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Alternate Monetary Aggregates and the Price Level

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Contents

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I. Introduction

Milton Friedman (1968a) claimed that "inflation is always and everywhere a monetary phenomenon" 1/ but which is the relevant monetary aggregate? 2/ There are several measures in use and each of these sometimes behaves differently. In the United Kingdom, for example, M2 rose by over 22 percent per year over the last 5 1/2 years while M1 rose at 16 percent and the monetary base at a scant 3.4 percent. Nor is the United Kingdom an exception. Denmark's M2 grew at 25.5 percent in 1983 and 17.0 percent in 1984 while the monetary base grew at a mere 7 percent. Which aggregate should one target to control the rate of inflation?

This paper could be viewed simply as an empirical examination of the choice between different monetary aggregates to influence the rate of inflation. The creation of new financial instruments (both within and outside the banking system) that are close substitutes for demand deposits have prompted many policymakers to focus on increasingly broader monetary aggregates that encompass them. The paper examines both broad and narrow aggregates and finds that, for the countries examined, currency with the non-bank public has a well specified demand function that is in some respects better than that of the broader monetary aggregates. Currency explains the out-of-sample price level better than do any of the other

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1/ The phrase illustrates the importance of etymology. Inflation originally meant an increase in bank notes in circulation. When price indices were developed in this century, inflation also came to mean an increase in the price level. The associated link to an increase in the "money" stock was somehow lost.

2/ Milton Friedman (1968b, 1969, 1977, 1985) has argued for a monetary rule but asserts that it does not matter which aggregate one chooses so long as its rate of growth is controlled. A recent quote is illustrative: "These sharp swings provide evidence on two important monetarist propositions: first, that different monetary aggregates move together; second, that movements in monetary aggregates produce corresponding movements in nominal income" (1984, p. 398). Perhaps he intended to drive home the more important point that changes in relative prices, such as wage or petroleum price increases, are not inflation.

Benjamin Friedman, examining the same (but unadjusted) data, and writing in the same journal, disagrees with Milton Friedman's claim that the aggregates move together and instead states "To use monetary aggregates in this way [i.e. as a target] the central bank must have a clear view about which specific aggregate it is using and why" (1984, p. 383).

monetary aggregates. The broad aggregates may, therefore, mislead one about the future course of inflation. This, by itself, may be an interesting result. 1/

That currency with the non-bank public bears a closer relation to the price level than do the other aggregates is not mere coincidence but is to be expected from value theory. In the first few sections of the paper, and before the empirical results are presented, the determination of the price level and its theoretical link to "money" is examined. "Money" has two connotations that need to be clearly distinguished: one is its function as a numeraire (unit of account) and the other is its role as a medium of exchange (transactions medium). It is argued that "money" which is the numeraire is very different from that which is the transactions medium.

The price level is determined by the supply of and demand for the numeraire. Any good in the economy can serve as the numeraire, but most economies have evolved from using a commodity (gold or silver) to units established by government fiat. 2/ The bulk of these units are held as fiat currency by the public for use also as a transactions medium 3/ and the remainder as commercial bank reserves with the central bank. The supply of and demand for this total, called the monetary base, it is argued, determine the price level. 4/

If banks passively hold a fraction of deposits as reserves with the central bank, then bank reserves will change with the fluctuations in bank intermediation or changes in the required reserve ratio. If these

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1/ Certain accounting identities are used within the International Monetary Fund when analyzing the economies of countries and in helping design adjustment policies to follow. Consolidating the Central Bank and commercial banks' balance sheets yields the identity that "money" equals domestic credit plus net foreign assets. This "money" is, from the accounting, the broad measure. This paper does not dispute the fundamental identity but it does question broad money's effect on the price level.

2/ Even when gold was the numeraire, the common trasactions medium were bank notes and checks.

3/ Although the numeraire may be one of several mediums of transactions, the converse does not hold. Assets whose ownership could be transferred can be, and to varying degrees are, used as a transactions mediums; these assets, as Section III argues, are not the numeraire.

4/ The terms "inside" and "outside" money have been used in the literature. "Outside" money is the monetary base while "inside" money are bank deposits. As the terms evoke memories of a confusing debate from the past, they are avoided.

fluctuations are frequent, the price level can be better analyzed through the supply of and demand for currency with the public, rather than the monetary base. The empirical sections of this paper demonstrate that the demand for the real quantity of currency with the public is a stable function. The price level, therefore, will depend upon the nominal quantity of currency with the non-bank public.

The quantity of "money" qua transactions medium, it is argued, is not the numeraire and has no bearing on the price level except to the extent that it may affect the demand (or supply of) for the numeraire. This paper goes beyond the common, and valid, criticism that the aggregates in use, such as M1 or M2, do not accurately measure the transactions medium: it gets at a more fundamental point that even if better transaction measures were found, (perhaps the "divisia indices" described in Spindt (1985) that weight aggregates by their turnover rates), these would not determine the price level and need not be targeted to curb inflation.

The real (nominal) quantity of transaction balances may vary with real (nominal) income leading many to advocate controlling "money" (qua transactions medium) in order to influence real income or the business cycle. Others dispute the direction of causality; but this controversy, important though it may be, is not central to the issue addressed in this paper. Taking real income and its fluctuations as given, this paper examines the relation between "money" and the price level. Accepting the arguments in this paper and the empirical results that link the quantity of the currency to the price level does not preclude either view about the causal relation between the transactions medium and income.

If the ratio of currency with the public to M1, M2 or other measures is fairly constant, the different aggregates will grow at similar rates and empirical studies cannot distinguish among them. So the proposition that the price level is determined by the supply of and demand for the monetary base (or equivalently, currency with the public) than of the conventional monetary aggregates (M1 or M2), is best examined in countries where the aggregates behave differently; perhaps growing at dissimilar rates.

The demands for various monetary aggregates (monetary base unadjusted for changes in reserve holdings, currency with the public, M1 and M2) are estimated in the conventional manner and the parameters are used to forecast the price level for several periods ahead. In all cases examined, currency was found to explain the out-of-sample price level best (i.e., with the smallest mean absolute and mean squared errors).

