Can we explain the shift in M0 velocity? Some time-series and cross-section evidence

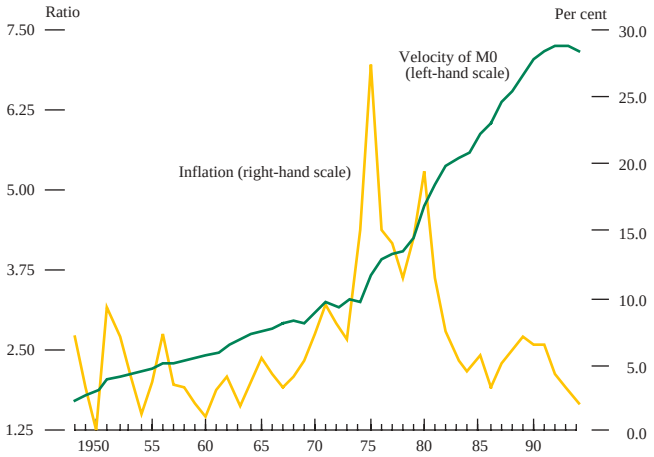
By Norbert Janssen of the Bank's Monetary Assessment and Strategy Division.

- *Narrow money velocity(1) has increased in the United Kingdom since the Second World War. This can be explained largely by innovations in the payments system. But in the 1990s narrow money velocity growth slowed sharply and recently became negative.*
- *Detailed analysis reveals a slowdown in cash-saving financial innovations in recent years.*
- *The recent shift in narrow money velocity may also be related to the move to lower inflation in the United Kingdom in the 1990s. A cross-country comparison of the relation between narrow money velocity and inflation indicates that falling velocity in the United Kingdom is not exceptional by international standards. However, shifts in inflation have not been the only reason for movements in narrow money velocity in other countries.*
- *It remains uncertain whether the recent emergence of negative narrow money velocity growth in the United Kingdom will prove to be permanent or temporary. Further financial innovations are likely to make a positive contribution to narrow money velocity growth.*

Overview

Until the early 1990s, narrow money(2) velocity in the United Kingdom had followed an almost uninterrupted upward trend since the Second World War (see Chart 1). This trend has usually been explained by progress in payments technology. The increased use of alternative means of payment has caused the proportion of expenditure financed by cash to fall almost continuously over this period, even during the low-inflation episodes of the 1950s and 1960s.

Chart 1
United Kingdom: velocity of M0 and inflation



Since 1990, however, this pattern has changed. Narrow money velocity became flat, and has fallen over the past two years. During 1994 and 1995, narrow money growth—at an annual rate of 6%–7%—exceeded the growth rate of nominal income by around one percentage point.(3)

Does this recent strength in M0 relative to nominal spending represent a permanent or temporary change in the behaviour of narrow money velocity? A closer look at the longer-run behaviour of currency velocity in the United Kingdom, and in some overseas economies, may provide useful insights into the underlying causes of the currently strong demand for M0.

One explanation for M0's strength may be a slowdown in the pace of innovation in payments technology. Another may be that the shift to a low-inflation environment in the United Kingdom in the 1990s has led agents to hold voluntarily a higher proportion of their portfolios in cash. Growth of narrow money velocity in periods of low inflation (as in the 1950s and 1960s) could, however, be consistent with the latter effect, if the introduction of substitutes for cash dominated the low-inflation effect. This article considers both explanations.

The first section of this article looks at the effect of financial innovation on the demand for cash in the United Kingdom and the evidence for a slowdown in the pace of change in

(1) Velocity is defined here as nominal income divided by nominal money balances. Thus an increase in narrow money velocity represents a reduction in cash in circulation per unit of national income.
(2) This article uses the terms M0, narrow money, currency and cash interchangeably. M0 consists of notes and coin in circulation, with a value of £23.3 billion at the end of December 1995, and bankers' operational balances at the Bank of England, which amounted to £443 million. Individuals and businesses hold about £20 billion of notes and coin, the rest being held by the public sector and the overseas sector.
(3) Part of the strength in M0 may be related to spending on the National Lottery.

recent years. The second section focuses on the move to a low inflation environment as a possible reason for the shift in currency velocity in the United Kingdom in the 1990s. The third section considers evidence from OECD countries on the long-run behaviour of currency velocity, to explore whether downward shifts in the velocity of currency in some other countries have been associated with a shift to a lower inflation regime. Some econometric results on the relation between the demand for M0 and inflation in the United Kingdom are reported in the annex.

Effects of financial innovation(1)

The effect of financial innovation on the demand for narrow money can be examined by using direct or indirect methods. In most econometric work, financial innovation has been proxied in an indirect way. Econometric explanations developed in the Bank for the demand for M0 have usually accounted for the upward trend in M0 velocity by including a cumulative interest rate term, as a proxy for developments in transactions technology.(2) A cumulative interest rate term can incorporate two distinct interest rate effects. First, a rise in interest rates leads to a fall in narrow money demand (an increase in the velocity of cash) for a given transactions technology. Second, it creates an incentive for financial institutions to invest in, and for people to use, cash-economising technology and payments systems. The cumulative interest rate term treats such innovations as irreversible(3) because of the large fixed costs involved. This implies that financial innovation follows a trend determined by the level of interest rates.

The variable costs associated with innovations in payments technology may also be important in determining the pace of financial innovation from the supply side. The current annual cost to the financial services industry of providing cash to customers through automated teller machines (ATMs) and across branch counters, and of collecting cash from retailers, is about £2 billion according to estimates by the Association for Payment Clearing Services (APACS). By comparison, the annual interest cost of holding the total stock of M0 is only half this amount at current interest rates. These interest costs are opportunity costs for people holding cash—the demand side of the market. Since total costs of the use of cash in the payments system are probably higher for the financial services industry than for the demand side of the market, financial innovation may be determined mainly by the supply side.

More direct evidence on advances in payments technology can be obtained by considering four important innovations in the UK payments system:(4)

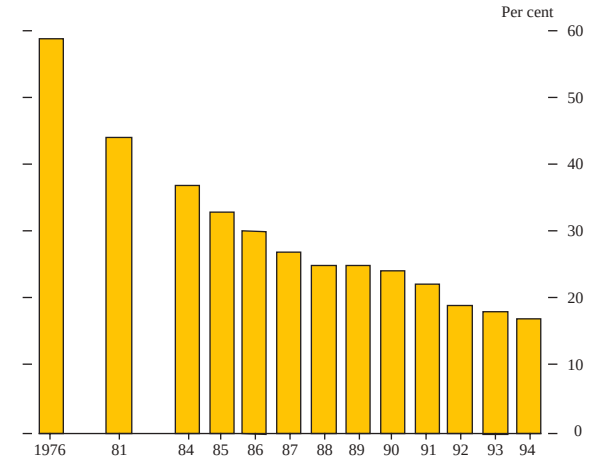
- the switch away from salaries being paid in cash;
- better access to cash from financial institutions;
- the increase in the proportion of the population with bank or building society accounts; and
- the introduction of non-cash payment mechanisms that guarantee payment (cheque guarantee cards, credit and debit cards).

