

# The transmission mechanism of monetary policy

*This report<sup>(1)</sup> has been prepared by Bank of England staff under the guidance of the Monetary Policy Committee in response to suggestions by the Treasury Committee of the House of Commons and the House of Lords Select Committee on the Monetary Policy Committee of the Bank of England.*

## Introduction and summary

The Monetary Policy Committee (MPC) sets the short-term interest rate at which the Bank of England deals with the money markets. Decisions about that official interest rate affect economic activity and inflation through several channels, which are known collectively as the ‘transmission mechanism’ of monetary policy.

The purpose of this paper is to describe the MPC’s view of the transmission mechanism. The key links in that mechanism are illustrated in the figure below.

First, official interest rate decisions affect market interest rates (such as mortgage rates and bank deposit rates), to varying degrees. At the same time, policy actions and announcements affect expectations about the future course of the economy and the confidence with which these expectations are held, as well as affecting asset prices and the exchange rate.

Second, these changes in turn affect the spending, saving and investment behaviour of individuals and firms in the economy. For example, other things being equal, higher interest rates tend to encourage saving rather than spending, and a higher value of sterling in foreign exchange markets,

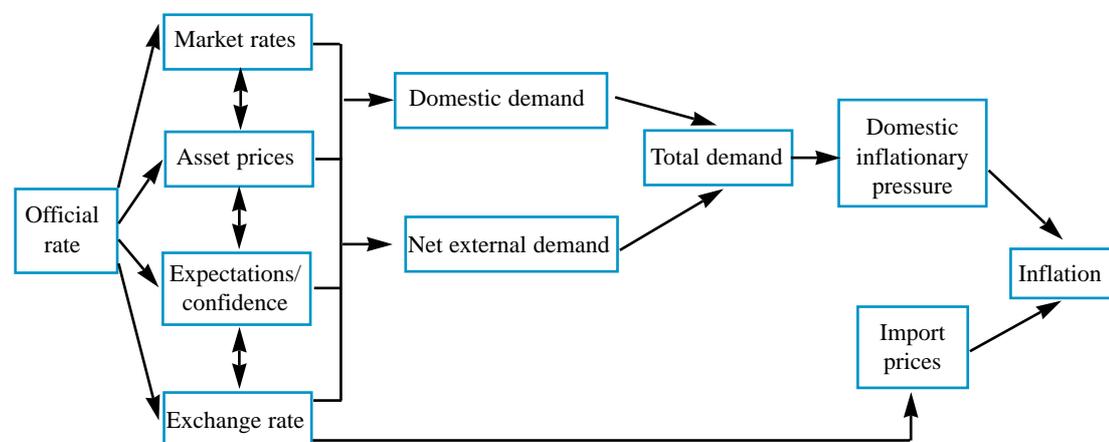
which makes foreign goods less expensive relative to goods produced at home. So changes in the official interest rate affect the demand for goods and services produced in the United Kingdom.

Third, the level of demand relative to domestic supply capacity—in the labour market and elsewhere—is a key influence on domestic inflationary pressure. For example, if demand for labour exceeds the supply available, there will tend to be upward pressure on wage increases, which some firms may be able to pass through into higher prices charged to consumers.

Fourth, exchange rate movements have a direct effect, though often delayed, on the domestic prices of imported goods and services, and an indirect effect on the prices of those goods and services that compete with imports or use imported inputs, and hence on the component of overall inflation that is imported.

Part I of this paper describes in more detail these and other links from official interest rate decisions to economic activity and inflation. It discusses important aspects that have been glossed over in the summary account above—such as the distinction between real and nominal interest rates, the role of expectations, and the interlinking of

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Note: For simplicity, this figure does not show all interactions between variables, but these can be important.

(1) This report is also available on the Bank’s web site: [www.bankofengland.co.uk](http://www.bankofengland.co.uk).

many of the effects mentioned. There is also a discussion of the role of monetary aggregates in the transmission mechanism.

Part II provides some broad quantification of the effects of official interest rate changes under particular assumptions. There is inevitably great uncertainty about both the timing and size of these effects. As to timing, in the Bank's macroeconomic model (used to generate the simulations shown at the end of this paper), official interest rate decisions have their fullest effect on output with a lag of around one year, and their fullest effect on inflation with a lag of around two years. As to size, depending on the circumstances, the same model suggests that temporarily raising rates relative to a base case by 1 percentage point for one year might be expected to lower output by something of the order of 0.2% to 0.35% after about a year, and to reduce inflation by around 0.2 percentage points to 0.4 percentage points a year or so after that, all relative to the base case.

## I Links in the chain

Monetary policy works largely via its influence on aggregate demand in the economy. It has little direct effect on the trend path of supply capacity. Rather, in the long run, monetary policy determines the nominal or money values of goods and services—that is, the general price level. An equivalent way of making the same point is to say that in the long run, monetary policy in essence determines the value of money—movements in the general price level indicate how much the purchasing power of money has changed over time. Inflation, in this sense, is a monetary phenomenon.

However, monetary policy changes do have an effect on real activity in the short to medium term. And though monetary policy is the dominant determinant of the price level in the long run, there are many other potential influences on price-level movements at shorter horizons. There are several links in the chain of causation running from monetary policy changes to their ultimate effects on the economy.