The paper is organized in eight sections. Sections II through IV are non-mathematical and draw on the analysis in Fama (1980), who in turn builds upon Patinkin (1961) and Tobin (1963). A simple mathematical

model in the Appendix repeats the analysis and presents some comparative statics results. In Section II, the determination of the price level is described. The conventional monetary aggregates are well entrenched measures and the justifications for them are examined in Section III. Section IV is a digression on monetary policy that examines the relation between real income and the various monetary aggregates.

Sections V through VII are the empirical parts of the paper. The techniques used are outlined in Section V and some additional technical issues on money demand estimation are discussed in Section VI. The results are presented in Section VII. The conclusions are in Section VIII.

II. The Determination of the Price Level

The price level is a weighted average of the relative prices of various goods and services in terms of the numeraire. These relative prices are simultaneously determined in Walrasian equilibrium; but, following Alfred Marshall's technique, it is useful to analyze the price level as being determined by the supply of and demand for the numeraire. When the "dollar" is the numeraire, the question that arises is whether total "dollars" should be measured as currency, or bank deposits, or the sum of the two.

In this section it is argued that the quantity of the numeraire is appropriately measured as total currency and not as total bank deposits or the sum of the two. The possible justifications for their aggregation are examined in the next section; but the choice of the numeraire and the distinction between currency and bank deposits becomes clear when deposits are measured in units other than currency.

Following Fama's example, consider an economy where banks and other financial intermediaries keep their accounts in steel ingots and make "million ingot loans." Fiat currency ("dollars") may exist and be used as a hand-to-hand transactions medium. It is not, however, used in keeping the bank's accounts.

If the amount of bank intermediation rises at the expense of other forms of intermediation, perhaps because banks compete more effectively with other institutions like mutual funds, bank deposits measured in ingots would increase. This increase of deposits measured in ingots does not affect the physical supply or demand for ingots and the structure of relative prices in the economy will be unchanged. 1/

1/ Changes in one market affects all others in Walrasian equilibrium. So it is conceivable that changes in the market for bank deposits affects the market for steel ingots. This effect, if any, would be small indeed and for all practical purposes can be ignored.

If a fiat currency is desired, perhaps for use in transactions of small value, it performs a useful function and is like any other good. Like any other good, currency's price in ingots is determined by its supply and demand, neither of which may be altered by the substitution of non-bank for bank intermediation. If the price level is measured in terms of fiat currency, it will be equal to the price level measured in steel ingots times the price of steel ingots in terms of currency. It was just seen that the structure of relative prices is unaffected by the volume of bank intermediation. The price level will be unchanged whether measured in ingots or in currency, although bank deposits and consequently "money" (M1 or M2) increased.

Fama (1980) makes the same point relying on the Modigliani-Miller theorem that "the banking sector is at most a passive force in the determination of prices and real activity" (p. 45). The structure of relative prices and the price level is unaffected by the volume of bank intermediation (which nevertheless affects M1 and M2).

If banks are required to hold physical units of the numeraire as reserves, the analysis is slightly different. Currency with the public is freely convertible to bank reserves and vice versa. The price level measured in "dollars" is determined by the supply of and demand for the monetary base, the sum of currency and bank reserves. As in Fama (1980), the monetary base is the outside nominal variable that determines the price level. However, it is argued below that this is equivalent to analyzing the supply of and demand for currency with the non-bank public.

The demand for the monetary base may be split in two parts; that by the public to hold as currency and that by commercial banks to hold as reserves. 1/ ("Vault cash" is counted as bank reserves.) Changes in the

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1/ If banks are not required to hold reserves, this portion of the demand for currency disappears and the analysis of the earlier paragraph applies. If banks undertake to exchange deposits for currency, they may hold some "vault cash" but their holdings of currency will be affected by the same set of economic variables, like the nominal interest rate, as the non-bank public and their demand can be aggregated with that by the non-bank public.

More interesting, but a bit esoteric, is what would happen if the demand for fiat currency disappears entirely and all transactions can be undertaken through an accounting system of exchanging various forms of wealth. Fama (1980) examines this issue and shows that the price level does not explode or become indeterminate, as many of the earlier writers thought. Rather, currency can no longer be used as the numeraire, but the price level is determinate when measured in terms of some other good.

Fama also shows that an arbitrary unit may be restored as a numeraire if a demand may be artificially created by the government. Forcing banks to hold the artificial units is one, but by no means the only way. Fama's imaginative example involves forcing the space travel industry to hold units; and this, by creating a demand for units, derived from the demand for space shuttle seats, enables the units to be the numeraire.

volume of bank intermediation alters the bank's demand for the base. Banks will never hold more reserves than they are required to because they could hold interest-bearing assets instead. (Some excess reserves may inadvertently result if the penalties of falling short are onerous.) So the bank's demand for the base is the specified fraction of its deposits and passively reflects the amount of bank deposits the public chooses to hold.

The public's demand for currency 1/ arises from the need to effect transactions of small value for which bank checks or other transactions media are inappropriate. Their demand is for the real quantity of currency. For a given price level, this translates to a particular nominal quantity.

The total nominal demand for the base is the sum of that which banks have to hold as reserves and that the public wishes to hold as currency. If this equals the nominal stock of the monetary base (that the government has supplied), all is well. If not, the price level changes until equilibrium is attained.

The mechanism through which the price level changes is the familiar one of attaining market equilibrium and can operate through expenditures on goods and services and through attempts at portfolio rebalancing. If, say, the non-bank public holds more currency than it desires, they try to spend it on consumption goods that will eventually drive up their nominal prices. (Real output is taken as given, because the focus here is on the price level and not on the business cycle.) At the same time, they will wish to reallocate their portfolio of assets of various kinds (including bank deposits, common stocks, etc.) and drive up their nominal prices as well. Finally, the nominal prices of all goods, services, and assets (including bank deposits) will be higher; or the price level, measured in terms of currency, will be higher.