Developments in these innovations may indicate whether a slowdown in the pace of financial innovation can explain the recent slowdown in narrow money velocity growth.

Switch away from salaries being paid in cash

There has been a well established trend away from cash payment for salaries for many years. In the late 1970s, 50% of employees were paid in cash; by 1994 this had fallen to less than 20% (see Chart 2). Since the late 1980s, the rate of progress has been slower, even though the proportion remains high relative to some other countries. Nearly all those still paid in cash in the United Kingdom are paid weekly or fortnightly—only 2% of employees paid on a monthly basis are still paid in cash.

Chart 2
Percentage of employees paid in cash



Source: APACS/IBRO.

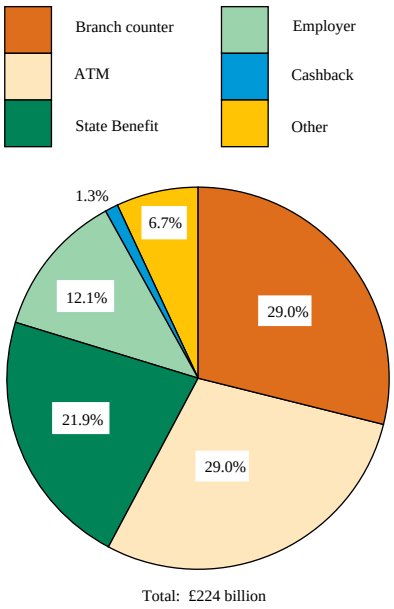
Improved access to cash from financial institutions

The fall in the proportion of employees being paid in cash has been accompanied by a rise in the amount of cash obtained from bank and building society accounts, mainly through ATMs (see Charts 3 and 4). ATMs were the source of only 6% of the total amount of cash accessed from accounts in 1981. But this share had risen to 44% in 1990 and 49% in 1994. While 'cashback'(5) is growing fast, it accounted for only a small proportion of the total amount of cash obtained by the public in 1994.

In theory, the widespread availability of cash via ATMs could have two effects on the demand for M0. First, easier access to cash may increase its use. For many small purchases the use of cash is convenient: it saves time and

(1) The detailed analysis in this section on recent trends in financial innovation and the effects on cash holdings is based on work by Marcus Manuel in HM Treasury, but the views expressed are not necessarily those of HM Treasury.
(2) Examples include Hall *et al* (1989), Brookes *et al* (1991), Hoggarth and Pill (1992) and Breedon and Fisher (1993)—see page 48 of this *Bulletin*.
(3) Since the cumulative interest rate term will not decline unless nominal interest rates become negative.
(4) The data used in this section were provided by APACS.
(5) A cashback facility enables debit-card holders to use their card to obtain extra cash in, for example, supermarkets and petrol stations, by having their card debited for a larger amount than they actually purchase.

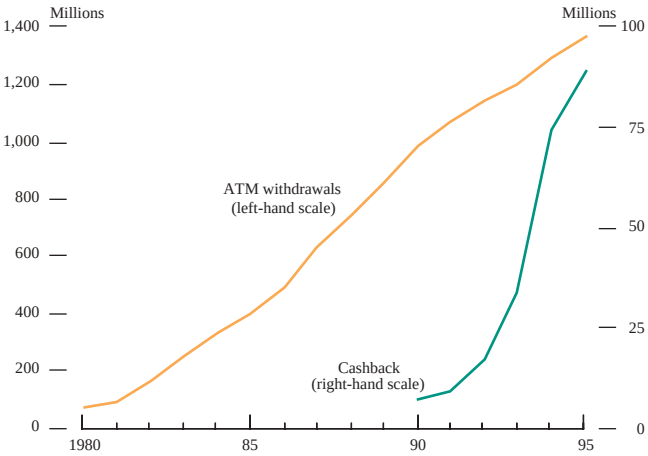
Chart 3
Sources of cash—1994



Total: £224 billion

Source: APACS.

Chart 4
Plastic card cash acquisition volumes



Source: APACS.

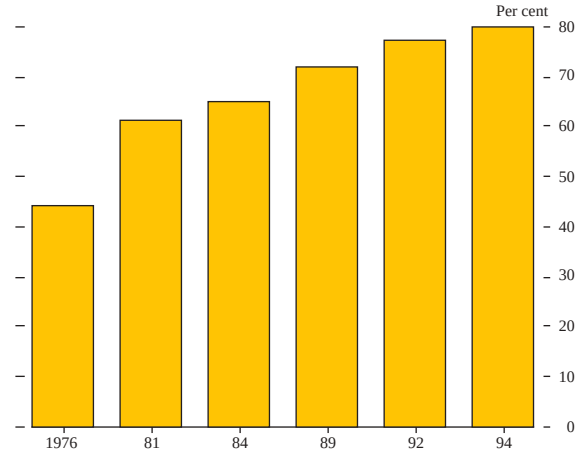
avoids bank charges. Second, ATMs enable individuals to operate with smaller average holdings of cash. Theory would also suggest that the marginal impact of an extra ATM could vary substantially from the first introduction to eventual saturation. The effect may decrease as a further rise in the number of ATMs could imply that the average use of each individual ATM falls. But there may also be a more constant marginal effect arising from developments such as the shift from first to second generation machines, the introduction of shared facilities, and the move to more convenient sites away from banks. These developments may enable agents to hold smaller average cash balances because it is easier to obtain smaller amounts of cash more frequently.

Cashback facilities are likely to have a more direct negative impact on the demand for M0 than ATMs. Cashback facilities are an incentive for customers to use debit cards to pay for relatively small purchases which had previously been bought with cash.

Improved access to bank accounts

The proportion of the population with access to a current account with a cheque book facility at a bank or building society rose from 44% in 1976 to 80% in 1994 (see Chart 5), with the fastest growth in the late 1970s. While 20% of the adult population still has no access to a current account, only 7% has no access to any form of bank or building society account.

Chart 5
Percentage of adults with a current account(a)



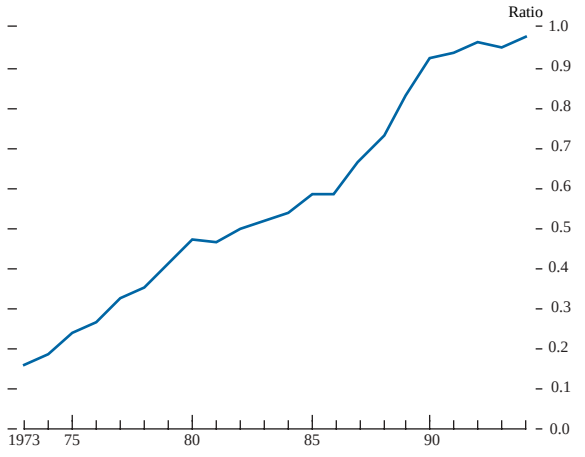
Source: APACS.

