data: is the central bank's balance sheet available daily? Weekly? Only monthly with a lag? If the forecasters do not have an accurate and up-to-date starting point, it will be harder to produce an accurate estimate of future changes. In some countries the lag in producing balance sheet data can be several days, or longer. This does not mean that the forecast team needs to wait that long before having an idea of what is happening. It is normally possible to obtain reliable data for certain balance sheet items early — commercial bank balances, government balances, changes in foreign exchange balances.<sup>(2)</sup> In some countries, there is a lag in obtaining full data from all of the central bank's branches. Can Head Office data be used as a proxy? An analysis of past relationships between Head Office and total data will give an indication of this.
- Some data may be available within the central bank, but not necessarily available to the department producing the liquidity forecast. It is important that available data be disseminated quickly.
- Rigorous analysis of errors on as detailed and precise a basis as possible is an important part of the forecast process. As with inflation projections, it is more likely than not that the forecast will be inaccurate: the task is to start with what is possible and aim to improve. If the reasons for inaccuracies can be understood, this should help to correct them. If the reasons are not clear, it may still be possible to identify if there is a standard bias, and make allowances for this. It can also be useful to the operational team to know how accurate forecasts tend to be: is the forecast for a surplus of 100 million currency units accurate within 5 million, or is it really for a surplus of anything between 70–130 million? This may affect the decision on maturity of operations. For example, the uncertain element could be drained on a short-term basis, rather than a long-term drain which might need to be unwound if the forecast is inaccurate.
- Where cash is important, regular surveys of behaviour of users might help in understanding trend changes, for

(1) For instance, Hamilton (1996), *The daily market for federal funds*. There is 'overwhelming evidence against the hypothesis that the federal funds rate follows a martingale over the two-week reserve maintenance period, establishing that banks do not regard reserves held on different days of the week to be perfect substitutes'. See also Bartolini, Bertola and Prati (1999), *Banks' reserves management, transaction costs and the timing of Federal Reserve intervention*.

(2) It may be easier to obtain data for net foreign exchange sales — flow data, which the dealers should know same day — than a full revaluation of net foreign exchange assets (stock data); but as it is the flow which impacts on liquidity, this is all that is needed.

instance in de-dollarisation, or changes from use of cash to non-cash alternative means of payments (cheques, direct credits etc).

- In the United Kingdom, HM Treasury uses financial incentives to encourage major departments to produce an accurate forecast. If the department's cash-flow forecast — measured on a daily basis — falls outside pre-determined margins of error, the department is fined. Money collected from the fines is distributed back to departments, benefiting those which produce a more accurate forecast. The size of the fine relates to the notional cost to the cash management team of such errors.

### The forecast team

How many people should be involved, and with what skill sets? Directly or indirectly, a large number of people will be involved in the forecast. For instance, if a good forecast of net government transactions is to be obtained, reporting will be required at many different levels of all departments. Many people in the banking and accounting departments of the central bank may also have some input. But for most of these people, the forecast is not a full-time or major role.

As a minimum, pulling together the various strands of data, checking them and keeping them up to date, could be a major role for at least one person, with ideally a fully-trained backup. How many are needed in the team will depend in part of the importance of the various autonomous factors and the need to forecast demand for liquidity. A regular second member of the forecast 'team' is also helpful in ensuring that the forecast data are checked. If a lot of data are being assembled, it is always possible that an incorrect number will be entered ('straight-through' processing of all input data is unlikely), or that a number might be omitted or entered with the wrong sign. Having someone available to check the data, albeit quickly, can help to pick up such errors.

Cash demand could be estimated very simply, with a spreadsheet-based extrapolation of past data, assuming the same weekly and seasonal patterns. But if the cash forecast is an important part of the forecast — for instance, if changes in cash demand constitute a significant proportion of the net liquidity fluctuations — then a much more sophisticated approach could be taken. This might require an additional person, and that person would need strong mathematical skills. Even with very well-established and clear procedures, errors will arise. For example, with cash forecasting the two main errors are wrong input data (wrong size and sign) and failure to check the pattern. These errors are most likely to arise if the job of forecasting cash becomes routine and concentration weakens. If the forecast is run by junior staff, it must be checked and signed off by senior staff to reduce the risk of such errors.

If the government is persuaded of the benefits of liquidity management, it may devote a number of its staff to forecasting its own cash flows. In the United Kingdom, a team in the Ministry of Finance co-ordinates information with staff in all of the major spending ministries, on a daily basis, in order to elaborate a reliable forecast. Altogether, perhaps 20–30 people might be involved as a substantial part of their job. This in itself is important: people are more likely to prioritise their key responsibilities than to give time and energy to minor tasks which have been added on and in which their own management takes little interest. The United Kingdom has also devised a system of rewarding departments which produce an accurate forecast, and penalising those who do not, as a further incentive to accuracy. Some of these people will need to have a good grasp of accounting and budget procedures; all will need to be good enough with numbers to be reliably accurate. But if the Ministry of Finance does not provide reliable forecast data, the central bank may need to make its own estimates, based on published budget data and detailed daily information available from the Ministry's accounts at the central bank.