Variations in bank intermediation will affect the price level but only because the reserve requirement on banks translates these into fluctuations in the demand for the monetary base. (Or, depending on which way one looks at it, into fluctuations in the supply of currency to the non-bank public.) When this happens, the price level and the conventional measures of money will move in opposite directions. Briefly, an increase in bank intermediation, caused perhaps by banks competing more effectively with other intermediaries, will increase the reserves they hold. This will reduce the nominal stock of currency with the public whose demand

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1/ "Currency" here should include notes and coins of all denominations. The aggregation is permissible, as will be shown in the next section, because of the issuer's credible promise to maintain the relative prices at which any denomination may be exchanged for another.

for the real quantity is unchanged, resulting in an equilibrium at a lower price level. The nominal quantity of M1, the sum of currency (which declined) and bank deposits (which increased) is shown in the appendix to have increased. Other comparative statics on the effects of various changes are also shown in the appendix.

Any change in the bank's holding of reserves, which may be either due to changes in bank intermediation or changes in the required reserve ratio, will affect the price level through the demand for the base. It is difficult to allow for these fluctuations, especially in countries where explicit reserve ratios are augmented by "suggestions" which bankers can only ignore at their peril. And no adjustments can be made for changing bank intermediation. Under these circumstances, it would be easier to examine currency held by the non-bank public, a series readily available for most countries, in predicting the price level. The implicit assumption in focusing on currency with the non-bank public, rather than on the monetary base, is that shifts in the demand for currency are less common than shifts in bank intermediation or changes in bank reserves with the central bank. This is an empirical issue but, given the rapid financial innovations that have occurred, this may be reasonable.

Many central banks target M1 and can alter the monetary base (the policy instrument) through an open market operation to achieve it. In countries with a pegged exchange rate, however, the monetary base automatically reflects external factors and the balance of payments. If the monetary base is made "endogenous" in this manner, does it still determine the price level? The issue may be a semantic one and "determine" had best be understood as the proximate cause, rather than as the ultimate source, of the price level.

In developing countries, currency may be used more than are other assets as a means of payment and perhaps even as a store of value. Subsistence agriculture and poverty results in few transferable assets other than currency. Transacting with currency may also reflect a desire to evade taxes, especially when tax rates are high. Whatever the reason for holding it, so long as the demand for currency is a stable function, all of what has been said before applies.

When the domestic currency's value erodes rapidly, a foreign currency, such as the United States dollar, could become the medium of exchange at least in some segments of the economy 1/. This "currency substitution" will reduce the demand for the domestic currency. Once the parallel use stabilizes, domestic currency will have a stable demand function that can be estimated.

1/ If the foreign currency merely serves as the numeraire, and does not physically serve as a transactions medium, it will not affect the demand for the domestic currency as a medium of exchange.

The main point of this section is that, the price level is determined by the supply of and demand for the monetary base, or, equivalently the supply of and demand for currency with the non-bank public. The price level does not depend upon the volume of bank intermediation except to the extent that it may affect the demand for (or supply of) the monetary base. As an empirical proposition, it may be easier to examine the supply and demand for currency with the non-bank public than for the monetary base because bank intermediation and reserve requirements may vary.

III. Conventional Aggregates Examined

After decades of adding demand deposits to currency, and estimating the demand for "money" or M1 (albeit having to add shift parameters and making arbitrary adjustments whenever needed), it would appear naive or arrogant to question its use. The possible justifications for adding the two are examined in this section. It should be reiterated that the discussion is solely about the determination of the price level, taking real income as given, and not over what may affect, or reflect, the business cycle (which is briefly discussed in the next section).

Items that are perfect substitutes, such as dollar bills with different serial numbers, may be aggregated. Alternatively, items (which may not be perfect substitutes) may be aggregated if the price of one in terms of the others is always unchanged. An example of this would be a one cent coin and $100 bills (whose relative price is 1:10,000, although they are not perfect substitutes) which allows the aggregation of notes and coins of all denominations. It is shown in this section that neither of these conditions apply to currency and bank deposits.

That currency and bank deposits are not perfect 1/ substitutes is obvious. Many studies have found the elasticity of substitution to be less than perfect; to cite a recent paper, Hancock (1985) finds that all cross price elasticities between cash and demand and time deposits are less than unity.

Nor is the relative price between currency and bank deposits fixed. That a dollar of currency will always buy a dollar of demand deposits is rather like a dollar of currency always buying a "dollar's worth of

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1/ "Good" or "close enough" substitutes is not enough. Aggregation will not cause problems if the relative price between them happens not to change; but this paper examines precisely those periods when such changes do take place.

apples." That such confusion does not arise with apples but does arise with bank deposits is because apples have a physical measure (kilograms) but bank deposits do not. 1/

Deposit insurance (FDIC or FSLIC) does not fix the relative price between currency and bank deposits. For such a price to be fixed, one must be able to exchange one item for the other and vice versa. Deposit insurance undertakes to buy the deposit at the specified price but does not sell it. 2/ Commercial banks, not the government or the central bank, sell deposits and the deposits at different banks provide services of different quality and so yield different returns.

If currency and bank deposits are not perfect substitutes, and if their relative prices are not fixed, can they be aggregated for use as a numeraire? A few other possible justifications are examined below.

Demand deposits, until quite recently in the United States, seemed "barren" like currency and this was thought to be reason enough to add

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1/ One way to arrive at a physical measure of bank deposits is by viewing them in a radically different way. Black and Scholes (1973) observed that equity is a call option to buy the firm from the bondholders at an exercise price equal to the principal (plus interest) of the bonds at a date corresponding to the maturity of the bond.

A bank depositor may be viewed as owning the assets of the bank and having sold a call option to the bank equity holder to buy back the bank's assets. Deposit insurance is a put option that allows the depositor to sell the assets of the bank to the insuring agency (FDIC). The put will be exercised only when the assets are worth less than the insured amount (when the call option that the bank equity holder owns will be "out of the money" and worth nothing).

Bank assets, in turn, are loans to commercial and industrial firms. Banks, as holders of the debt, own the assets of the firms and have sold a call option to the borrowing firm's equity holders.