(a) With at least a cheque facility, at a bank or building society.

Increased availability of non-cash methods of guaranteed payment

The cheque-guarantee card was the first easy way for people to guarantee non-cash payment; it is still the most widespread. By 1994, there was nearly one card for each adult in the population. While some adults may hold more than one cheque card, this part of the market seems close to saturation (see Chart 6). But there is likely to be further growth in the use of other types of plastic card, such as credit and debit cards, although increased use of these cards

Chart 6
Number of cheque cards/adult population



Source: APACS.

may lead to a move away from the use of cheques, rather than a move away from the use of cash (as discussed in Trundle, 1982). These considerations are partly supported by recent data, which show that the spread of credit and debit cards has increased at a time when the demand for cash has also grown rapidly.

Future pace of innovation

All of the major financial innovations discussed above share two common features. First, they are taking a long time to reach full market coverage. Second, their pace of change slowed significantly in the past five to ten years. There remains scope for even wider coverage, but this is limited and may well continue to spread only slowly. For example, international comparisons suggest that the proportion of adults being paid in cash could fall further. And access to current account facilities is still not uniform across all sections of the population. But even in the case of ATM withdrawals—which are expected to grow significantly—there has been a marked slowdown in the pace of growth in recent years.

More recent smaller-scale innovations in the payments system may have some impact on the demand for cash, such as banks' moves to reduce holdings of cash in ATMs and the easing of restrictions on non-cash payments in some retail outlets. However, many new proposals, such as electronic money, are unlikely to have much effect in the near future.

Effects of financial innovation on cash holdings

The effects of financial innovation have been significant over the past 50 years. Most individuals no longer receive their income in cash, and most invest part of their savings in a bank or building society account. Most individuals can now obtain easy access to the cash they need and most have access to alternative, guaranteed forms of payment. So there is now much less need to hold transactions and precautionary balances in the form of cash.

It is possible to make an estimate of the personal sector's transactions holdings of cash using data from APACS which obtains information from banks, building societies, and its own consumer surveys.

- APACS estimates that total recorded cash receipts by the personal sector were some £220 billion in 1994.
- Two thirds of this cash was obtained by withdrawals from bank and building society accounts. The total number of cash withdrawals each year corresponds to each adult making around one withdrawal a week.
- More detailed survey data on the use of ATMs in 1994 showed that users made a withdrawal of £50 on average at least once a week.
- The two other major sources of cash—payments by employers and state benefits (mainly pensions)—are also usually made weekly.

These observations suggest that most households refresh their stock of cash at least once a week and can adjust their cash holdings at least at the same frequency. If the personal sector on average adjusts its balances every week, then the estimated annual flow of £220 billion could be supported by turning over a stock of around £4 billion each week. This would imply that each adult held on average around £100 of cash for transactions purposes. This implies that just one fifth of the total M0 stock would be sufficient to finance individuals' cash transactions. The rest may be held by businesses (although survey evidence suggests this is a relatively small amount), held overseas, hoarded or used in the black economy.

Innovations in transactions technology have therefore probably slowed in the past few years. However, this could explain only a flattening of narrow money velocity. It could explain negative velocity growth—as has occurred in the United Kingdom over the past two years—only if technological progress had been reversed, not just reached a saturation point.

Time-series evidence on narrow money velocity

Although the flattening and subsequent fall in M0 velocity in the 1990s seems difficult to reconcile with continuing progress in payments methods, it might be explained in part by structural shifts in agents' behaviour following the move of the UK economy from relatively high inflation rates in the 1970s and the first half of the 1980s to lower inflation.

The effect of inflation is already incorporated indirectly in traditional demand for M0 equations by using nominal interest rates. According to the Fisher effect, the nominal interest rate and the expected inflation rate should move together, so that nominal interest rates are equal to real interest rates plus expected inflation. Investors want to be compensated for expected inflation because inflation erodes the real return on their assets. So persistently lower inflation may have led to an increase in the demand for cash by reducing the opportunity cost of holding it. And, at low interest rates a one percentage point change in interest rates has a larger proportional effect on interest receipts and payments than at high rates. If the income effects of interest rate changes alter the demand for narrow money, then a shift to lower inflation and lower nominal interest rates might be expected to show up in traditional money demand equations as a rise in the interest elasticity of the demand for M0.

Inflation may also have an impact on the demand for narrow money through factors other than nominal interest rates. First, if real cash balances and physical goods (or assets) are substitutes, then inflation may affect the demand for cash, because it proxies the return on real goods or assets relative to the return on cash. Inflation may reduce the demand for real cash balances because higher inflation, and hence higher returns on physical goods, induces economic agents to invest in real assets which are thought to offer better protection against inflation. In the 1970s and much of the 1980s, when inflation in the United Kingdom was high, this inflation effect may have contributed to a lower demand for

real money balances. Lower inflation since then may be an important reason for the subsequent shift in the path of narrow money velocity.

Second, the lower variability of inflation that usually accompanies a fall in the inflation rate(1) may affect the demand for M0. Lower inflation variability reduces the perceived risk of an adverse inflation surprise affecting the opportunity cost of agents' cash holdings. Because risk-averse agents want to be compensated for bearing this uncertainty, and to invest their wealth in interest-bearing assets if uncertainty is high, less uncertainty may imply that people voluntarily hold a relatively larger share of their wealth in non-interest-bearing assets, like cash.

A period of low inflation, low inflation variability and low interest rates (compared with the 1970s and 1980s) may have led to an acceleration in the demand for narrow money in the United Kingdom in the 1990s and a downward shift in its velocity. It is, however, unclear in theory whether such a change in inflation performance should cause a temporary or a permanent shift in the rate of change of agents' demand for cash and thus in the growth rate of narrow money velocity. A switch to a lower inflation environment may reduce incentives to financial innovation and lead to less use of existing alternatives to cash, because the opportunity costs of holding cash have fallen below some threshold level. This may then affect the trend growth rate of narrow money velocity, which would amount to a permanent behavioural shift.