### From a change in the official rate to other financial and asset markets

A central bank derives the power to determine a specific interest rate in the wholesale money markets from the fact that it is the monopoly supplier of 'high-powered' money, which is also known as 'base money'.<sup>(1)</sup> The operating procedure of the Bank of England is similar to that of many other central banks, though institutional details differ slightly from country to country. The key point is that the Bank chooses the price at which it will lend high-powered money to private sector institutions. In the United Kingdom, the Bank lends predominantly through gilt sale and repurchase agreements (repo) at the two-week maturity. This repo rate is the 'official rate' mentioned above. The box opposite outlines how the Bank implements an official rate decision in the money markets.

The quantitative effect of a change in the official rate on other interest rates, and on financial markets in general, will depend on the extent to which the policy change was anticipated and how the change affects expectations of future policy. We assume here for simplicity that changes in the official rate are not expected to be reversed quickly, and that no further future changes are anticipated as a result of the change. This is a reasonable assumption for purposes of illustration, but it should be borne in mind that some of the effects described may occur when market expectations about policy change, rather than when the official rate itself changes.

#### *Short-term interest rates*

A change in the official rate is immediately transmitted to other short-term sterling wholesale money-market rates, both to money-market instruments of different maturity (such as rates on repo contracts of maturities other than two weeks) and to other short-term rates, such as interbank deposits. But these rates may not always move by the exact amount of the official rate change. Soon after the official rate change (typically the same day), banks adjust their standard lending rates (base rates), usually by the exact amount of the policy change. This quickly affects the interest rates that banks charge their customers for variable-rate loans, including overdrafts. Rates on standard variable-rate mortgages may also be changed, though this is not automatic and may be delayed. Rates offered to savers also change, in order to preserve the margin between deposit and loan rates. This margin can vary over time, according to, for example, changing competitive conditions in the markets involved, but it does not normally change in response to policy changes alone.

#### *Long-term interest rates*

Though a change in the official rate unambiguously moves other short-term rates in the same direction (even if some are slow to adjust), the impact on longer-term interest rates can go either way. This is because long-term interest rates are influenced by an average of current and expected future short-term rates, so the outcome depends upon the direction and extent of the impact of the official rate change on expectations of the future path of interest rates. A rise in the official rate could, for example, generate an expectation of lower future interest rates, in which case long rates might fall in response to an official rate rise. The actual effect on long rates of an official rate change will partly depend on the impact of the policy change on inflation expectations. The role of inflation expectations is discussed more fully below.

#### *Asset prices*

Changes in the official rate also affect the market value of securities, such as bonds and equities. The price of bonds is inversely related to the long-term interest rate, so a rise in long-term interest rates lowers bond prices, and *vice versa*

(1) The monetary base, M0, consists of notes and coin plus bankers' deposits at the Bank of England.

## How the Bank sets interest rates

The Bank implements monetary policy by lending to the money market at the official repo rate chosen by the MPC. The Bank's dealing rate changes only when the MPC decides that it should. Arbitrage between markets ensures that the MPC's decisions are reflected across the spectrum of short-term sterling markets.

The Bank holds on its balance sheet assets acquired from its counterparties in its money-market operations. These are mostly private sector obligations; they are short-term, and a proportion of them matures every business day. This means that at the start of each day, the private sector is due to pay money to the Bank to redeem these obligations. However, in order to do so, the Bank's counterparties typically have to borrow additional funds from the Bank. This gives the Bank the opportunity to provide the necessary finance once more, at its official repo rate. The fact that this 'stock of refinancing' is turning over regularly is the main factor creating the demand for base money (the 'shortage') in the market each day.

The panel below shows the announcements that the Bank's dealers made to the market on 8 April, a day on which rates were changed. At 9.45 am, the Bank announced the estimated size of that day's shortage and the main factors behind it. At 12 noon, it published the outcome of the MPC meeting, and market rates adjusted immediately. The first round of operations was not conducted until 12.15 pm, but the knowledge that the dealing rate would be 5.25%, down from 5.5%, moved market rates ahead of that. The bulk of the day's

shortage was financed at 12.15 pm, and the (downwardly revised) remainder in a further round of operations at 2.30 pm.

In its open market operations, the Bank deals with a small group of counterparties who are active in the money market: banks, securities dealers and building societies are eligible to take on this role. Finance is provided primarily in the form of repo, which is short for 'sale and repurchase agreement'. Counterparties sell assets to the Bank with an agreement to buy them back in about a fortnight's time, and the repo rate is the (annualised) rate of interest implied by the difference between the sale and repurchase price in these transactions. The assets eligible for repo are gilts and sterling Treasury bills, UK government foreign-currency debt, eligible bank and local authority bills, and certain sterling bonds issued by supranational organisations and by governments in the European Economic Area. The Bank also buys outright Treasury bills and other eligible bills.

On non-MPC days, the first round of operations is held at 9.45 am rather than 12.15 pm. The timetable is otherwise the same. If the remaining shortage is not entirely relieved at 2.30 pm, the Bank holds a round of overnight operations at 3.30 pm. If the system is still short at 4.20 pm, the Bank deals directly with the settlement banks, whose accounts at the Bank of England need to be in credit at the end of the day. But on 8 April, no operations were needed at 3.30 pm or 4.20 pm.