So the bank depositor actually has a complex portfolio of the fractional ownership of machinery and other physical assets, put options (FDIC insurance) with short positions in various call options (to the equity holders of the banks and the equity holders of the bank's borrowers).

2/ The government establishes the floor price but not the ceiling price for the item--as it does when it establishes wheat or dairy supports--but it does not pay the price.

If a floor price is sufficient to add items to currency, wheat and other products should, by the same logic, be added.

the two. 1/ However, bank deposits have always paid an implicit return in the form of free or underpriced banking and accounting services. An explicit return has been paid in recent years and bank deposits now resemble other financial securities more than they do currency. These changes have prompted many to include other deposits that are increasingly being used to effect transactions.

Any form of wealth whose ownership may be transferred can, and to varying degrees does, serve as the transactions medium. Transactions differ in value and the form of wealth that is used to effect it depends upon the costs of transferring different assets. Currency is the preferred medium for transactions of small value. Bank deposits are used when accurate accounting and periodic statements are needed and stocks and bonds (perhaps owned through mutual funds of various kinds) are used for transactions of larger value. 2/ So the proper transactions measure is really a measure of transferable wealth. But surely wealth cannot be said to determine the price level. 3/

1/ Milton Friedman implies that the payment of interest distinguishes aggregates for he wrote "The current M1 is conceptually, though in the earlier years not numerically, closer to the aggregate we labelled M2 rather than our M1 because, like our M2, it includes deposits bearing interest." (1984, page 398. Emphasis added.)

It is interesting to contrast this view with Keynes (1930) who observed that "In Great Britain the oldfashioned distinction between deposit accounts and current accounts, namely that the former earn interest but the latter do not, is fast becoming blurred; for, increasingly, banks allow interest on the average of a customer's current account in excess of an agreed minimum--with the result that deposit accounts and current accounts are tending to correspond to differences of banking custom between different parts of the country and different classes of customers, rather than to the payment or non-payment of interest." (page 32)

2/ The Federal Reserve Board (1986) survey on the use of different accounts confirms this pattern.

In the United States, where mutual funds are common and some that hold very short term bonds (money market funds) allow checks to be written. However, funds may be transferred over the telephone from a stock or a bond fund to the money market funds effectively permitting stocks and bonds to also be used as the transactions medium. Perhaps the major impediment to their more widespread use is that capital gains and losses are taxed when realized requiring one to keep track of these--an inconvenience, but not an insurmountable problem.

3/ No one has actually claimed that increasing wealth is inflationary. However, this would be the logical implication of "broad money" or "transactions medium" determining the price level because all wealth (or, in the absence of slavery, non-human wealth) can be used as the transaction medium.

Some might favor the inclusion of "liquid" assets only. However, liquidity (the ease with which assets can be traded with no appreciable

Although both currency and bank deposits (or any transferable asset) can be used to effect transactions, there is a fundamental distinction between the two. The value of a currency (i.e., a determinate relative price with other goods) arises solely from its use as a transactions medium; 1/ the value of other assets that serve as a transactions medium arises because of the goods they produce (e.g., land and machinery), or the consumer satisfaction they render (e.g., paintings, gems, etc.). Bank deposits, as argued earlier, are claims to such assets and its value does not depend upon its use as a transactions medium. So although the numeraire may be a transactions medium, all transactions media are not the numeraire.

Occasionally, M1 is justified on empirical rather than theoretical grounds. Laidler (1977) after discussing various money measures states "the correct definition of money becomes an empirical matter" (page 103). Both the monetary base and M1 seem to explain the inflation in the United States since World War II. In the 1930s, however, M1 declined drastically as did the price level but the monetary base did not. This is specious evidence because, when the solvency of financial intermediaries is questioned, the demand for currency (and that for the monetary base) shifts and if the nominal stock does not change in accordance, the price level will fall. If these shifts are common, then the demand for currency (or that for the monetary base) will not be a stable function but while the stability of the function is an empirical issue, the determination of the price level is a theoretical one.

It is possible, but unlikely, that the demand for currency (or that for the monetary base) is unstable but that the demand for currency plus

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3/ (Continued from page 10) effect on their prices) would require the inclusion of most stocks and bonds. Scholes (1972) shows that stock prices do not change when large trading occurs for portfolio reasons.

There have been attempts recently to measure what is actually used as the transaction medium using divisia indices (e.g. Spindt (1985)). These weight different assets (commercial paper is included but long term bonds and stocks are inexplicably excluded) by the rate at which they turn over. It appears as if such a measure is of interest because its velocity is constant; but this is so from construction.

Even if such a measure is constructed, it can be readily seen that its supply and demand cannot be said to determine the price level. It is easiest to see this when some other good, say steel ingots, is used as the numeraire. A divisia measure of "money" can change without altering the supply or demand of ingots, or the structure of relative prices, leaving the price level unchanged.

1/ See the earlier footnote on how the price level can be made determinate when the demand for currency for use on a transactions medium disappears.

bank deposits is stable. 1/ Even so, as may be seen from the comparative statics of the model presented in the appendix, the price level will reflect the supply and demand for currency, unstable though it may be, and not M1. The empirical sections in this paper, however, find that currency demand, far from being unstable, seems better behaved than that of the broader monetary aggregates.

To summarize this section, currency should not be added to bank deposits in calculating the numeraire that determines the price level. Broader measures of the transactions medium do not determine the price level either. All transferable wealth can, in principle, be used for transactions but it is not "money" qua transactions medium but qua numeraire that determines the price level.

IV. A Digression on Monetary Policy

The foregoing analysis has not been concerned about fluctuations in real income (the business cycle) but has focused exclusively on the determination of the price level. The analysis therefore implies nothing about whether "monetary policy" can be effective in moderating the business cycle and, if so, which monetary aggregate would be the appropriate target or whether "rules or discretion" should be employed. Yet distinguishing between "money" as the numeraire and as the transactions medium may help in understanding monetary policy.