There are, however, also reasons why the lower inflation profile of the 1990s should have affected only the level of M0 velocity, and not its trend growth rate. On the demand side, the improvement in inflation performance is likely to induce a once-and-for-all increase in desired holdings of cash balances. In that case, the recent fall in M0 velocity would be temporary. But the fall in velocity may occur only gradually, with a slow portfolio adjustment to the increase in desired holdings of cash balances, because agents do not adjust their inflation expectations down until they consider the shift to lower inflation permanent. Cash balances, and the level of velocity, may therefore take time to reach their new equilibrium, with narrow money velocity declining—or at least growing less fast—throughout this period. Eventually, however, narrow money velocity may resume its positive trend growth path, since the opportunity costs of holding cash will remain positive in equilibrium and the incentives for financial innovation from both the demand and the supply side will continue.

Time-series evidence for the United Kingdom seems to be consistent with temporary rather than permanent effects on currency velocity from lower inflation. During the 1950s and the first half of the 1960s inflation was relatively low, while the velocity of currency grew steadily at an annual rate of around 2.3%. This growth of narrow money velocity is not inconsistent with the hypothesis that narrow money velocity could fall as a result of a shift to low inflation following a period of relatively high inflation. In the 1950s and 1960s, the dominant influence on currency velocity was probably the introduction of substitutes for the use of cash—in particular, the growing availability of current accounts with a cheque book facility.

The rise of narrow money velocity growth during the 1970s and 1980s—to an annual average rate of 4.3%—might have reflected the combined effect of higher and more variable inflation rates and the continuing rapid pace of financial innovation. But during the 1990s narrow money velocity has flattened and fallen, which may be explained in part by lower inflation. Narrow money velocity growth in the United Kingdom may therefore have been influenced throughout the post-war period by both the inflation regime and the pace of financial innovation.

Econometric work undertaken in the Bank suggests that the shift in inflation performance in the United Kingdom may provide a partial explanation for the recent fall in currency velocity. But the effects of interest rates and inflation on the demand for cash cannot easily be identified separately. This problem may be resolved partly by the inclusion of terms representing both inflation and inflation variability in the demand for narrow money equation. Inflation variability may be less correlated with nominal interest rates than is inflation itself, for example if inflation variability and interest rates respond at different speeds to changes in inflation. The results for the United Kingdom, reported in the annex, indicate that the demand for M0 can be explained reasonably well with an equation including inflation and inflation variability, although this is not the only possible specification of agents' behaviour.

Cross-section evidence on currency velocity

It is useful to compare UK narrow money experience with evidence from other OECD countries. Cross-country evidence may indicate whether common factors can explain the relations between narrow money velocity and inflation overseas. Charts 7 to 19 show the behaviour of the velocity of currency and inflation(2) in 13 OECD countries. These charts suggest that the switch to a low-inflation environment might have generated sizable and persistent effects on narrow money velocity in some countries, although they do not resolve the question of whether the shift in velocity growth is permanent or not. The profiles of currency velocity in a number of countries exhibit clear similarities, although their timing differs.

First, velocity trended upward over the early part of the sample period in all countries (except Japan) when inflation, and inflation variability, was rising. Second, this was followed by a period of flat velocity in eight countries (notably Canada, the Netherlands and Spain) and, most recently, by a period in which velocity growth was negative—strongly so in seven of the countries and usually

(1) See Joyce (1995). Full references for sources quoted in this article are on page 48.
(2) For these countries velocity is calculated as quarterly nominal GDP divided by the measure of currency held outside the banking system (source: *International Financial Statistics*, row 14a). The inflation measure used is the annual change in the GDP deflator.