### Bank of England messages to money markets via screen services on 8 April 1999

<b>9.45 am</b>	Initial liquidity forecast Stg 1150 mn shortage Principal factors in the forecast Treasury bills and maturing outright purchases -596 Maturing bill/gilt repo -216 Bank/Exchequer transactions -180 Rise in note circulation -105 Maturing settlement bank late repo facility -39 Bankers' balances below target -20
<b>12.00 pm</b>	BANK OF ENGLAND REDUCES INTEREST RATES BY 0.25% TO 5.25% The Bank of England's Monetary Policy Committee today voted to reduce the Bank's repo rate by 0.25% to 5.25%. The minutes of the meeting will be published at 9.30 am on Wednesday 21 April.
<b>12.15 pm</b>	Liquidity forecast revision—Stg 1100 mn A round of fixed-rate operations is invited. The Bank's repo rate is 5.25%. The operations will comprise repos to 22 and 23 April and outright offers of bills maturing on or before 23 April.
<b>12.24 pm</b>	Total amount allotted—Stg 900 mn of which—outright Stg 57 mn, repo Stg 843 mn
<b>2.30 pm</b>	Liquidity forecast revision—Stg 1000 mn. Residual shortage—Stg 100 mn A round of fixed-rate operations is invited. The Bank's repo rate is 5.25%. The operations will comprise repos to 22 and 23 April and outright offers of bills maturing on or before 23 April.
<b>2.35 pm</b>	Total amount allotted—Stg 100 mn of which—outright Stg 16 mn, repo Stg 84 mn
<b>3.30 pm</b>	No residual shortage No further operations invited
<b>4.20 pm</b>	No liquidity forecast revision No residual shortage The settlement bank late repo facility will not operate today

for a fall in long rates. If other things are equal (especially inflation expectations), higher interest rates also lower other securities prices, such as equities. This is because expected future returns are discounted by a larger factor, so the present value of any given future income stream falls. Other things may not be equal—for example, policy changes may have indirect effects on expectations or confidence—but these are considered separately below. The effect on prices of physical assets, such as housing, is discussed later.

### *The exchange rate*

Policy-induced changes in interest rates can also affect the exchange rate. The exchange rate is the relative price of domestic and foreign money, so it depends on both domestic and foreign monetary conditions. The precise impact on exchange rates of an official rate change is uncertain, as it will depend on expectations about domestic and foreign interest rates and inflation, which may themselves be affected by a policy change. However, other things being equal, an unexpected rise in the official rate will probably lead to an immediate appreciation of the domestic currency in foreign exchange markets, and *vice versa* for a similar rate fall. The exchange rate appreciation follows from the fact that higher domestic interest rates, relative to interest rates on equivalent foreign-currency assets, make sterling assets more attractive to international investors. The exchange rate should move to a level where investors expect a future depreciation just large enough to make them indifferent between holding sterling and foreign-currency assets. (At this point, the corresponding interest differential at any maturity is approximately equal to the expected rate of change of the exchange rate up to the same time-horizon.)

Exchange rate changes lead to changes in the relative prices of domestic and foreign goods and services, at least for a while, though some of these price changes may take many months to work their way through to the domestic economy, and even longer to affect the pattern of spending.

### *Expectations and confidence*

Official rate changes can influence expectations about the future course of real activity in the economy, and the confidence with which those expectations are held (in addition to the inflation expectations already mentioned). Such changes in perception will affect participants in financial markets, and they may also affect other parts of the economy via, for example, changes in expected future labour income, unemployment, sales and profits. The direction in which such effects work is hard to predict, and can vary from time to time. A rate rise could, for example, be interpreted as indicating that the MPC believes that the economy is likely to be growing faster than previously thought, giving a boost to expectations of future growth and confidence in general. However, it is also possible that a rate rise would be interpreted as signalling that the MPC perceives the need to slow the growth in the economy in order to hit the inflation target, and this could dent expectations of future growth and lower confidence.

The possibility of such effects contributes to the uncertainty of the impact of any policy change, and increases the importance of having a credible and transparent monetary policy regime. We return to these issues below.

In summary, though monetary policy-makers have direct control over only a specific short-term interest rate, changes in the official rate affect market interest rates, asset prices, and the exchange rate. The response of all these will vary considerably from time to time, as the external environment, policy regime and market sentiment are not constant. However, monetary policy changes (relative to interest rate expectations) normally affect financial markets as described above.

### **From financial markets to spending behaviour**

We now consider how the spending decisions of individuals and firms respond to the changes in interest rates, asset prices and the exchange rate just discussed. Here, we focus on the immediate effects of a monetary policy change. Those resulting from subsequent changes in aggregate income, employment and inflation are considered below. Since the effects of policy changes on expectations and confidence are ambiguous, we proceed on the basis of a given level of expectations about the future course of real activity and inflation, and a given degree of confidence with which those expectations are held. We also assume an unchanged fiscal policy stance by the government in response to the change in monetary policy.

### *Individuals*

Individuals are affected by a monetary policy change in several ways. There are three direct effects. First, they face new rates of interest on their savings and debts. So the disposable incomes of savers and borrowers alter, as does the incentive to save rather than consume now. Second, the value of individuals' financial wealth changes as a result of changes in asset prices. Third, any exchange rate adjustment changes the relative prices of goods and services priced in domestic and foreign currency. Of these three effects, the one felt most acutely and directly by a significant number of individuals is that working through the interest rate charged on personal debt, especially mortgages, and the interest rate paid on their savings. We focus first on those with significant debts, and return to those with net savings below.

Loans secured on houses make up about 80% of personal debt, and most mortgages in the United Kingdom are still floating-rate. Any rise in the mortgage rate reduces the remaining disposable income of those affected and so, for any given gross income, reduces the flow of funds available to spend on goods and services. Higher interest rates on unsecured loans have a similar effect. Previous spending levels cannot be sustained without incurring further debts (or running down savings), so a fall in consumer spending is likely to follow. Those with fixed-rate mortgages will not face higher payments until their fixed term expires, but all new borrowers taking out such loans will be affected by rate

changes from the start of their loan (though the fixed interest rate will be linked to interest rates of the relevant term, rather than short rates).