Net foreign exchange movements may require some input from foreign exchange dealers. It is unlikely that a daily forecast could be elaborated in as sophisticated a way as cash forecasting: short-term fluctuations in wholesale demand for foreign exchange — which depend on a wide range of different factors — could easily swamp the more regular pattern of retail demand. But some mathematical analysis of market demand could be conducted, requiring the appropriate amount of time and technical skill; and it may be possible to identify longer-term trends and seasonality, and links to the forecast level of economic activity (which the central bank will be forecasting for other purposes). Likewise, forecasting the cash float, in countries where this is important, will require some technical skills in picking out clear seasonal patterns, and knowing how to make adjustments for public holidays, weather etc.

If a longer-term forecast is to be undertaken, whether for monetary policy purposes, or to estimate what the balance sheet might look like in twelve months time or more, a different level of skills — macroeconomic forecasting skills, in particular — may be required. Building such behavioural models is data intensive.

Finally, it will be useful, if not essential, if some people in the forecast team are outgoing and good communicators. Much of the forecast relies on obtaining good and timely data from other departments, from government ministries and from commercial banks. Someone with good people skills is likely to be more successful than a different person who is non-communicative, unthankful or even rude!

## Where in the central bank should the forecast team be located?

Is the forecast a job for the operational desk, or banking department, or research? Practice varies among central banks. Some have chosen to move the function of the daily liquidity forecast into the markets/operational area of the bank, as this is the area which uses the information. It seems reasonable that the area which uses it should be able to decide how the forecast is structured, and what level of resources to devote to it. For instance, the operational area may benefit from employing a skilled mathematician to improve the cash-demand forecast; but if another part of the bank is responsible for it, they may not want to bear the budgetary cost of so doing. On the other hand, if the skilled mathematician only uses 20% of his/her time for the cash forecast, it may be better for this person to be in the Analysis/Research Department which can make good use of the remaining 80%.

If a longer-term forecast is constructed, this could be handled by the research/macro-economic team, as it will involve economic, perhaps econometric skills and match well with other work undertaken in that area. The longer-term forecast will still be useful to the operational team — for instance in deciding on the maturity of operations — but they will not rely on it on a day-by-day basis.

Some central banks take the view that the short-term forecast gives rise to policy decisions regularly: operations cannot simply respond to the forecast on an automatic basis, since — for instance — the size of the surplus may raise questions of affordability of liquidity management. They argue that the forecast team should therefore be close to the policy area of the bank.

It is certainly very important to be aware of the distinction between an operation which is largely automatic and carries no policy signal, and an operation which does include an element of policy (for instance, a decision to let short-term rates fall rather than drain all the surplus liquidity); and to ensure that policy decisions are taken consciously and at the appropriate level. This also begs the question as to how such 'reactive' policy decisions are communicated to the market, if at all. But it does not, in itself, determine the location of the team which compiles the forecast. Rather, it determines the decision path for operations undertaken on the basis of the forecast.

Regardless of the location of the forecast team, several different areas of the central bank will have to provide input into the forecast. It is important that they are at least aware of the purpose of the forecast. If other areas, or even more so government departments, view requests by the forecast team as 'yet more pointless data demands', they may not in practice give it the same care and attention, or deliver as promptly, as if

they appreciate that the forecast is used to support the central bank's monetary operations. The forecast team could undertake periodic seminars to explain to colleagues how the data is used and what for.

## Publication of the forecast

Should the short-term forecast be published? And if so, how frequently, and with what level of detail? Here it may be useful to consider the question from the point of view of the market, since the central bank itself clearly gains no new information by publishing (unless there is a strong market reaction to a particular forecast, but this would be unusual).

The key question for the market will be: is the market long or short of liquidity? And what operations will the central bank undertake as a result? Treasurers in commercial banks are unlikely to care much about the composition of the forecast — which of the autonomous factors are driving the net change in liquidity? — since this will not make a difference to their behaviour. The Bank of England splits the forecast into changes in cash in circulation, and other autonomous factors (in the past more detail was published). The ECB publishes a single figure for autonomous factors. The US Fed does not publish a forecast at all. Some central banks do not publish because they do not judge their forecast to be of good enough quality. Some central banks are reluctant to publish data about short-term changes in their foreign exchange reserves. Publication of a single figure for the net change in autonomous factors can safeguard this information.<sup>(1)</sup>

In general, it may be useful to an individual treasurer to know how his position compares with that of the overall market. For instance, if a treasurer is short of liquidity, and knows that the market as a whole has a surplus, he may try to borrow funds in the market; but if he knows the market as a whole is short, he may wait until the next central bank operation, rather than trying to borrow when conditions are difficult. The treasurer is asking the question: are the funds, or is the demand for funds, out there in the market?

On days on which the central bank is conducting an operation, there are additional questions: is the central bank aiming to bring the market back to balance in its operations, and is there any signal to be read into the central bank's actions?