Chart 7
Belgium: velocity of currency and inflation

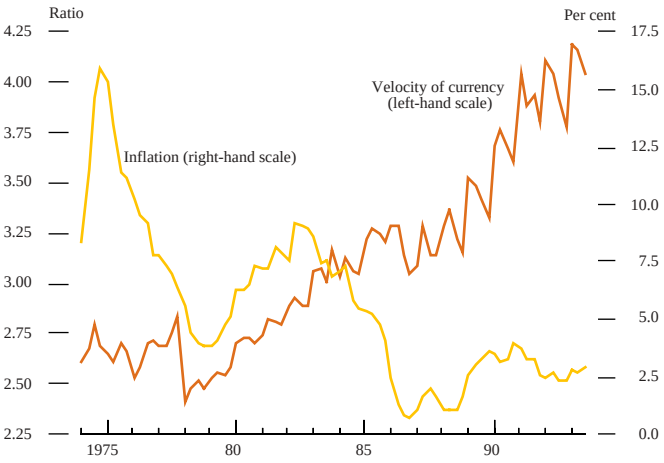


Chart 8
Canada: velocity of currency and inflation

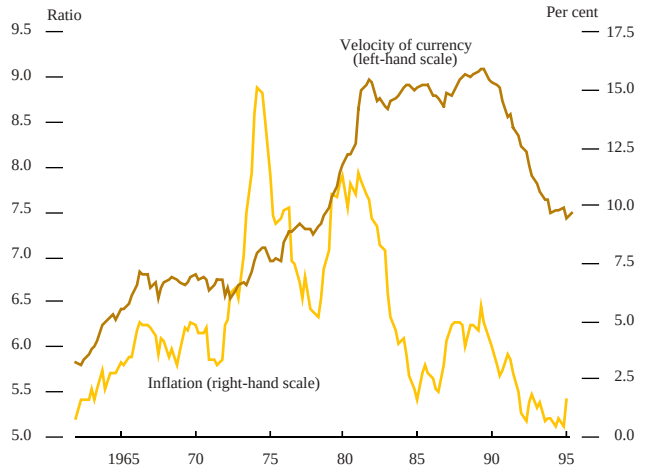


Chart 9
Denmark: velocity of currency and inflation

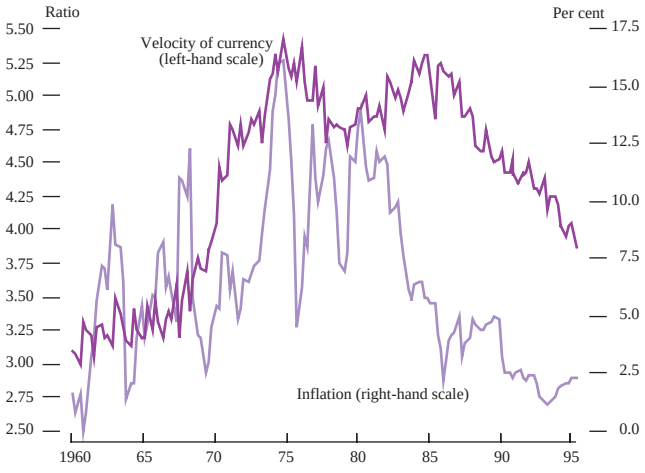


Chart 10
France: velocity of currency and inflation

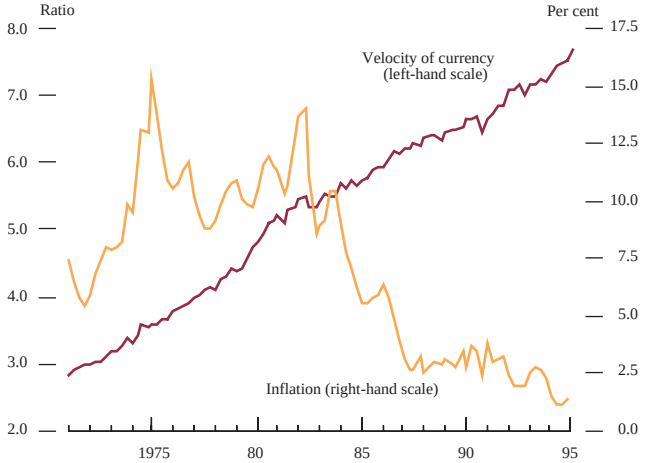


Chart 11
Germany: velocity of currency and inflation

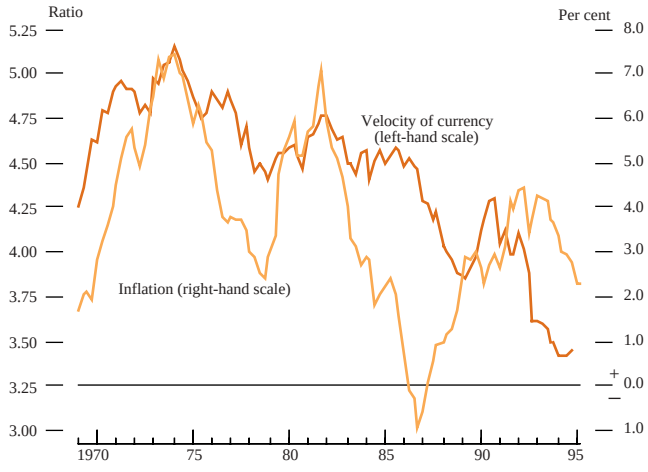


Chart 12
Ireland: velocity of currency and inflation

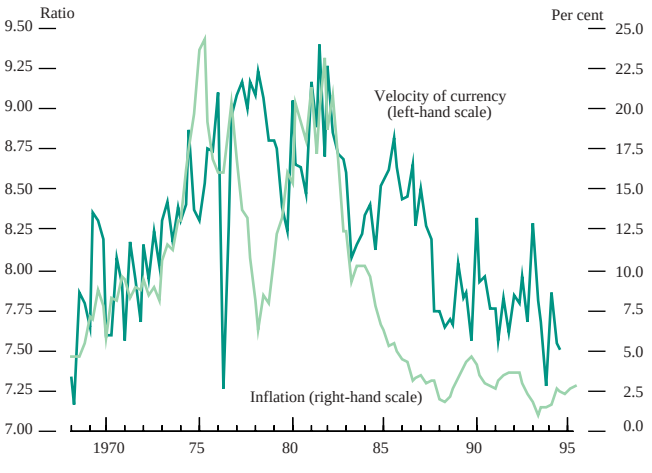


Chart 13
Italy: velocity of currency and inflation

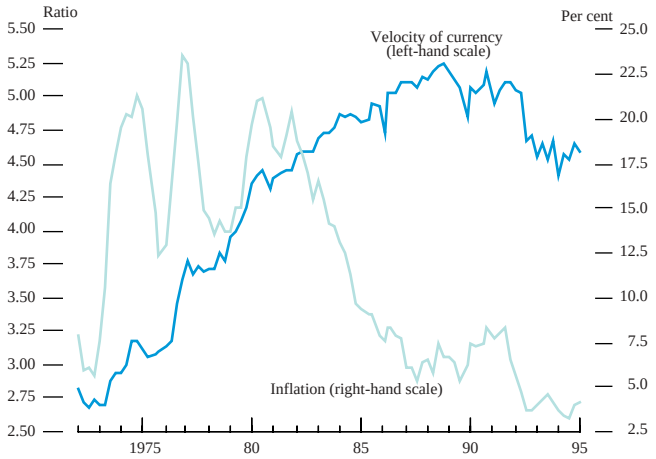


Chart 14
Japan: velocity of currency and inflation

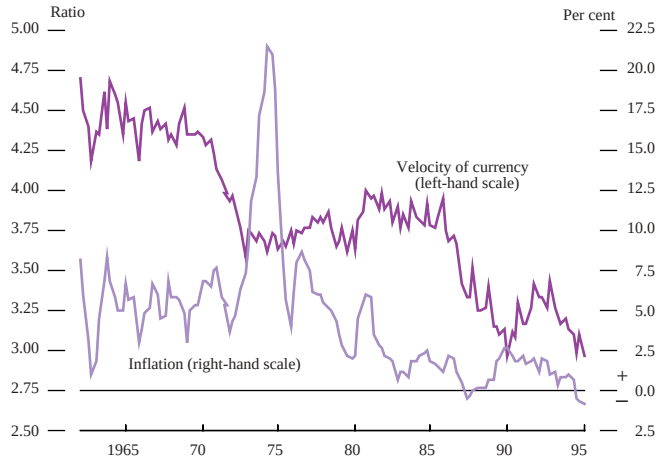


Chart 15
Netherlands: velocity of currency and inflation

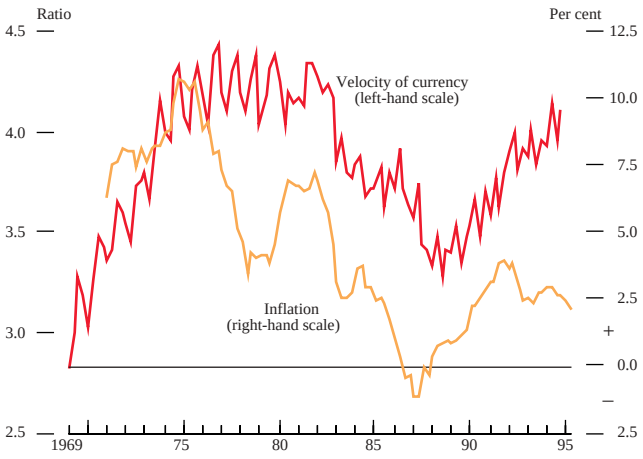


Chart 16
New Zealand: velocity of currency and inflation

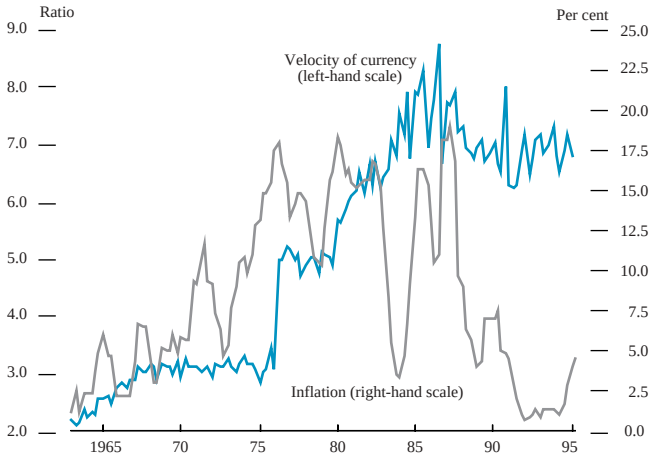


Chart 17
Spain: velocity of currency and inflation

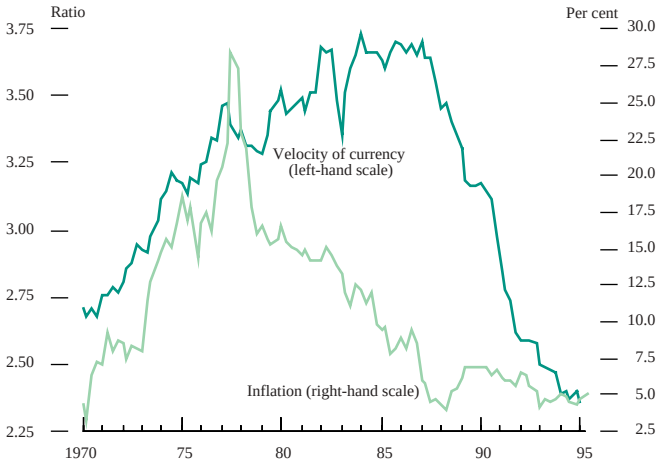


Chart 18
Switzerland: velocity of currency and inflation

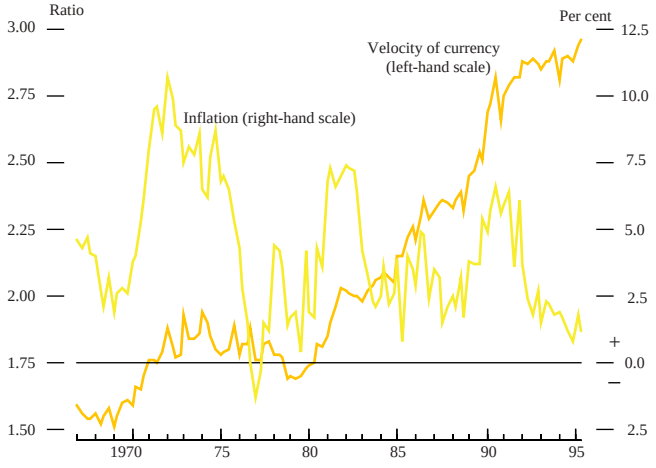
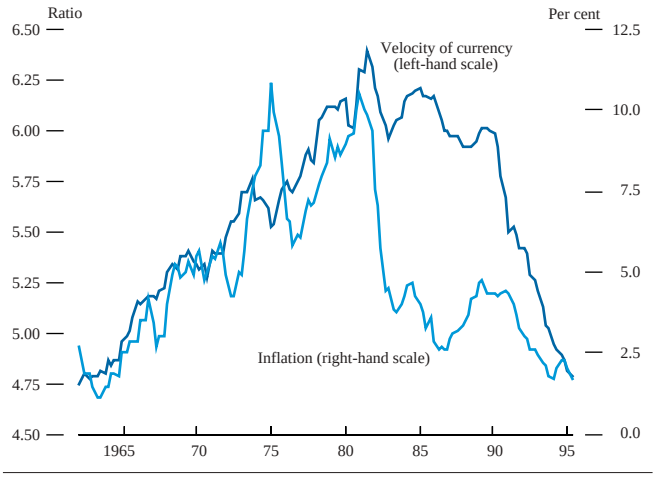


Chart 19
United States: velocity of currency and inflation



for several years. Most of these shifts in velocity coincided with downward shifts in inflation.

Third, in most countries velocity growth slowed sharply in the 1990s, and in several it was negative, while inflation was significantly lower than in the 1980s. In Germany, the Netherlands and Switzerland, inflation rose sharply in the late 1980s, which seems consistent with the pickup in their velocity growth rates, although the rise was only temporary for some. But in Belgium and France velocity has continued on a steady upward path, independently of changes in the inflation profile. So the link between inflation and narrow money velocity may be weaker in some countries than in others, and differences in financial innovation may also be important (see Boeschoten, 1992, for some cross-country evidence).

Fourth, although inflation rates in most overseas economies peaked in the early 1980s and have fallen since, currency velocity growth did not generally begin to fall until the early 1990s. This suggests a lagged, and perhaps non-linear, response in the demand for cash—inflation may have to fall and remain below a critical level for some time before velocity falls. For many countries, the charts suggest that currency velocity begins to decline once inflation has fallen below about 5%; the correlation between currency velocity and inflation then becomes stronger. This is consistent with the UK experience of negative narrow money velocity growth in the 1990s once inflation had fallen decisively below 5%. Overall, these cross-country comparisons suggest that the recent UK experience of flat or falling currency velocity is not unusual, nor is the apparent link with low inflation. Based on cross-section estimates, Boeschoten (1992) shows that the differences in national currency demand can be explained partly by differences in average rates of inflation, which makes a similar point.