Wealth effects will also be likely to work in the same direction. Higher interest rates (current and expected) tend to reduce asset values, and lower wealth leads to lower spending. Securities prices were mentioned above; another important personal asset is houses. Higher interest rates generally increase the cost of financing house purchase, and so reduce demand. A fall in demand will lower the rate of increase of house prices, and sometimes house prices may even fall. Houses are a major component of (gross) personal wealth. Changes in the value of housing wealth affect consumer spending in the same direction as changes in financial wealth, but not necessarily by the same amount. Part of this effect comes from the fact that individuals may feel poorer when the market value of their house falls, and another part results from the fact that houses are used as collateral for loans, so lower net worth in housing makes it harder to borrow. As an example of this, the house-price boom of the late 1980s was linked to rapid consumption growth, and declining house prices in the early 1990s exerted a major restraint on consumer spending.

Some individuals have neither mortgage debt nor significant financial and housing wealth. They may, however, have credit card debts or bank loans. Monetary policy affects interest rates charged on these, and higher rates will tend to discourage borrowing to finance consumption. Even for those with no debts, higher interest rates may make returns on savings products more attractive, encouraging some individuals to save more—and so to spend less. In essence, higher interest rates (for given inflation expectations) encourage the postponement of consumption, by increasing the amount of future consumption that can be achieved by sacrificing a given amount of consumption today. Future consumption is substituted for current consumption.

Another influence on consumer spending arises from the effects of an official rate change on consumer confidence and expectations of future employment and earnings prospects. Such effects vary with the circumstances of the time, but where a policy change is expected to stimulate economic activity, this is likely to increase confidence and expectations of future employment and earnings growth, leading to higher spending. The reverse will follow a policy change expected to slow the growth of activity.

So far, the effects mentioned all normally work in the same direction, so that higher interest rates, other things being equal, lead to a reduction in consumer spending, and lower interest rates tend to encourage it. However, this is not true for all individuals. For example, a person living off income from savings deposits, or someone about to purchase an annuity, would receive a larger money income if interest rates were higher than if they were lower. This higher income could sustain a higher level of spending than would otherwise be possible. So interest rate rises (falls) have redistributive effects—net borrowers are made worse

(better) off and net savers are made better (worse) off. And to complicate matters further, the spending of these different groups may respond differently to their respective changes in disposable income.

However, the MPC sets one interest rate for the economy as a whole, and can only take account of the impact of official rate changes on the aggregate of individuals in the economy. From this perspective, the overall impact of the effects mentioned above on consumers appears to be that higher interest rates tend to reduce total current consumption spending, and lower interest rates tend to increase it.

Exchange rate changes can also affect the level of spending by individuals. This could happen, for example, if significant levels of wealth (or debt) were denominated in foreign currency, so that an exchange rate change caused a change in net wealth—though this is probably not an important factor for most individuals in the United Kingdom. But there will be effects on the composition of spending, even if there are none on its level. An exchange rate rise makes imported goods and services relatively cheaper than before. This affects the competitiveness of domestic producers of exports and of import-competing goods, and it also affects service industries such as tourism, as foreign holidays become relatively cheaper. Such a change in relative prices is likely to encourage a switch of spending away from home-produced goods and services towards those produced overseas. Of course, official rate changes are not the only influence on exchange rates—the appreciation of sterling in 1996, for example, appears to have been driven to a significant extent by other factors.

In summary, a rise in the official interest rate, other things (notably expectations and confidence) being equal, leads to a reduction in spending by consumers overall and, via an exchange rate rise, to a shift of spending away from home-produced towards foreign-produced goods and services. A reduction in the official rate has the opposite effect. The size—and even the direction—of these effects could be altered by changes in expectations and confidence brought about by a policy change, and these influences vary with the particular circumstances.

### *Firms*

The other main group of private sector agents in the economy is firms. They combine capital, labour and purchased inputs in some production process in order to make and sell goods or services for profit. Firms are affected by the changes in market interest rates, asset prices and the exchange rate that may follow a monetary policy change. However, the importance of the impact will vary depending on the nature of the business, the size of the firm and its sources of finance. Again, we focus first on the direct effects of a monetary policy change, holding all other influences constant, and discuss indirect effects working through aggregate demand later (though these indirect effects may be more important).

An increase in the official interest rate will have a direct effect on all firms that rely on bank borrowing or on loans of any kind linked to short-term money-market interest rates. A rise in interest rates increases borrowing costs (and *vice versa* for a fall). The rise in interest costs reduces the profits of such firms and increases the return that firms will require from new investment projects, making it less likely that they will start them. Interest costs affect the cost of holding inventories, which are often financed by bank loans. Higher interest costs also make it less likely that the affected firms will hire more staff, and more likely that they will reduce employment or hours worked. In contrast, when interest rates are falling, it is cheaper for firms to finance investment in new plant and equipment, and more likely that they will expand their labour force.

Of course, not all firms are adversely affected by interest rate rises. Cash-rich firms will receive a higher income from funds deposited with banks or placed in the money markets, thus improving their cash flow. This improved cash flow could help them to invest in more capacity or increase employment, but it is also possible that it will encourage them to shift resources into financial assets, or to pay higher dividends to shareholders.