The Bank of England and the ECB both operate with a one-month reserve maintenance period, and conduct regular OMO once a week. Ahead of the operation, they publish a forecast of the forecast volume of lending required in order for the banking system as a whole to maintain reserves at the

(1) If net government transactions across the central bank's books are expected to be close to zero, and the market can produce a reasonable forecast of cash demand, it might be able to imply a figure for net foreign exchange reserves movements; but it would not be confident about this unless the figure were very large.

targeted average level for the coming week; and in normal conditions they aim to lend exactly that amount. In doing so, they affirm to the market that there is no monetary policy signal in the volumes being provided: the central bank is simply accommodating forecast aggregate demand. If the forecast is accurate and the market believes it to be so, there will be no expected use of SFs, and market rates are likely to reflect the policy rate. Although the operation is essentially accommodative, the forecast is necessary since the market does not know what the autonomous factors will be, and individual firms do not know how others will bid. There will normally be excess demand in bidding at the OMO, and if the central bank satisfied all bids in full, it would in fact be providing excess liquidity (or draining too much, if the operation were in the other direction). This would probably lead to use of SFs — whether to deposit the excess or borrow to cover the shortage created — with a consequent impact on market interest rates after the OMO operation.

The logic in publishing the forecast only as far out as the next OMO (ie up to one week, in the case of the Bank of England and the ECB) is that the operation is only intended to balance liquidity for this period, and the forecast further out is less certain. If the central bank conducts OMO every day, it could publish the forecast simply for the current day.

If the forecast is not published, but the central bank aims to meet aggregate demand, and the market expects it to do so, the impact should be broadly the same as if the forecast were published — to the extent that a published forecast, when compared with OMO results, confirms the stated policy of accommodative operations. That said, there is still a benefit to publishing, as it allows the participants to gauge their likely transactions volumes with the central bank. Moreover, if there is a seasonality in the scaling — if overbidding is higher at particular points of the year — then publication of the data can help market participants to gauge their bids more accurately.

If a forecast is published and the central bank lends a different amount, this could — intentionally — be used to send a signal to the market. For instance, in 2006 both the ECB and the Bank of Canada found that market rates were diverging from the policy rate (too high in the case of the euro area, too low in Canada). These central banks adjusted the amount provided away from the forecast (over-lending and under-lending respectively) in order to influence market rates, and made this clear to the market.

If there is a surplus of liquidity in the market which the central bank does not intend to drain fully, then publishing a forecast would send a clear signal to the markets, and would be expected to push short-term interest rates down to the SF level. A very similar result is likely if the forecast is not published; but the market will be more uncertain about conditions, and this could lead to more rate volatility and a

greater reluctance at times to participate in the interbank market.

Examples of liquidity forecasts can be found in Annex 2.

## Using the forecast

The accuracy of the forecast, and its use (central bank OMO) can be enhanced if the behaviour of the various items is well understood.

- An excess or shortage of liquidity will be expected to affect interest rates, and perhaps indirectly the exchange rate. Does this happen? It may be possible to use developments in market rates as a check on the liquidity forecast: if rates are moving unexpectedly, might this indicate that the forecast is wrong? It should also be possible, over time, to analyse the relationship between divergences from the targeted level of liquidity, on the one hand, and short-term market rates on the other. This will help the central bank to have a better picture of the demanded level of reserves, and the thresholds which typically trigger a market response.
- Do changes in demand for foreign exchange matter? And does the central bank (CB) monitor black market/street rates? A weakening of the exchange rate may indicate a lack of confidence in the domestic currency, which will typically be accompanied by reduced demand for it. Even if the central bank operates an official exchange rate, it still makes sense to pay attention to the street, or black market rate, for the information it will provide.<sup>(1)</sup>
- Is it clear which CB liabilities are remunerated? Conceptually, this should be clear. For instance, some countries will remunerate required or contractual reserves, but not balances above that. However, the balance sheet may simply show banks' current accounts. Liquidity managers need enough information to know whether banks will be expecting to hold unremunerated reserve balances or not. It will also be important to be able to distinguish between liabilities carrying market rates of return, and below market rates.
- How will changes to payment systems, or other financial sector developments, affect cash demand and demand for free reserves? Enhancements to an RTGS payment system may reduce the need for precautionary balances. Or if banking supervisors make changes to the regime for liquid asset requirements, the banking system's demand for balances at the central bank may be affected.

(1) Some central banks are reluctant to monitor the black market rate, on the grounds that it is, strictly speaking, illegal. But where it can easily be observed, the central bank should use the information. As an example, the Reserve Bank of Zimbabwe's website in March 2007 showed the exchange rate at USD1 = Z\$250, while the black market rate was around Z\$9,000.

- What about financial or political crises? In some cases, a crisis may increase the demand for central bank liquidity — for instance, uncertainty about the creditworthiness of other market participants, in response to a shock, will tend to increase demand. But a political crisis, if it is perceived to create an exchange rate risk, may prompt banks to reduce holdings of domestic currency liquidity temporarily.