Total wealth, including that held through intermediaries of all kinds, may vary with the business cycle. The velocity of wealth (defined as the flow of income divided by the stock of wealth) may then be fairly constant over the business cycle. If an unvarying fraction of wealth is used as the transactions medium and is included in the measure of "money", then the velocity of this "money" measure would also be fairly constant. If, in contrast, the monetary base is kept constant, its velocity would be procyclical. 2/ King and Plosser (1984) build a model of a real business cycle along these lines. Their tests find evidence, consistent with the reasoning in this paper, that "much of the contemporaneous correlation of economic activity and money is apparently with inside money, with inflation

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1/ For this, the demand for bank deposits should also be unstable but in a manner that exactly offsets changes in currency demand: a very unlikely possibility.

2/ While fluctuations in real income may cause wealth, and hence that part of it that is included in the transactions measure of "money" to vary, it does not affect the monetary base ("money" qua numeraire) unless the authorities choose to let this happen either because of a pegged exchange rate or because they choose to conduct or abstain from an open market operation.

principally resulting from changes in the stock of fiat (or outside) money and variations in real activity. This empirical observation implies that care should be taken in empirical studies to distinguish inside from outside money" (page 378).

The broader the monetary aggregate (M2 or M3), the more wealth is included in it (and proportionately less currency) and the less variable will be its velocity over the business cycle. This seems to be the case in several countries (Isard and Rojas-Suarez (1986)). If one were to examine the divisia measures, the velocity would be even more stable by construction.

Stable velocity of a monetary aggregate does not, however, imply that targeting that aggregate would be effective in moderating the business cycle. The aggregate may reflect, rather than affect, changes in real income; the direction of "causality" is uncertain.

There is also the question as to how the broader monetary aggregates can be controlled. An open market operation exchanges securities with the public (usually government bonds) for the monetary base and while the base can thus be directly controlled, the quantities of M1, M2 and M3 depend on how the public responds and how much of their wealth they choose to hold through banks. The only other instrument available to the government to influence the share of bank intermediation is the tax imposed on banks through the reserve requirements--an instrument too crude to fine tune the business cycle.

Even if the wealth held through banks can be controlled, an activist "monetary policy" can be justified only if (1) bank credit complements other types of credit so that inducing greater bank intermediation prompts additional credit rather than substitution from one to the other and (2) that lower credit was the cause, rather than a mere symptom, of reduced economic activity. It is far from clear that either holds.

The effect of "money" qua transactions medium on business cycles is an important issue as is the direction of causality. This paper makes no attempt to deal with these issues, but instead, taking real income and its fluctuations as given, examines the narrower question of which "money" affects the price level.

V. Outline of the Empirical Technique

The earlier sections have argued that the price level is determined by the supply of and demand for the monetary base and that this is equivalent to examining the supply of and demand for currency with the non-bank public. Many, while conceding that the monetary base or currency might be

the appropriate numeraire, might nevertheless favor the broader monetary aggregates on empirical grounds. The empirical parts of this paper seek to demonstrate that for the several countries examined, there is no empirical reason to favor the broader monetary aggregates.

Money affects prices with long and variable lags. Friedman (1985) reports that for the United States, prices tend to be affected 18 to 24 months after a monetary disturbance. If the monetary aggregates vary in a very similar manner, it would be difficult for any technique to distinguish between the aggregates. The demands for the aggregates are therefore best examined in countries, and during periods, when the aggregates vary in a markedly dissimilar fashion. For this reason, the countries examined were selected by the variability of the M1 to currency ratio (as well as by the availability of sufficient data). So the countries in the sample were those whose rates of growth of currency diverged markedly from their M1 growth rate. 1/

In estimating the demand for "money", this paper adopts a fairly conventional technique, outlined in the section that follows, to demonstrate that the demand for currency by the non-bank public is, by commonly used criteria, as well behaved a function as that of the conventional monetary aggregates (M1 or M2). If the demand for currency is a stable function of relevant economic variables then it should be able to predict the price level better outside the period used to estimate the parameters than a similar function for the other monetary aggregates.

The "money demand" is estimated over a particular period for each of the monetary aggregates and the price level in subsequent periods is predicted using the estimated parameters and the actual monetary aggregates. Such a procedure allows for the effects of real incomes and of nominal interest rates, variables that affect the real quantity of "money" demanded. Prediction automatically judges parameter stability although this can also be done with the Chow test or other techniques. The accuracy of the price forecasts is judged by different criteria, such as mean absolute errors, or mean square errors. (And one hopes that they rank them similarly.) If the reasoning in the earlier sections holds, currency with the non-bank public would forecast the price level better than M1 or M2.

1/ It is unfortunate that the United States, where many economic propositions are tested, is particularly unsuitable because the bulk of U.S. currency issued (some $136 billion or 88 percent of total currency issued, according to the Federal Reserve survey, 1986) is not in circulation and has most likely been spirited abroad perhaps to take the place of other more rapidly eroding currencies. In the United States, M1's rate of growth approximates the inflation rate, and this may be why M1 has been avidly embraced as the aggregate that causes inflation.

Hendry (1985) has criticized the conventional techniques that have been used to estimate money demand; but this controversy is not relevant for our purpose. The purpose of the empirical sections in this paper is to demonstrate that, quite apart from the theoretical reasons for focusing on the monetary base or currency, there is no empirical reason to favor the broader monetary aggregates over the narrow ones.

VI. Some Additional Technical Issues

A simple money demand equation in a log linear form is

$$(\ln M_t - \ln P_t) = a + b \ln y_t + c \ln (1 + i_t) + u_t$$

where M_t is the nominal stock of "money" (currency, M1, M2, etc.), P_t the price level, y_t is a scale variable to measure real activity and i_t an opportunity cost measure. u_t is the residual. Theory suggests that "b" is positive and "c" negative.

The literature on estimating "money demand" is vast and the surveys by Laidler (1977) and Judd and Scadding (1982) are useful. It appears that to improve the statistical results, variables are often included without a theory or in a form that does not have a sound rationale.

The scale variable that will be used in this study is measured (current) real income. Some have used wealth or permanent income. The real quantity of money will vary with transactions. 1/ Current real income is the best available measure of these transactions.