Some firms may be less affected by the direct impact of short-term interest rate changes. This could be either because they have minimal short-term borrowing and/or liquid assets, or because their short-term liquid assets and liabilities are roughly matched, so that changes in the level of short rates leave their cash flow largely unaffected. Even here, however, they may be affected by the impact of policy on long-term interest rates whenever they use capital markets in order to fund long-term investments.

The cost of capital is an important determinant of investment for all firms. We have mentioned that monetary policy changes have only indirect effects on interest rates on long-term bonds. The effects on the costs of equity finance are also indirect and hard to predict. This means that there is no simple link from official rate changes to the cost of capital. This is particularly true for large and multinational firms with access to international capital markets, whose financing costs may therefore be little affected by changes in domestic short-term interest rates.

Changes in asset prices also affect firms' behaviour in other ways. Bank loans to firms (especially small firms) are often secured on assets, so a fall in asset prices can make it harder for them to borrow, since low asset prices reduce the net worth of the firm. This is sometimes called a 'financial accelerator' effect. Equity finance for listed companies is also generally easier to raise when interest rates are low and asset valuations are high, so that firms' balance sheets are healthy.

Exchange rate changes also have an important impact on many firms, though official rate changes explain only a small proportion of exchange rate variation. A firm producing in the United Kingdom, for example, would have

many of its costs fixed (at least temporarily) in sterling terms, but might face competition from firms whose costs were fixed in other currencies. An appreciation of sterling in the foreign exchange market would then worsen the competitive position of the UK-based firm for some time, generating lower profit margins or lower sales, or both. This effect is likely to be felt acutely by many manufacturing firms, because they tend to be most exposed to foreign competition. Producers of exports and import-competing goods would certainly both be affected. However, significant parts of other sectors, such as agriculture, may also feel the effects of such changes in the exchange rate, as would parts of the service sector, such as hotels, restaurants, shops and theatres reliant on the tourist trade, financial and business services, and consultancy.

The impact of monetary policy changes on firms' expectations about the future course of the economy and the confidence with which these expectations are held affects business investment decisions. Once made, investments in fixed capital are difficult, or impossible, to reverse, so projections of future demand and risk assessments are an important input into investment appraisals. A fall (rise) in the expected future path of demand will tend to lead to a fall (rise) in spending on capital projects. The confidence with which expectations are held is also important, as greater uncertainty about the future is likely to encourage at least postponement of investment spending until prospects seem clearer. Again, it is hard to predict the effect of any official rate change on firms' expectations and confidence, but there can be little doubt that such effects are a potentially important influence on business investment.

In summary, many firms depend on sterling bank finance or short-term money-market borrowing, and they are sensitive to the direct effects of interest rates changes. Higher interest rates worsen the financial position of firms dependent on such short-term borrowing (other things being equal) and lower rates improve their financial position. Changes in firms' financial position in turn may lead to changes in their investment and employment plans. More generally, by altering required rates of return, higher interest rates encourage postponement of investment spending and reduced inventories, whereas lower rates encourage an expansion of activity. Policy changes also alter expectations about the future course of the economy and the confidence with which those expectations are held, thereby affecting investment spending, in addition to the direct effect of changes in interest rates, asset prices, and the exchange rate.

### From changes in spending behaviour to GDP and inflation

All of the changes in individuals' and firms' behaviour discussed above, when added up across the whole economy, generate changes in aggregate spending. Total domestic expenditure in the economy is equal by definition to the sum of private consumption expenditure, government consumption expenditure and investment spending. Total domestic expenditure plus the balance of trade in goods and

services (net exports) reflects aggregate demand in the economy, and is equal to gross domestic product at market prices (GDP).

### *Second-round effects*

We have set out above how a change in the official interest rate affects the spending behaviour of individuals and firms. The resulting change in spending in aggregate will then have further effects on other agents, even if these agents were unaffected by the direct financial effects of the monetary policy change. So a firm that was not affected directly by changes in interest rates, securities prices or the exchange rate could nonetheless be affected by changes in consumer spending or by other firms' demand for produced inputs—a steel-maker, for example, would be affected by changes in demand from a car manufacturer. Moreover, the fact that these indirect effects can be anticipated by others means that there can be a large impact on expectations and confidence. So any induced change in aggregate spending is likely to affect most parts of the private sector producing for the home market, and these effects in turn can create further effects on their suppliers. Indeed, it is in the nature of business cycles that in upturns many sectors of the economy expand together and there is a general rise in confidence, which further feeds into spending. In downturns, many suffer a similar slowdown and confidence is generally low, reinforcing the cautious attitude to spending. This means that the individuals and firms most directly affected by changes in the official rate are not necessarily those most affected by its full repercussions.

### *Time-lags*

Any change in the official rate takes time to have its full impact on the economy. It was stated above that a monetary policy change affects other wholesale money-market interest rates and sterling financial asset prices very quickly, but the impact on some retail interest rates may be much slower. In some cases, it may be several months before higher official rates affect the payments made by some mortgage-holders (or received by savings deposit-holders). It may be even longer before changes in their mortgage payments (or income from savings) lead to changes in their spending in the shops. Changes in consumer spending not fully anticipated by firms affect retailers' inventories, and this then leads to changes in orders from distributors. Changes in distributors' orders then affect producers' inventories, and when these become unusually large or small, production changes follow, which in turn lead to employment and earnings changes. These then feed into further consumer spending changes. All this takes time.