### Reserve averaging and the frequency of operations

Reserve averaging, whether over a week or a month, should improve banks' liquidity management (although in practice a one-week period appears to make little difference — a longer period is needed). It may be particularly useful where the central bank finds a short-term liquidity forecast difficult, as it is normally much easier to be reasonably accurate over a two or four week period, than on any given day. Banks can of course use SFs to help manage their liquidity (provided they hold sufficient eligible collateral for any needed borrowing); but the interest rate cost of using SFs would have a very different impact on market behaviour than use of reserve averaging. In some countries, there may additionally be a certain stigma associated with using SFs — sometimes as a legacy of the way a previous system operated. Even when the central bank approach changes, so that use of SFs is seen as neutral, it may take years before the banking system fully accepts this.

It is still very important to take account of within-week and within-month seasonality, and any known large transactions, as they may push the banking system outside of its 'comfort zone' for a day or two, and so impact on interest rates, even if the system as a whole has the right amount of liquidity for the period as a whole.

Changes to reserve maintenance requirements — for example, extending the length of the period, or allowing greater use of averaging,<sup>(1)</sup> or introducing a carry-over amount or a range rather than a point target — may affect banks' behaviour gradually, making forecasting harder for a period. More information on reserve averaging can be found in *Handbook no. 24*.

With a perfect forecast and daily operations, the central bank could in theory target free reserves to equal demanded reserves exactly, on a daily basis. But there would be no obvious gain to the central bank as compared with a one-month averaging period and weekly operations, and it would involve more work and more risk.

Does the way banks use averaging give clues about future behaviour? If the banking system as a whole had a standard pattern of holding reserves in a maintenance period, the central bank could use this in helping to forecast the demand for liquidity — for instance, if banks preferred to hold reserves somewhat below the target level in the early part of the

maintenance period, and then above average towards the end. This pattern might indeed be logical, as it would help banks to avoid the risk of 'burnt' reserves.<sup>(2)</sup> But in practice, many central banks find there is no regular pattern. The US Fed, for instance, publishes the average holding pattern for reserves; but this is simply an average. In most maintenance periods, the actual pattern is different.

That said, in normal conditions, individual banks will tend to keep reserves within certain bounds. (The system as a whole has little choice, if the central bank decides on the volume of OMO, and the autonomous factors are outside the control of the commercial banks just as much as they are out of the control of the central bank.) If there were indications that the banks, or at least some banks, were trying to hold a substantially different pattern, this might be a signal to the central bank to ask questions and find out what is affecting behaviour.

(1) Some central banks allow only partial averaging eg if the average requirement is 5%, the minimum balance on a commercial bank's account may be set at 3% or 4% rather than zero.

(2) Burnt reserves occur if a bank exceeds its requirement (X currency units \* the number of days in the period) before the end of the maintenance period. As banks cannot hold balances below zero, they cannot use the excess.

## Summary

It is clearly important to remember the purpose of the liquidity forecast, and indeed of the monetary operations undertaken by the central bank. If it is possible to structure operations — the combination of OMO, SF and a reserve maintenance period — such that errors in the liquidity forecast (which are inevitable) have less impact, then it may be possible to improve liquidity management, and gain the benefits for market stability, market development and so on, even if problems remain with the forecast itself.

It is also important to try to understand what motivates behaviour of different items in the central bank's balance sheet, as this will give the central bank a better idea of when it needs to respond to forecast developments. Such an understanding cannot be developed simply by looking at data: it is necessary to communicate regularly with the main participants in the market — primarily banks who have an important role in the payment system — and the central bank must be pro-active in this respect.

Relying on others for data, and for an understanding of the data, points to a need to build and maintain good relationships with a wide range of people (and there will be spin-off benefits relating to market surveillance and management of abnormal/crisis situations). This is not a one-off exercise, but needs to be undertaken continuously. And the need to manipulate a lot of data, at times in a complex way, clearly has implications for the make-up of the team.

Finally, when faced with a seemingly impossible task, the forecast team should start with what is possible, and aim for continual improvement.

## Annex 1

### Example of government expenditure pattern

**Table A1** Illustration of daily cash flow forecast for a given month

	<i>of which, salaries etc</i>	Other	Total
Annual expenditure	60	40	100
Seasonality, current month	1.1	1.02	1.068
Forecast expenditure, current month	5.5	3.4	8.9
<i>of which, known dates</i>		1.1	
<b>Day</b>			
1		0.1	0.10
2		0.1	0.10
3		0.1	0.10
4	0.55	0.1	0.65
5		0.1	0.10
6			
7			
8		0.1	0.10
9		0.6	0.60
10		0.1	0.10
11	0.55	0.1	0.65
12		0.1	0.10
13			
14			
15		0.1	0.10
16		0.1	0.10
17		0.1	0.10
18	0.55	0.1	0.65
19	3.3	0.1	3.40
20			
21			
22		0.1	0.10
23		0.1	0.10
24		0.1	0.10
25	0.55	0.1	0.65
26		0.1	0.10
27			
28			
29		0.7	0.70
30		0.1	0.10
31		0.1	0.10
<b>Total</b>	<b>5.5</b>	<b>3.4</b>	<b>8.90</b>