For the opportunity cost of money, some have included long-term bond yields or even the entire term structure of interest rates. While such bonds (and common stocks) are substitute assets, their opportunity costs are their expected returns, not yields to maturity. Expected returns are difficult to measure but yields, though readily available, are quite inappropriate. The opportunity cost used here will be only the short-term nominal interest rate, whose yield is the same as the expected return.

1/ A person's currency holding will not be a fraction of wealth but will depend upon the number of petty transactions undertaken. David Rockefeller's wallet will therefore have about as much currency as mine although his income and non-human wealth are greater. "Money demand" has been estimated using (a) M1 rather than currency and (b) time series rather than cross-section data. Studies appear to find wealth a better scale variable than income but this could be because there is more non-human wealth in M1 than in currency resulting in a closer relation.

It is important, when estimating the function, that the interest rate be market-determined (i.e., an equilibrium rate) and not administered by the government. The central bank's discount rate, although readily available, is inappropriate. In countries for which data on market interest rates are not available, or where the reported nominal interest rate is inordinately low compared to the rate of change in the price level, the rate of inflation is used instead. 1/ A person may hold goods (with a real return of zero in the absence of storage costs) instead of bonds whose value is rapidly eroding through inflation.

A time trend is sometimes included in estimating money demand but rarely explained. A constant term in an equation of first differences, as in Fama (1982), is equivalent to a time trend. Population changes and economic growth cannot justify a trend term, because both of these are already captured by real income. Secular changes in transacting technology would also not justify a trend term, especially when used with M1 rather than with bank deposits alone, or currency alone, because it is unclear what the technology changes are and especially when these changes affect the use of currency and bank deposits differently. Besides, real income is generally increasing and a time trend often simply duplicates this, introducing multicollinearity needlessly. Without an independent measure of technological change, it is not possible to allow separately for its effects.

Then there is the intricate timing issue. If y_t and i_t refer to the period from "t" to "t+1," M_t and P_t should both refer to the beginning of the period. This is because asset prices are forward looking and at "t", people hold the real money needed for transactions undertaken from "t" to "t+1" and the asset returns (i_t) adjust so the existing real money stock (M_t/P_t) is willingly held.

Money demand is rarely estimated in this manner. Often, M_t is averaged over the period between "t" and "t+1," and sometimes over the previous period as well, without an explanation.

The price level is never actually measured at an instant, because the prices of goods included in the index are sampled at different times. The reported price index, P_t, is therefore an average of prices between "t" and "t+1." There is therefore little point in adhering strictly to the reasoning in the earlier paragraph and using the nominal money stock at an instant if the price level is a period average. It made little difference whether one used period averages of money stocks or instantaneous stocks and, to conform with most studies, the results reported use period

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1/ The implicit assumption here is that a zero real interest rate is more reasonable than a large, negative one.

averages. The quarterly nominal money stock, M_t, is an average of nominal money stocks between "t" and "t+1" (calculated as an arithmetic mean of four end-of-month numbers).

Quarterly series are used whenever possible. Although more frequent money, interest rate and price series are sometimes available, data on GNP is available only quarterly. Besides, because of the infrequent sampling of several prices, quarterly price indices may be more accurate than monthly measures.

In countries where annual, rather than quarterly GNP is available, a quarterly series is constructed using industrial production as the benchmark series to be followed. In order to estimate the parameters accurately, at least 30 observations are needed. If quarterly series cannot be constructed, 30 annual observations, even if available, are not useful because they would ignore the substantial changes in transactions technology over 30 years. The omission may not be as severe with 30 quarters.

The price level and interest rates are not observed to be seasonal (although they could be, so long as there is no room for intertemporal arbitrage in storable goods). In a few countries, the different money measures (both nominal and real) are seasonal, as are real incomes. So both supply of and demand for money appear to be seasonal. Quarterly seasonal dummy variables are therefore included in the money demand equation.

Lagged real money stock is invariably included when estimating money demand with an appeal to unspecified "adjustment lags." This is implausible, especially when examining quarterly or annual data. Although goods prices 1/ may adjust slowly, asset prices do not. Innumerable studies have demonstrated the remarkable speed with which asset prices adjust in financial markets. The interest rate would change, so the existing real stock of money is willingly held at all times.

Lagged real money has, nevertheless, been found to be statistically significant and without it, the equation has little explanatory power. This could be because the price index measures the true price level with

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1/ Some goods prices may adjust slowly when producers respond to higher nominal prices by raising, or attempting to raise, output before realizing that their nominal costs have risen too. Friedman (1985) observes that the effect, though transitory, of "money" on real ouput has shorter lags than on the price level.

error 1/ and these errors are autocorrelated. Goodfriend (1985) has another explanation. He interprets the lagged dependent variable as picking up downward biases of the estimated coefficients due to measurement errors in the independent variables.

So, despite misgivings based on theoretical reasoning, the lagged real stock of money is included as an explanatory variable. The equation estimated is, therefore, the one that most economists use when examining money demand.

VII. The Results

The equation estimated is

$$(\ln M_t - \ln P_t) = a + b \ln y_t + c \ln(1+i_t) + d (\ln M_{t-1} - \ln P_{t-1}) + u_t$$

1/ Sluggish price movements are often explained by staggered nominal contracts. Such contracts are more common in the labor market than for goods (and may explain why nominal wages are rigid). There may be another reason for sluggish goods prices.

In constructing a price index, many goods are sampled infrequently and listed, rather than transaction, prices are used. Listed prices are infrequently revised (perhaps because they are expensive to do so, especially if changes are thought to be temporary) and actual price changes may initially appear through discounts or queues, which are rarely reflected in an index. It may be some months before the measured index reflects all changes in the true price level. If the price index has more measurement error than the other variables, it would seem that the equation is better estimated as

$$\ln P_t = - a - b \ln y_t - c \ln(1+i_t) - k \ln M_t - u_t.$$

These residuals of this equation are highly autocorrelated. If lagged real money stock is added as an explanatory variable to this equation, it is statistically significant. Furthermore, if lagged nominal money and lagged price level are used in place of lagged real money (i.e., the terms are not constrained to be of equal magnitudes and opposite signs) the coefficient of lagged price level is positive and close to unity while the other variables are not of great importance. So, theory notwithstanding, an AR(1) model is among the better predictors of the price level.