The empirical evidence is that on average it takes up to about one year in this and other industrial economies for the response to a monetary policy change to have its peak effect on demand and production, and that it takes up to a further year for these activity changes to have their fullest impact on the inflation rate. However, there is a great deal of variation and uncertainty around these average time-lags. In particular, the precise effect will depend on many other

factors such as the state of business and consumer confidence and how this responds to the policy change, the stage of the business cycle, events in the world economy, and expectations about future inflation. These other influences are beyond the direct control of the monetary authorities, but combine with slow adjustments to ensure that the impact of monetary policy is subject to long, variable and uncertain lags. This slow adjustment involves both delays in changing real spending decisions, as discussed above, and delays in adjusting wages and prices, to which we turn next. A quantitative estimate of the lags derived from the Bank's macroeconomic model appears below.

### *GDP and inflation*

In the long run, real GDP grows as a result of supply-side factors in the economy, such as technical progress, capital accumulation, and the size and quality of the labour force. Some government policies may be able to influence these supply-side factors, but monetary policy generally cannot do so directly, at least not to raise trend growth in the economy. There is always some level of national output at which firms in the economy would be working at their normal-capacity output, and would be under no pressure to change output or product prices faster than at the expected rate of inflation. This is called the 'potential' level of GDP. When actual GDP is at potential, production levels are such as to impart no upward or downward pressures on output price inflation in goods markets, and employment levels are such that there is no upward pressure on unit cost growth from earnings growth in labour markets. There is a broad balance between the demand for, and supply of, domestic output.

The difference between actual GDP and potential GDP is known as the 'output gap'. When there is a positive output gap, a high level of aggregate demand has taken actual output to a level above its sustainable level, and firms are working above their normal-capacity levels. Excess demand may partly be reflected in a balance of payments deficit on the current account, but it is also likely to increase domestic inflationary pressures. For some firms, unit cost growth will rise, as they are working above their most efficient output level. Some firms may also feel the need to attract more employees, and/or increase hours worked by existing employees, to support their extra production. This extra demand for labour and improved employment prospects will be associated with upward pressure on money wage growth and price inflation. Some firms may also take the opportunity of periods of high demand to raise their profit margins, and so to increase their prices more than in proportion to increases in unit costs. When there is a negative output gap, the reverse is generally true. So booms in the economy that take the level of output significantly above its potential level are usually followed by a pick-up of inflation, and recessions that take the level of output below its potential are generally associated with a reduction in inflationary pressure.

The output gap cannot be measured with much precision. For example, changes in the pattern of labour supply and

industrial structure, and labour market reforms, mean that the point at which producers reach capacity is uncertain and subject to change. There are many heterogeneous sectors in the economy, and different industries start to hit bottlenecks at different stages of an upturn and are likely to lay off workers at different stages of a downturn. No two business cycles are exactly alike, so some industries expand more in one cycle than another. And the (trend) rate of growth of productivity can vary over time. The latter is particularly hard to measure except long after the event. So the concept of an output gap—even if it could be estimated with any precision—is not one that has a unique numerical link to inflationary pressure. Rather, it is helpful in indicating that in order to keep inflation under control, there is some level of aggregate activity at which aggregate demand and aggregate supply are broadly in balance. This is its potential level.

Holding real GDP at its potential level would in theory (in the absence of external shocks) be sufficient to maintain the inflation rate at its target level only if this were the inflation rate expected to occur by the agents in the economy. The absence of an output gap is consistent with any constant inflation rate that is expected. This is because holding aggregate demand at a level consistent with potential output only delivers the rate of inflation that agents expect—as it is these expectations that are reflected in wage settlements and are in turn passed on in some product prices. So holding output at its potential level, if maintained, could in theory be consistent with a high and stable inflation rate, as well as a low and stable one. The level at which inflation ultimately stabilises is determined by the monetary policy actions of the central bank and the credibility of the inflation target. In the shorter run, the level of inflation when output is at potential will depend on the level of inflation expectations, and other factors that impart inertia to the inflation rate.

### *Inflation expectations and real interest rates*

In discussing the impact of monetary policy changes on individuals and firms, one of the important variables that we explicitly held constant was the expected rate of inflation. Inflation expectations matter in two important areas. First, they influence the level of real interest rates and so determine the impact of any specific nominal interest rate. Second, they influence price and money wage-setting and so feed through into actual inflation in subsequent periods. We discuss each of these in turn.

The real interest rate is approximately equal to the nominal interest rate minus the expected inflation rate. The real interest rate matters because rational agents who are not credit-constrained will typically base their investment and saving decisions on real rather than nominal interest rates. This is because they are making comparisons between what they consume today and what they hope to consume in the future. For credit-constrained individuals, who cannot borrow as much today as they would like to finance activities today, nominal interest rates also matter, as they affect their cash flow.

It is only by considering the level of real interest rates that it is possible, even in principle, to assess whether any given nominal interest rate represents a relatively tight or loose monetary policy stance. For example, if expected inflation were 10%, then a nominal interest rate of 10% would represent a real interest rate of zero, whereas if expected inflation were 3%, a nominal interest rate of 10% would imply a real interest rate of 7%. So for given inflation expectations, changes in nominal and real interest rates are equivalent; but if inflation expectations are changing, the distinction becomes important. Moreover, these calculations should be done on an after-tax basis so that the interaction between inflation and the tax burden is taken into account, but such complications are not considered further here.