## Annex 2

### Examples of published liquidity forecasts

#### Bank of England

##### (i) A non-OMO day (Monday 29 January 2007)

10.00 am Stg mn

Aggregate reserves forecast for today	17,742
Previous day's aggregate holdings of reserves	14,836
Previous day's aggregate reserves forecast error	+26
Average aggregate reserves held to date in maintenance period	16,439
Residual average aggregate reserve requirement	17,059
Excess reserves	0
Previous day's use of lending standing facility on aggregate	0
Previous day's use of deposit standing facility on aggregate	0
Current standing facility rate — loans	6.25%
— deposits	4.25%

##### (ii) An OMO day (Thursday 21 September 2006)

Aggregate reserves forecast for today	18,019
Previous day's aggregate holdings of reserves	18,376
Previous day's aggregate reserves forecast error	-124
Average aggregate reserves held to date in maintenance period	16,684
Residual average aggregate reserve requirement	16,596
Previous day's use of lending standing facility on aggregate	0
Previous day's use of deposit standing facility on aggregate	0
Current standing facility rate — loans	5.75%
— deposits	3.75%
Forecast liquidity shortage	30,796
Average forecast level of notes	40,011
Average forecast level for other autonomous factors	-25,767
Forecast average reserves	16,552
Forecast error (since previous operation)	-88
Amount of maturing OMOs	31,138
Size of OMO offered	30,800

##### (iii) A post-OMO announcement (Thursday 21 September 2006)

A round of fixed-rate operations is invited at 10.00 am. The operation will comprise repos at 4.75% maturing on 28 September.

10.15 am Stg mn

Size of OMO bid	101,225
Amount of OMO allocated	30,800
Percentage of OMO bid allocated	30.4%
Aggregate reserves forecast for today (post OMO)	18,019

#### ECB

'The ECB normally aims to satisfy the liquidity needs of the banking system via its open market operations.'

#### Data

##### Daily liquidity conditions (€ millions)

Reserve maintenance period	17/01/2007 to 13/02/2007
Average reserve requirements	175,756
Figures as at	29/01/2007
Average current account holdings in the MP	177,193
Current account holdings	179,732
Use of the marginal lending facility	2
Use of the deposit facility	12
Autonomous factors	257,760

##### Forecasts of autonomous factors (€ millions)

Estimate on 30/01/2007 of average daily autonomous factors for the period 29/01/2007 to 06/02/2007	248,100
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##### Key figures for outstanding open market operations

	Main refinancing operations	Longer-term refinancing operations	Other operations		
Settlement date	31/01/2007	26/10/2006	30/11/2006	21/12/2006	none
Maturity date	07/02/2007	01/02/2007	01/03/2007	29/03/2007	
Minimum rate (bids)	3.50%	—	—	—	—
Marginal rate	3.56%	3.48%	3.58%	3.66%	
Weighted average rate	3.56%	3.50%	3.58%	3.67%	
Allotted amount*	€292.5 billion	€40 billion	€40 billion	€40 billion	

(\*): + [plus] indicates liquidity providing and - [minus] indicates liquidity absorbing operations.

## Annex 3

### Government cash flows in the euro area

From the ECB website, providing information on euro-member government transactions across national central bank books.

In Austria, Belgium, Finland, Germany, Luxembourg, the Netherlands and Portugal the volatility of the overnight balances on government deposits with the central bank is low or even close to zero. Liquidity effects are therefore negligible. In Ireland, the Government stabilises its balance with the central bank around a target level. The volatility of government balances is therefore comparatively low.

In Spain, since February 2001, the Treasury has transferred its deposits to the banking system on a daily basis via overnight repos. These transactions have completely offset the unexpected liquidity shocks caused by Spanish Treasury deposits. The other sub-items contributing to the approximately €15 billion total of government deposits at the Banco de España (eg accounts related to social security, autonomous government and other administrative agencies related to the Spanish Government) are relatively stable and do not cause large disturbances. Information regarding Treasury activities is publicly available on different websites.

The Banco de España posts the *Public Debt Market Bulletin* on its website ([www.bde.es](http://www.bde.es)) on a daily basis, giving information on the outstanding amounts of Treasury bonds and bills, dates of issuance, allotments, coupon payments and other items. Data concerning the Spanish Treasury bond and bill market are also available on Reuters' pages TESORESP01 — TESORESP12 and on the Bloomberg page TESO. Likewise, the Spanish Treasury website ([www.mineco.es](http://www.mineco.es)) provides information on government debt.

In France, an interest rate below the market level is paid on government balances held with the central bank above a certain threshold; thus the Government has an incentive to place its funds in the market at the end of the day. Since 30 April 2002, the ceiling of remunerated government deposits has been reduced after a convention was signed between the French Government and the Banque de France. The French Treasury sets a target balance for its account. Consequently, the volatility of the Government deposits is low. Information on operations relating to the French Government's debt is available on the French Treasury's website ([www.francetresor.gouv.fr](http://www.francetresor.gouv.fr)). Information on fiscal deadlines is available in French only on another website ([www.impot.gouv.fr](http://www.impot.gouv.fr)). Tax and other public payments are distributed evenly over the month.