This is really no help in distinguishing among the different monetary aggregates. However, if "k" is constrained to be unity and the coefficients of the lagged nominal money stock and lagged price level are added, they are of opposite signs and have remarkably similar magnitudes. So the constraint that binds is not on the coefficients of the lagged real money term but rather on the contemporaneous nominal money stock.

where $a = a_0 + a_1 S1 + a_2 S2 + a_3 S3$ and S1, S2 and S3 are quarterly seasonal dummy variables.

The estimated "b"s are expected to be positive, although when using observations made over time, technological changes could cause it to be very different (possibly negative) from the true income elasticity at any moment. "c" is expected to be negative. "d" is not dictated by theory, but earlier studies have found it to be positive but less than unity.

Such an equation is estimated for each country with each of the four monetary aggregates in turn. The four aggregates are the monetary base uncorrected for changes in reserve holdings (currency with the non-bank public plus commercial bank reserves), currency with the non-bank public, M1 (currency with the non-bank public plus demand deposits), M2 (M1 plus "quasi-money" or other short term bank deposits). 1/

The last several observations available are omitted when estimating the parameters used to forecast the price level. The estimated parameters are then used in conjunction with the later observations of the appropriate monetary aggregate to forecast the price level. The forecasts are dynamic, using actual values of the independent variables (y_t and i_t) and the predicted values of the lagged dependent variable (M_{t-1}/P_{t-1}) to obtain the predicted value of the real money stock. The predicted price level is obtained from the predicted real money stock and the actual nominal money stock. The difference between the actual and forecast price levels is the forecast error; and the mean absolute values and the root mean squared values of forecast errors are shown in Table 1. Currency with the non-bank public provides the best out-of-sample forecasts of the price level for every country examined.

Plots of the actual price level and those forecast by the different monetary aggregates are shown in the figures that follow. For the United Kingdom, M2 seems to have taken on a life of its own, growing much faster than M1 or currency. This is because the estimated coefficient of the lagged dependent variable is greater than unity in absolute value resulting in an explosive path. Although the parameter used in predicting the price level could have been adjusted, it is interesting that such difficulties do not arise in the estimates of currency demand.

The regressions estimates are in Table 2. The upper panel shows estimates using the entire period and the lower panel shows the estimates

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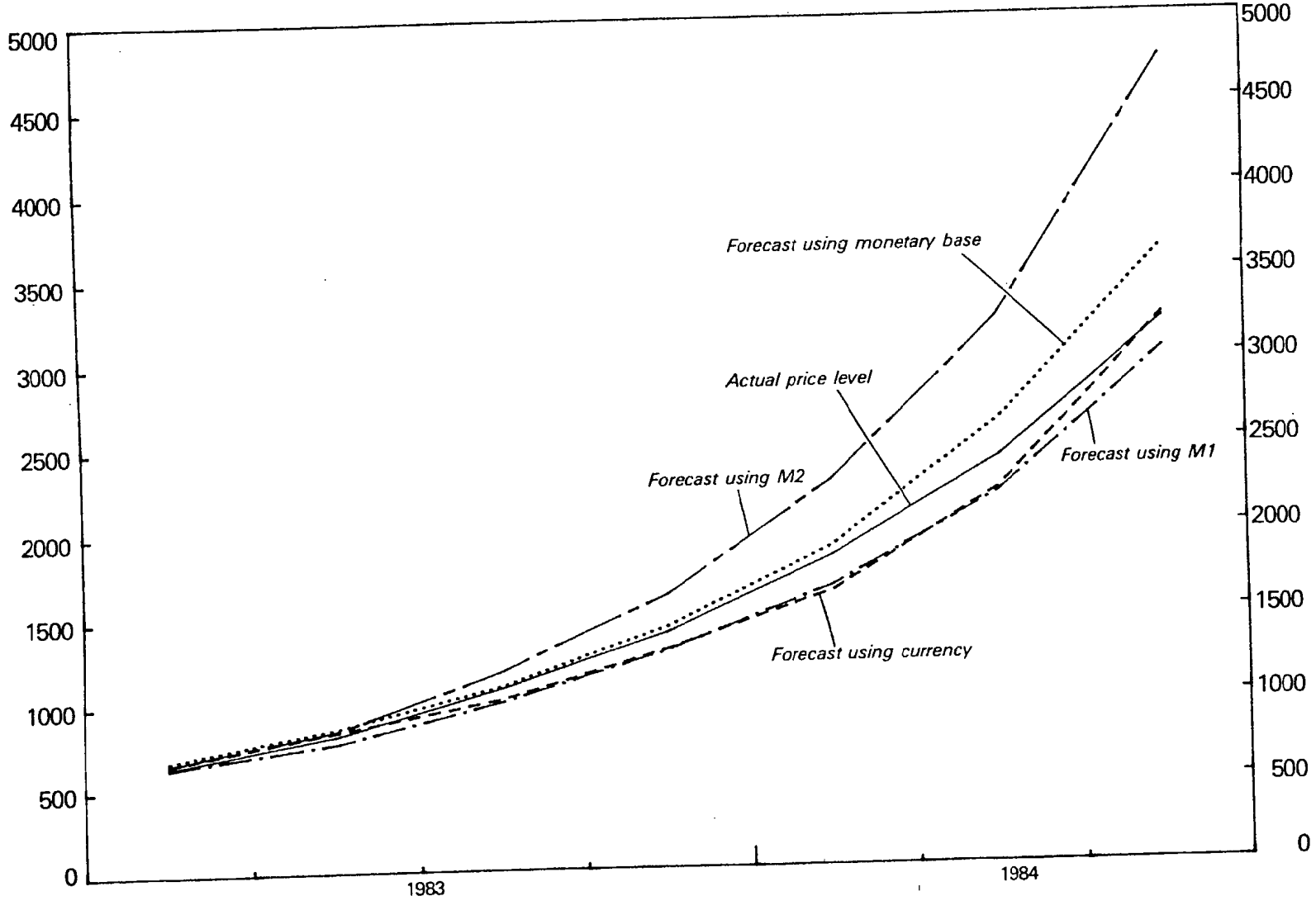
1/ The data are taken from the International Financial Statistics (IFS), lines 14, 14a, 34 and (lines 34 plus line 35) respectively for each country. They are seasonally un-adjusted. The price level is the consumer price index reported in the IFS, line 64.