Money wage increases in excess of the rate of growth of labour productivity reflect the combined effect of a positive expected rate of inflation and a (positive or negative) component resulting from pressure of demand in labour markets. Wage increases that do not exceed productivity growth do not increase unit labour costs of production, and so are unlikely to be passed on in the prices charged by firms for their outputs. However, wage increases reflecting inflation expectations or demand pressures do raise unit labour costs, and firms may attempt to pass them on in their prices. So even if there is no excess demand for labour, unit costs will tend to increase by the expected rate of inflation simply because workers and firms bargain about real wages. This increase in unit costs—to a greater or lesser extent—will be passed on in goods prices. It is for this reason that, when GDP is at its potential level and there is no significant excess demand or supply of labour, the coincidence of actual and potential GDP delivers the inflation rate that was expected. This will only equal the inflation target once the target is credible (and so is expected to be hit).

### *Imported inflation*

So far, this paper has set out how changes in the official rate lead to changes in the demand for domestic output, and how the balance of domestic demand relative to potential supply determines the degree of inflationary pressure. In doing so, it considered the impact of exchange rate changes on net exports, via the effects of changes in the competitive position of domestic firms *vis à vis* overseas firms on the relative demand for domestic-produced goods and services. There is also a more direct effect of exchange rate changes on domestic inflation. This arises because exchange rate changes affect the sterling prices of imported goods, which are important determinants of many firms' costs and of the retail prices of many goods and services. An appreciation of sterling lowers the sterling price of imported goods, and a depreciation raises it. The effects may take many months to work their way fully through the pricing chain. The link between the exchange rate and domestic prices is not uni-directional—for example, an exchange rate change resulting from a change in foreign monetary policy will lead to domestic price changes, and domestic price rises caused by, say, a domestic demand increase will have exchange rate

implications. Indeed, both the exchange rate and the domestic price level are related indicators of the same thing—the value of domestic money. The exchange rate is the value of domestic money against other currencies, and the price level measures the value of domestic money in terms of a basket of goods and services.

### The role of money

So far, we have discussed how monetary policy changes affect output and inflation, with barely a mention of the quantity of money. (The entire discussion has been about the price of borrowing or lending money, ie the interest rate.) This may seem to be at variance with the well known dictum that ‘inflation is always and everywhere a monetary phenomenon’. It is also rather different from the expositions found in many textbooks that explain the transmission mechanism as working through policy-induced changes in the money supply, which then create excess demand or supply of money that in turn leads, via changes in short-term interest rates, to spending and price-level changes.

The money supply does play an important role in the transmission mechanism but it is not, under the United Kingdom’s monetary arrangements, a policy instrument. It could be a target of policy, but it need not be so. In the United Kingdom it is not, as we have an inflation target, and so monetary aggregates are indicators only. However, for each path of the official rate given by the decisions of the MPC, there is an implied path for the monetary aggregates. And in some circumstances, monetary aggregates might be a better indicator than interest rates of the stance of monetary policy. In the long run, there is a positive relationship between each monetary aggregate and the general level of prices. Sustained increases in prices cannot occur without accompanying increases in the monetary aggregates. It is in this sense that money is the nominal anchor of the system. In the current policy framework, where the official interest rate is the policy instrument, both the money stock and inflation are jointly caused by other variables.

Monetary adjustment normally fits into the transmission mechanism in the following way. Suppose that monetary policy has been relaxed by the implementation of a cut in the official interest rate. Commercial banks correspondingly reduce the interest rates they charge on their loans. This is likely to lead to an increased demand for loans (partly to finance the extra spending discussed above), and an increased extension of loans by banks creates new bank deposits that will be measured as an increase in the broad money supply (M4). So the change in spending by individuals and firms that results from a monetary policy change will also be accompanied by a change in both bank lending and bank deposits. Increases in retail sales are also likely to be associated with an increased demand for notes and coin in circulation. Data on monetary aggregates—lending, deposits, and cash—are helpful in the formation of

monetary policy, as they provide corroborative, or sometimes leading, indicators of the course of spending behaviour, and they are available in advance of much of the national accounts data.

In the long run, monetary and credit aggregates must be willingly held by agents in the economy. Monetary growth persistently in excess of that warranted by growth in the real economy will inevitably be the reflection of an interest rate policy that is inconsistent with stable inflation. So control of inflation always ultimately implies control of the monetary growth rate. However, the relationship between the monetary aggregates and nominal GDP in the United Kingdom appears to be insufficiently stable (partly owing to financial innovation) for the monetary aggregates to provide a robust indicator of likely future inflation developments in the near term. It is for this reason that an inflation-targeting regime is thought to be superior to one of monetary targeting when the intention is to control inflation itself. In other words, money matters, but not in such a precise way as to provide a reliable quantitative guide for monetary policy in the short to medium term.

Another reason why monetary policy-makers need to monitor developments in monetary aggregates and bank lending closely is that shocks to spending can have their origin in the banking system. From time to time, there may be effects running from the banking sector to spending behaviour that are not directly caused by changes in interest rates.<sup>(1)</sup> There could, for example, be a fall in bank lending caused by losses of capital on bad loans or by a tightening of the regulatory environment. Negative shocks of this kind are sometimes referred to as a ‘credit crunch’. Positive shocks (such as followed from the removal of the ‘Corset’ and consumer-credit controls in the early 1980s) may by contrast induce a credit boom that has inflationary consequences. The potential existence of shocks originating in the monetary system complicates the task of monetary policy-makers, as it makes it much more difficult to judge the quantitative effects of monetary policy on the economy in any specific period. But this is only one of many uncertainties affecting this assessment.