In Greece, there is no upper limit on the amount of deposits that the Government can hold with the Bank of Greece. Remuneration is close to market rates, up to a certain threshold. In its efforts to enhance cash management

efficiency and reduce the volatility of its deposits, the Greek Government has been placing funds in the form of term deposits with credit institutions on a regular basis. Information regarding government operations in government bonds and Treasury bills (announcements, issue calendar, results of previous auctions and historical data) is available on Reuters' page GR/PDMA01. Further information on public debt and budget implementation is also provided on the Greek Treasury's website ([www.mof-glk.gr](http://www.mof-glk.gr)).

In Italy, the liquidity effects of government activities are considerable. No upper limit is applied to the government deposit balance. The Banca d'Italia remunerates the balances held by the Government on the current account with an interest rate close to market rates. The main movements in government deposits occur because of the transfer of tax and social security payments to the Government's account at the Banca d'Italia. Until mid-June 2002, the transfer of the tax collection took place on the fifth working day after the payment date (usually on the 23rd of each month or, if the payment system is closed on the 23rd, on the next business day). Under a new arrangement introduced on 10 July 2002 (Decree no. 63/2002, Article 1), at least 80% of the tax collected has to be transferred to the Government on the third working day following the day on which the payments were made by taxpayers. The rest has to be transferred in the following two days. This means that the main changes in government deposits will now take place between the 21st (due to calendar effects, sometimes the 20th or 19th) and the 23rd of each month. Relevant amounts of liquidity are also absorbed each year by tax payments in June and July (personal income tax) and in August and December (corporate income tax). Conversely, liquidity is provided on the first business day of each month, mainly because of pension and interest payments. The Italian Government sometimes decides to carry out operations such as the issuance of bonds, buy-backs and borrowing in the international market and the exact amounts involved are only known at short notice, leading to unexpected liquidity shocks.

The Italian Government provides information on its issuance programme and outstanding debt on its website and through wire services (see, for example, the index on Reuters' page TESOROITALIA; only in Italian). The Banca d'Italia also provides information on the conditions of new issues and the results of government bond and Treasury bill auctions (see the index on Reuters' page BANKITALIA02; only in Italian). The Italian Association of Bank Treasurers (ATIC, see index on Reuters' page ATJA25) jointly with the consulting firm Prometeia conduct a daily survey of the main banks established in Italy, with the aim of forecasting the domestic liquidity flows for the following week on a daily basis. These forecasts are published on wire services, along with information on liquidity flows related to public debt in other EU Member States (see the index on Reuters' page PROMEUR01).

## Annex 4

### UK Treasury cash-flow management

The importance of central government cash-flow management has increased since the Debt Management Office (DMO) took over this responsibility from the Bank of England in 2000. Whereas previously a significant element of cash-flow management was met passively by adjusting the government's overdraft at the Bank, the policy now is to meet the whole of the government's residual cash management needs actively via market borrowing and lending.

The DMO's function is to raise the necessary cash to fund government expenditure which is not met by tax receipts (or the relatively small amount of net retail borrowing raised by National Savings and Investments). This is achieved through a mixture of debt and cash management. Debt management is defined to cover the government's overall borrowing requirement for the financial year, whereas cash management deals with the intra-year peaks and troughs.

*Debt management:* debt management aims to meet the government's long-term financing needs (the net sum of the annual budget deficit/surplus plus any maturing loans): long-term funding is managed on a medium to long-term basis, and the annual remit is tied in to the annual budget cycle.<sup>(1)</sup>

*Cash management:* The objective of cash management is to balance the government's cash inflows and outflows *each day*. On days when the government's cash revenue is less than its cash expenditure, the DMO must borrow the shortfall via its market operations. Conversely, when there is a cash surplus the DMO needs to lend this out (or repay prior borrowing). To do this cost-effectively requires good information on the government's cash flow, in aggregate, which in turn needs a strong input from the government departments that give rise to these flows.

The Cashflow Management Scheme was introduced in 2001. Its objectives are to obtain reliable forecasts of departmental cash flows to inform the Debt Management Office's operational work of managing the government's daily cash needs. It covers the expenditure and receipts of spending departments, but not the tax revenues received by the revenue-collecting departments.

Advance information by method of payment is important for monitoring cash flow because that is the form in which the corresponding outturn emerges. Unless departments tell the Treasury about their expected transactions, the Treasury is unlikely to learn of them until they are reported as transfers through the banking system. For cheques and Bankers Automated Payments System (BACS)<sup>(2)</sup> flows this information

is generally available on the day before value is transferred, but for same day electronic transfers made via Clearing Houses Automated Payments System (CHAPS),<sup>(3)</sup> there is no prior warning. As payments via this method tend to be for high values, this can cause the final position for the day to vary considerably from forecast, which makes it much more difficult for the DMO to equalise the day's inflows and outflows via its market dealings. Reliable advance information on CHAPS payments and receipts — in advance as well as on the day — is therefore essential for an effective Cashflow Management Scheme.