Country-specific evidence

A more detailed analysis of the available cross-country evidence shows that the following country-specific factors[1] may also explain the relation between the velocity of currency and inflation.

- Although the flattening and subsequent fall in narrow money velocity in Germany and the United States (see Charts 11 and 19) coincided with shifts to lower inflation, it might also be explained partly by shifts in the amounts of currency circulating abroad. Therefore German and US evidence should be treated cautiously. The share of US dollar currency held by non-residents has increased since the early 1980s and was about two thirds of the total in 1993 (estimates reported in Porter, 1993). About 40% of Deutsche Mark notes and coin were held abroad in 1994 (see Deutsche Bundesbank, 1995). Currency velocity in Germany, however, began to fall in the second half of the 1970s, in line with lower inflation and the introduction of the Bundesbank's monetary targeting strategy in December 1974. In the first half of the 1980s velocity was flat, and in the 1990s it fell again, roughly corresponding to a move to lower inflation. Inflation in Germany has been below 8% throughout the period shown in the chart. This, together with the relatively slow trend in financial innovation, probably account for much of the pattern of currency velocity in Germany, despite effects from currency held abroad.

- The charts for Canada (Chart 8), Ireland (Chart 12),[2] the Netherlands (Chart 15) and Spain (Chart 17) suggest a relatively high correlation between inflation and the velocity of currency. Empirical research in the Bank of Canada (Lafléche, 1994, and Hyland, 1994) suggests that the rise in currency velocity until the late 1980s was primarily because of increasing use of cheques and credit cards. But the decline in interest rates since 1990, which was triggered by a fall in inflation, was a significant factor in the decline in the velocity of currency in the 1990s. In addition, the growth of the black economy, which is likely to be mostly cash-financed, may provide another explanation for the increased use of cash in the 1990s. Estimates of the size of the black economy in Canada range from 4%–15% of GDP. Larger denomination notes have increased as a proportion of total notes and coin in circulation, which may also be related to growth of the underground economy.