## II The impact of a policy change on GDP and inflation: orders of magnitude

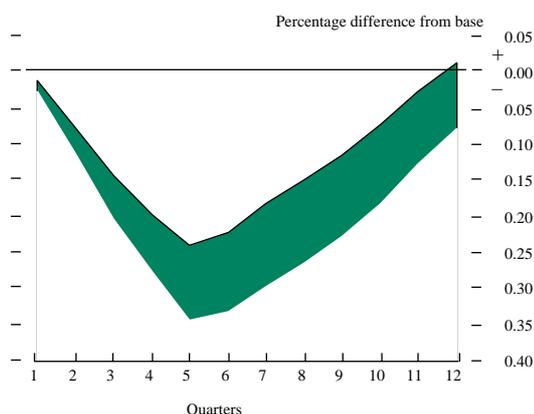
We now illustrate the broad orders of magnitude involved when changes in monetary policy affect GDP and the inflation rate. Two major caveats are necessary at this point. First, we have talked above as if monetary policy changes were causing a perturbation in the economy relative to some equilibrium state. For the purposes of exposition, this is how the impact of a change in monetary policy is illustrated below. But in reality, the economy is continually being affected by a variety of disturbances, and the aim of monetary policy is to return the economy to some equilibrium, rather than to disturb it. Disentangling the

(1) This is sometimes referred to as the ‘bank lending channel’. Another aspect of what is more generally called the ‘credit channel’ is the financial accelerator effect, which was mentioned above in the context of the effect of firms’ asset values on their ability to borrow. The financial accelerator effect is a normal part of the monetary transmission mechanism, but the bank lending channel is not.

effects of monetary policy from those of the initial shocks is often very difficult. Second, at many points above we have talked about the effect of a policy change ‘other things being equal’. Other things are rarely equal between episodes of policy tightening or loosening. The actual outcome of any policy change will depend on factors such as the extent to which it was anticipated, business and consumer confidence at home and abroad, the path of fiscal policy, the state of the world economy, and the credibility of the monetary policy regime itself.

In order to give some broad idea of the size and time-path of the responses involved, we illustrate a simulation range using the Bank’s macroeconomic model (see Charts 1 and 2). There is no sense in which this represents a forecast of what would happen in any real situation (as this would require, among other things, forecasts of many exogenous variables, such as world trade, which are here held at their

**Chart 1**  
Effect on real GDP, relative to base, of 100 basis point increase in the official rate maintained for one year



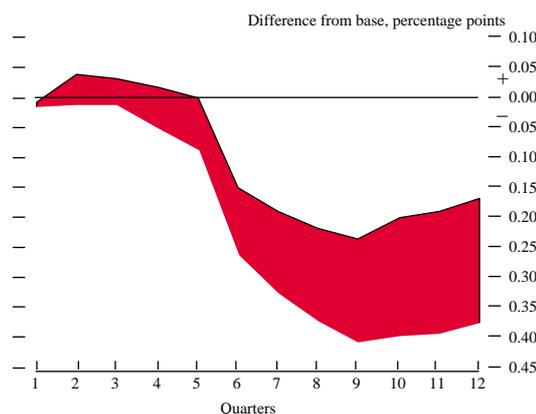
Note: The shaded area represents the range between the paths of two specific simulations, as explained in the text.

base level). Nor is there any probability assigned to the outcome being within this range. Rather, this band is constructed from two alternative simulations, making different assumptions about monetary and fiscal policy reaction functions. Other simulations could give paths outside this range.<sup>(1)</sup> The upper limit of the bands in both the charts is derived from a simulation that assumes a price-level targeting rule for monetary policy, with government consumption spending fixed in money terms. The lower limit assumes a monetary policy rule that feeds back from both the output gap and deviations of inflation from target, with government consumption fixed as a proportion of GDP.

The charts show the response of real GDP and inflation (relative to a base projection) to an unexpected 1 percentage point rise in the official rate that lasts for one year. In both

the upper and lower example, real GDP starts to fall quite quickly after the initial policy change. It reaches a maximum fall of between 0.2% and 0.35% of GDP after around five quarters. From the fifth quarter onwards, GDP returns smoothly to base, as a result both of the effects of the equilibrating forces within the model and of the reversal of policy.

**Chart 2**  
Effect on inflation rate, relative to base, of 100 basis point increase in the official rate maintained for one year



Note: The shaded area represents the range between the paths of two specific simulations, as explained in the text.

The course of inflation, in contrast, is little changed during the first year under either of the simulations reported. But in the second year, inflation falls sharply, and the maximum effect is felt after about nine quarters. In one case, the fall is about 0.2 percentage points at its largest, and in the other, it is around 0.4 percentage points. In both cases, the impact on inflation then starts to diminish, but it has not returned to base three years after the initial policy change, even though policy was reversed after one year. It should be stressed that this simulation is only illustrative, and the explicit assumption that the hypothetical policy change is reversed after one year means that this chart cannot be used to infer how much interest rates would need to be changed on a sustained basis to achieve any given reduction in inflation. The key point to note is that monetary policy changes affect output and inflation with lags.

A final issue that needs clarification is whether the response of the economy to official rate changes is symmetric. The Bank’s macroeconomic model used to generate the simulations discussed above is approximately linear, so rises and falls in the official rate of equal size would have effects of similar magnitude but opposite sign. But for some changes in official interest rates, where expectations and confidence effects are particularly important, the quantitative impact and the lags involved may exhibit considerable variation. This is as true for moves at different times in the same direction as it is for moves in the opposite direction.

(1) More details and an additional simulation that falls within the band, plus the full model-listing used to generate these charts, are reported in Chapter 2 of *Economic Models at the Bank of England*, Bank of England, April 1999.