Seminars and workshops are held on a regular basis. As a further incentive, league tables are distributed on a monthly basis to participating departments showing their variance against forecast on a monthly and year-to-date basis. Some departments regard such 'naming and shaming' as a more effective incentive than the charging arrangements (see below). Departments that have performed well under the scheme have been known to mention their high position in the league table in their annual reports.

The following section describes the structure of the Cashflow Management Scheme as it operated in early 2006. However, from April 2006 the Scheme was extended to include new charges and rebates for payments made via BACS. BACS payments are three-day electronic payments that represent approximately 80% of departmental spending.

A pilot scheme was run from 1 April 2004 involving the fifteen large departments that use BACS as a payment method. Departments responded positively and introduced procedures to improve their forecasting. For the first six months of 2005, this resulted in a 45% reduction in shadow charges over the same period in 2004.

It is proposed to allow a £15 million tolerance on the daily BACS and a 5% tolerance on the monthly BACS forecasts before a charge is incurred. The 5% interest rate charge applied is a proxy for the overnight repo rate; it does not vary as actual interest rates move. To provide an incentive to departments, all charges incurred under the Scheme will be re-distributed on a *pro-rata* basis in line with their share of total BACS usage and applied annually to their end-year flexibility entitlement, which defines the amount of unspent provision that a department may carry over to the next year, subject to Parliament's approval.

(1) For more detailed information on debt management, see [www.dmo.gov.uk](http://www.dmo.gov.uk) and [www.bankofengland.co.uk/education/ccbs/handbooks/ccbshb05.htm](http://www.bankofengland.co.uk/education/ccbs/handbooks/ccbshb05.htm).

(2) BACS flows are made electronically through a central clearing house and provide for value to be exchanged (at the earliest) two days after the day of input. They can be used for making payments and collecting receipts by direct debit.

(3) CHAPS transfers are same-day bilateral electronic transfers used for making payments only.

## The departmental cash-flow management scheme

Each month spending departments are required to forecast, for the following month, their total gross payments, broken down by method of payment, and their total gross receipts. They must also show how they propose to finance the resulting net payment flow, including the amount of supply funding they want the Treasury to issue. The large departments are also asked to provide daily forecasts of their payments and receipts through the CHAPS and BACS systems.

The largest departments, covering over 98% of gross voted cash flows by value, are subject to a regime of charges and rebates related to the accuracy of their cash-flow forecasts. Gross charges are based on a stylised estimate of the cost to the Exchequer attributable to departmental forecasting errors. However, in order to give these departments a greater incentive to improve their forecasting accuracy, these gross charges are then rebated among them on a *pro-rata* basis related to their share of the total planned gross cash flows (ie both payments and receipts) for the year. As a result, the scheme is totally self-financing. Once set at the beginning of the year, the shares are not adjusted to take account of subsequent revisions to departments' spending plans approved by Parliament.

The smaller departments are required to submit a forecast of their gross payments and receipts each month for the following month along with their request for supply to be issued by HM Treasury, but are not subject to the charging and rebate regime.

If a department draws insufficient supply for the month, it can request additional funds at any time during the month, provided that it has not exhausted the provision voted to it by Parliament. Departments can also amend the amount of funding they require for the following month two days prior to the month end.

At the end of each month the Treasury determines the accuracy of departments' forecasts for (i) monthly net cash flow and (ii) daily CHAPS payments; and calculates the charges and rebates due. Thresholds are applied, so that errors below the following tolerance levels are not subject to charges:

- within £5 million of each daily CHAPS payment forecast; and
- within 5% of the monthly net payments forecast.

For CHAPS payments the departmental forecast used for calculating charges is the last one reported up to the cut-off point on the day before the cash transfer occurs. If departments change their plans after this cut-off point, they will not escape a charge, but they are still expected to report

the change to the Treasury, so that the Treasury can adjust its own forecasts.

Charges on errors in the daily CHAPS payment forecast are calculated at a rate of 5% per annum, applied for one day. An error of £10 million in a daily CHAPS forecast would generate a charge of:

$$£10\text{m} \times 5\%/365 = £1,370$$

The 5% rate is a proxy for the overnight repo rate: it does not vary as actual interest rates move.

On the other hand, for the monthly net payments, the departmental forecast used for calculating charges is the original forecast submitted, without amendment.

Charges on the error in the monthly cash-flow forecast are calculated at a rate of 0.25% per annum, applied for one month. This is based on the perceived difference between borrowing and lending rates. For example, an error of £10 million in a monthly forecast would generate a charge of:

$$£10\text{m} \times 0.25\%/12 = £2,083$$

The net charges or rebates are effected by adjustments to departments' end-year flexibility (EYF) entitlements. A department facing a net charge for the year would have its administration or general costs EYF entitlement reduced by this amount, whereas a department with a net rebate would benefit from an increase to its administration or general costs EYF entitlement. This gives a real (albeit small) financial effect to the charges, but avoids in-year action that might require numerous supplementary estimates for relatively small sums. (EYF is a device to enable spending departments to carry forward unspent provision from one year into the next, subject to Parliament's approval (which is normally granted).)