- The Netherlands' experience is similar to that of Canada. Boeschoten (1992) examines the effects of guaranteed cheque transactions, the number of chequeable deposits (which appears to be related to the small proportion of employees being paid in cash) and inflation on the demand for real cash balances in the Netherlands. The financial innovation variables affect the demand for cash significantly, but inflation does not. There is, however, also evidence of an increasing use of currency as a store of value, or for hoarding purposes, despite rising interest rates in the 1970s. As

(1) Most of these factors have been suggested and analysed by national central banks.
(2) Retail sales are used as the scale variable for Ireland.

in Canada, the share of large denomination notes in total circulation has increased and may explain the fall in velocity over the 1980s (Bos, 1994). The widespread introduction of cash dispensers since the late 1980s explains part of the subsequent increase in velocity (Boeschoten, 1995).

- Hoarding might also explain the decline in currency velocity in Denmark since 1985 (Chart 9). There has been a considerable rise in the demand for 1,000 kroner notes, with more than 50% estimated to be hoarded. Again, this may be partly related to the black economy. Widespread use of credit and debit cards has not depressed the demand for currency sufficiently to affect this.

- The rise in currency velocity in Spain in the 1970s was mainly because of innovations in the payments system. Although inflation in Spain has fallen since the late 1970s, velocity started to decline only in the late 1980s. From the Spanish experience it seems that inflation must first fall to a critical level before the velocity of currency begins to fall.

- Until 1985, New Zealand (Chart 16) experienced rising currency velocity. Since then, velocity has flattened off as inflation has fallen sharply. The profile of currency velocity in New Zealand is similar to that in the United Kingdom. Only the timing differs; in New Zealand velocity growth flattened earlier than in the United Kingdom. Siklos (1995) estimates demand for M1 equations, including proxies for inflation expectations, credit card billings and the number of electronic-funds-transfer-at-the-point-of-sales (EFTPOS) terminals. The demand for various monetary aggregates in New Zealand appears to be stable once these factors are taken into account. Inflation expectations affect the demand for M1 negatively, which is consistent with a positive relation between currency velocity and inflation. The New Zealand experience, with the rapid growth in EFTPOS transactions, ATMs and cashback facilities, is that technological progress has had an ambiguous effect on cash balances. The introduction of flat rate bank transactions charges may also have created incentives for the public to make more payments in cash.

- The countries without breaks in the velocity of currency—France, Belgium and, to a lesser extent, Switzerland—show a velocity profile which closely resembles that of the United Kingdom until 1990, with an upward trend over most of the sample. In France (Chart 10), the steady rise in velocity is largely the result of progress in payments technology, though the introduction of cash dispenser cards is not thought to have affected the demand for cash much. Cash is mainly used for small transactions up to FFr 100, with cheques traditionally being used for larger payments.

- The financial innovation effect also seems to have dominated any depressing effect of low inflation on currency velocity in Belgium (Chart 7), where velocity has risen since the late 1970s. Between 1984 and 1989, however, velocity was broadly flat, coinciding with significantly lower inflation. After this period, currency velocity in Belgium continued its earlier upward trend. This suggests that the switch to low inflation may have had temporary rather than permanent effects on velocity in Belgium. In Switzerland (Chart 18), estimates of demand equations for individual denomination notes (Peytrignet, 1995) suggest that parameter instability—observed since 1989—is also related to innovations in transactions technology, such as the increased use of credit cards and ATMs. There too, the profile of currency velocity seems to have been determined mainly by financial innovations.

Overall, several velocity patterns can be distinguished in these OECD countries. First, the rise in velocity in most countries over the early part of the sample, caused mainly by innovations in payments technologies and by high and variable interest and inflation rates in many of the countries. Second, the flattening-off and subsequent fall in currency velocity in a number of countries, which may have been the result of a shift to lower inflation. Third, the switch to a low inflation environment has not been the only explanatory factor in currency velocity; country-specific developments have also been important.

Summary and conclusions

There was until recently a steady upward trend in narrow money velocity in the United Kingdom since the Second World War, which could be explained partly by innovations in the payments system. But in the 1990s velocity growth slowed sharply. Detailed analysis of trends in cash-saving financial innovation in the United Kingdom reveals a slowdown in the pace of change. But the analysis also suggests that the personal sector's transactions demand for cash may now account for only around a fifth of the total stock, making estimates of the impact of any further innovation uncertain.

The shift in M0's velocity may also be related to the move of the UK economy to lower inflation. The recent strength in M0 in the United Kingdom can be explained relatively well with a demand for M0 equation that attempts to capture some of the effects of this low-inflation regime. A cross-country comparison of the relation between currency velocity and inflation indicates that falling velocity in the United Kingdom is not exceptional by international standards, although changes in inflation profile have not been the only reason for shifts in currency velocity overseas.

It remains uncertain whether negative velocity growth in the United Kingdom will be permanent or temporary. The potential for further financial innovation is likely to make a positive contribution to future narrow money velocity growth.

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Annex

The relation between the demand for M0 and inflation in the United Kingdom —some econometric results[1]

The econometric work presented here differs in four ways from traditional demand for narrow money specifications. First, short and long interest rates are used as opportunity cost variables that proxy the rates of return on alternative short-term assets, such as bank deposits, and bonds, respectively. Second, a financial wealth variable is included to capture the precautionary and speculative demand for cash. Third, it takes into account separately the effects of inflation and inflation variability on the demand for cash, in addition to any effect from long and short interest rates.

Fourth, the switch in currency velocity after the shift in inflation regime in the United Kingdom might be picked up by an increase in the interest elasticity of narrow money demand at low rates of inflation and interest rates. This potential change in behaviour is approximated here by the use of a logarithmic specification for interest rates in the demand for M0 function, as opposed to the usual semilog interest rate specification. The difference between these specifications is that the interest elasticity is higher at lower interest rates using the logarithmic specification.

For example, in a traditional semilog interest rate representation, all variables, except interest rates, are expressed in natural logarithms. The response of the demand for M0 to interest rate changes is then a semi-elasticity; it indicates the *percentage* change in cash holdings as a result of a one *percentage point* change in interest rates. The logarithmic (or log-log) specification used here adopts natural logarithm expressions for all variables. The elasticity of the demand for M0 with respect to interest rates is then a full elasticity; it shows the percentage change in the demand for M0 in response to a *1% change* in interest rates. Under a semilog specification, agents respond to *absolute* changes in interest rates, whereas they respond to *relative* or *proportional* changes under the log specification. For example, at 5% interest rates, a 1% increase amounts to a rise of 0.05 percentage points to 5.05%, whereas a one percentage point increase would increase rates to 6%.