## Handbooks in Central Banking

The text of all CCBS handbooks can be downloaded from our website at:

[www.bankofengland.co.uk/education/ccbs/handbooks\\_lectures.htm](http://www.bankofengland.co.uk/education/ccbs/handbooks_lectures.htm).

These handbooks are also available in Arabic (A), Russian (R) and Spanish (S).

No	Title	Author
1	Introduction to monetary policy (R) (S)	Glenn Hoggarth
2	The choice of exchange rate regime (R) (S)	Tony Latter
3	Economic analysis in a central bank: models versus judgement (R) (S)	Lionel Price
4	Internal audit in a central bank (R) (S)	Christopher Scott
5	The management of government debt (R) (S)	Simon T Gray
6	Primary dealers in government securities markets (R) (S)	Robin McConnachie
7	Basic principles of banking supervision (R) (S)	Derrick Ware
8	Payment systems (A) (S)	David Sheppard
9	Deposit insurance (R) (S)	Ronald MacDonald
10	Introduction to monetary operations — revised, 2nd edition (R) (S)	Simon T Gray, Glenn Hoggarth and Joanna Place
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17	Financial derivatives (S)	Simon T Gray and Joanna Place
18	The issue of banknotes <sup>(1)</sup> (S)	Peter Chartres
19	Foreign exchange reserves management (S)	John Nugee
20	Basic bond analysis (A)	Joanna Place
21	Banking and monetary statistics (A) (S)	John Thorp and Philip Turnbull
22	Unit root testing to help model building	Lavan Mahadeva and Paul Robinson
23	Consumption theory	Emilio Fernandez-Corugedo
24	Monetary operations (A) (R) (S)	Simon T Gray and Nick Talbot
25	Monetary and financial statistics (A) (S)	Monetary and Financial Statistics Division
26	Developing financial markets	Simon T Gray and Nick Talbot
27	Liquidity forecasting	Simon T Gray

(1) Withdrawn from publication. An updated version will be released in due course.

## Handbooks: Lecture Series

No	Title	Author
1	Inflation targeting: The British experience (S)	William A Allen
2	Financial data needs for macroprudential surveillance — what are the key indicators of risks to domestic financial stability?	E Philip Davis
3	Surplus liquidity: implications for central banks	Joe Ganley
4	Implementing monetary policy	William A Allen
5	Central banking in low income countries	Simon T Gray
6	Central bank management of surplus liquidity	Simon T Gray

## Handbooks: Research Series

No	Title	Author
1	Over the counter interest rate options	Richhild Moessner

Available in Spanish (S).

## CCBS publications

The CCBS also aims to publish the output from its Research Workshop projects and other research. The following is a list of books published or commissioned by CCBS:

**Brealey, R, Clark, A, Goodhart, C, Healey, J, Hoggarth, G, Llewellyn, D, Shu, C, Sinclair, P and Farouk, S (2001)**, *Financial stability and central banks — a global perspective*, Routledge.

**Capie, F, Goodhart, C, Fischer, S and Schnadt, N (1994)**, *The future of central banking: the tercentenary symposium of the Bank of England*, Cambridge University Press.

**Davis, E P, Hamilton, R, Heath, R, Mackie, F and Narain, A (1999)**, 'Financial market data for international financial stability', *Centre for Central Banking Studies*, Bank of England.\*

**Driver, R, Sinclair, P and Thoenissen, C (2005)**, *Exchange rates, capital movements and policy*, Routledge.

**Fry, M (1997)**, *Emancipating the banking system and developing markets for government debt*, Routledge.

**Fry, M, Goodhart, C and Almeida, A (1996)**, *Central banking in developing countries: objectives, activities and independence*, Routledge.

**Fry, M, Kilato, I, Roger, S, Senderowicz, K, Sheppard, D, Solis, F and Trundle, J (1999)**, *Payment systems in global perspective*, Routledge.

**Goodhart, C, Hartmann, P, Llewellyn, D, Rojas-Suárez, L and Weisbrod, S (1998)**, *Financial regulation: why, how and where now?*, Routledge.

**Gray, S and Nell, J (2005)**, 'A new currency for Iraq', *Centre for Central Banking Studies*, Bank of England.

**Halme, L, Hawkesby, C, Healey, J, Saapar, I and Soussa, F (2000)**, 'Financial stability and central banks: selected issues for financial safety nets and market discipline', *Centre for Central Banking Studies*, Bank of England.\*

**Mahadeva, L and Sinclair, P (2002)**, *The theory and practice of monetary transmission in diverse economies*, Cambridge University Press.

**Mahadeva, L and Sinclair, P (2004)**, *How monetary policy works*, Routledge.

**Mahadeva, L and Sterne, G (2000)**, *Monetary frameworks in a global context*, Routledge. (This book includes the report of the 1999 Central Bank Governors Symposium and a collection of papers on monetary frameworks issues presented at a CCBS Research Workshop.)

\*These are free publications which are posted on our website at: [www.bankofengland.co.uk/education/ccbs/publications/index.htm](http://www.bankofengland.co.uk/education/ccbs/publications/index.htm).



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