Why might agents respond to relative, rather than absolute, interest rate changes? One possibility is that they are sensitive to the income effects of interest rate changes. A one percentage point change in interest rates has a larger proportional effect on interest income at low interest rates than at high rates. If interest rate elasticities are stronger at low rates of inflation, then the use of the logarithmic interest rate specification may go some way towards capturing the recent growth of narrow money in the United Kingdom.

In the long-run equation for real cash balances, imposition of the theoretically correct sign on several coefficients could not be rejected by a Chi-squared test.[2] Real cash balances are homogenous in permanent income (proxied here by current income plus wealth), which is theoretically possible. The coefficient of 0.05 on net wealth may indicate economies of scale in cash holdings in a financially sophisticated economy. The long-run elasticity of real money balances with respect to the long interest rate is much smaller than the short interest rate elasticity, as expected if short-term assets are a closer substitute for cash than long-term assets.

The dynamic M0 equation is parsimonious and shows quite a satisfactory fit.[3] All variables that enter the dynamics have the 'correct' signs theoretically; in particular, inflation and changes in inflation variability affect growth in the demand for M0 significantly and negatively. The small coefficient on the lagged residual from the long-run equation indicates that adjustment to long-run equilibrium takes place slowly. This suggests that falling narrow money velocity could last for some years before velocity resumes its former trend growth profile.

Re-estimating the above dynamic equation over the sample 1972 Q2–1990 Q4, and using these estimates to obtain dynamic out-of-sample forecasts of quarterly real narrow money growth over the period 1991 Q1–1995 Q2, Chart A shows that there is no consistent under or overprediction of money growth over most of the out-of-sample period. And

(1) More detailed publication of these results will follow.

(2) The long-run equation uses the logarithmic interest rate specification in a portfolio framework of narrow money demand, over the sample 1972 Q1–1995 Q2 (applying Johansen's maximum likelihood estimation method for cointegrating vectors):

$$M0/P = 0.95\, y + 0.05\, w - 0.01\, t - 0.2\, rs - 0.05\, rl - 0.01\, \sigma$$

where $M0/P$ refers to real M0 balances, y is the volume of retail sales, w represents real net private sector financial wealth (all in natural logarithms), t is a linear time trend that proxies financial innovation, rs represents the log of short interest rates, rl is the log of long interest rates and σ denotes inflation variability (calculated as the moving 20-quarter standard deviation of inflation).

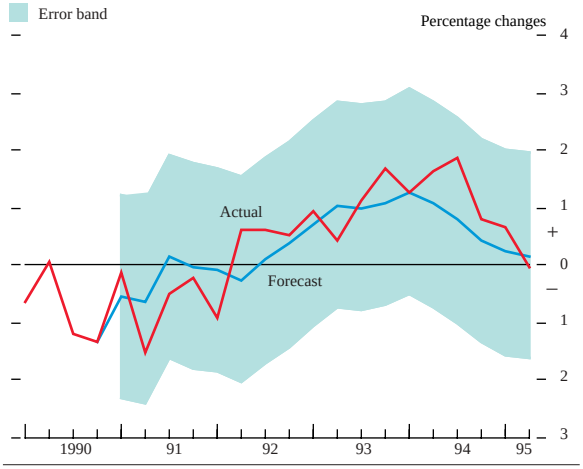
(3) Estimated over the sample 1972 Q2–1995 Q2 the dynamic error-correction form of the equation for the demand for M0 is (where D refers to first differences, $\neq$ to inflation and ECM (-1) to the lagged residual from the long-run demand for narrow money equation):

$$D(M0/P) = 0.04 + 0.26\, Dy - 0.18 \neq - 1.99\, D\sigma(-1) - 0.08\, ECM(-1) - 0.03\, d74Q4 - 0.03\, d76Q4$$
(3.87) (4.15) (-2.86) (-2.28) (-5.84) (-3.08) (-3.50)

$R^2 = 0.64$, SE = 0.008, DW = 2.30
AR = 1.47 [0.21]
ARCH = 2.82 [0.03]**
Normality = 2.50 [0.29]
Heteroskedasticity = 2.67 [0.01]***
Reset = 0.77 [0.38]

The variables $d74Q4$ and $d76Q4$ are dummies for outliers in the residuals of the equation. t-statistics are shown in parentheses. Probability values are shown in square brackets. ** significant at 5% level; *** significant at 1% level.

Chart A
Actual values and dynamic forecasts of quarterly real narrow money growth

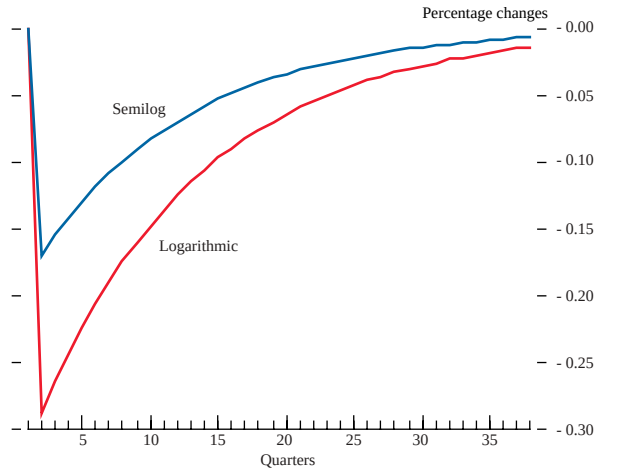


all forecasts are within the error variance bands, suggesting forecast errors are not statistically significant.

Overall, the results for the United Kingdom indicate that the demand for M0 can be explained reasonably well with the above dynamic equation. This is not the only possible specification of narrow money demand; it is meant only to be illustrative of how separate inflation effects might be encompassed within a M0 specification. And, in this respect, it is striking how significant a role they seem potentially to play, and the implications this has for understanding narrow money behaviour.

For example, Chart B shows a comparison of simulations of the effects of a one percentage point increase in short-term

Chart B
Interest rate simulations: response of quarterly real money growth to interest rate shocks (assuming 5% average interest rates)



interest rates on real M0 balances, under a semilog and a logarithmic specification on the assumption that average interest rates are 5%. At these average interest rates, the response of real M0 is around twice as high under the logarithmic specification as under the semilog function (although the profiles are similar in qualitative terms). In the logarithmic model, the demand for real cash balances falls by about 0.3% after one quarter and then gradually returns to its initial equilibrium. But, at higher interest rates (10%), both specifications lead to similar interest elasticities, because 10% is the average interest rate over the sample period.