Table 1. Errors in Price Level Forecasts

Country	Base	Currency	M1	M2
United Kingdom: 22 quarters (Q1 1980 to Q2 1985) based on 26 quarters (Q3 1973 to Q4 1979)				
Mean absolute error	13.6	7.4	11.3	166.3
Root mean squared error	17.3	9.7	13.3	203.1
Denmark: 8 quarters (Q1 1983 to Q4 1984) based on 44 quarters (Q1 1972 to Q4 1982)				
Mean absolute error	20.1	7.4	12.0	14.7
Root mean squared error	23.6	8.5	12.9	15.6
Finland: 9 quarters (Q1 1983 to Q1 1985) based on 20 quarters (Q1 1978 to Q4 1982)				
Mean absolute error	31.7	7.1	10.7	9.0
Root mean squared error	40.3	7.9	11.1	10.6
Argentina: 9 quarters (Q1 1983 to Q1 1985) based on 20 quarters (Q1 1978 to Q4 1982)				
Mean absolute error	10,551.0	3,720.0	6,696.0	3,952.0
Root mean squared error	18,422.3	5,458.6	11,914.5	6,616.3
Brazil: 7 quarters (Q1 1983 to Q3 1984) based on 28 quarters (Q1 1976 to Q4 1982)				
Mean absolute error	124.6	89.1	113.6	450.1
Root mean squared error	192.1	115.5	133.2	682.5

BRAZIL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4500
4000
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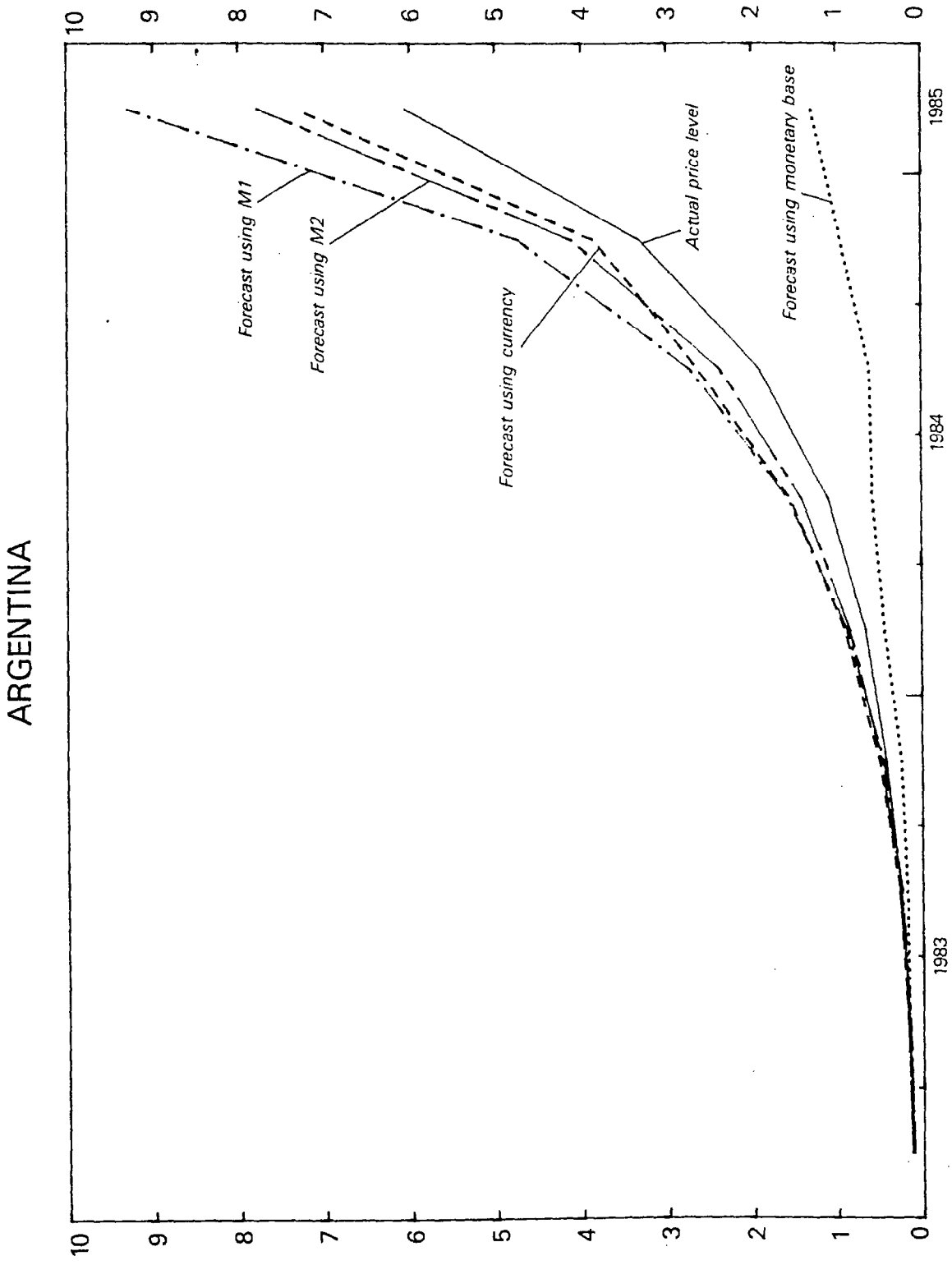
Forecast using monetary base
Actual price level
Forecast using M2
Forecast using M1
Forecast using currency
1983
1984


ARGENTINA
Forecast using M1
Forecast using M2
Forecast using currency
Actual price level
Forecast using monetary base
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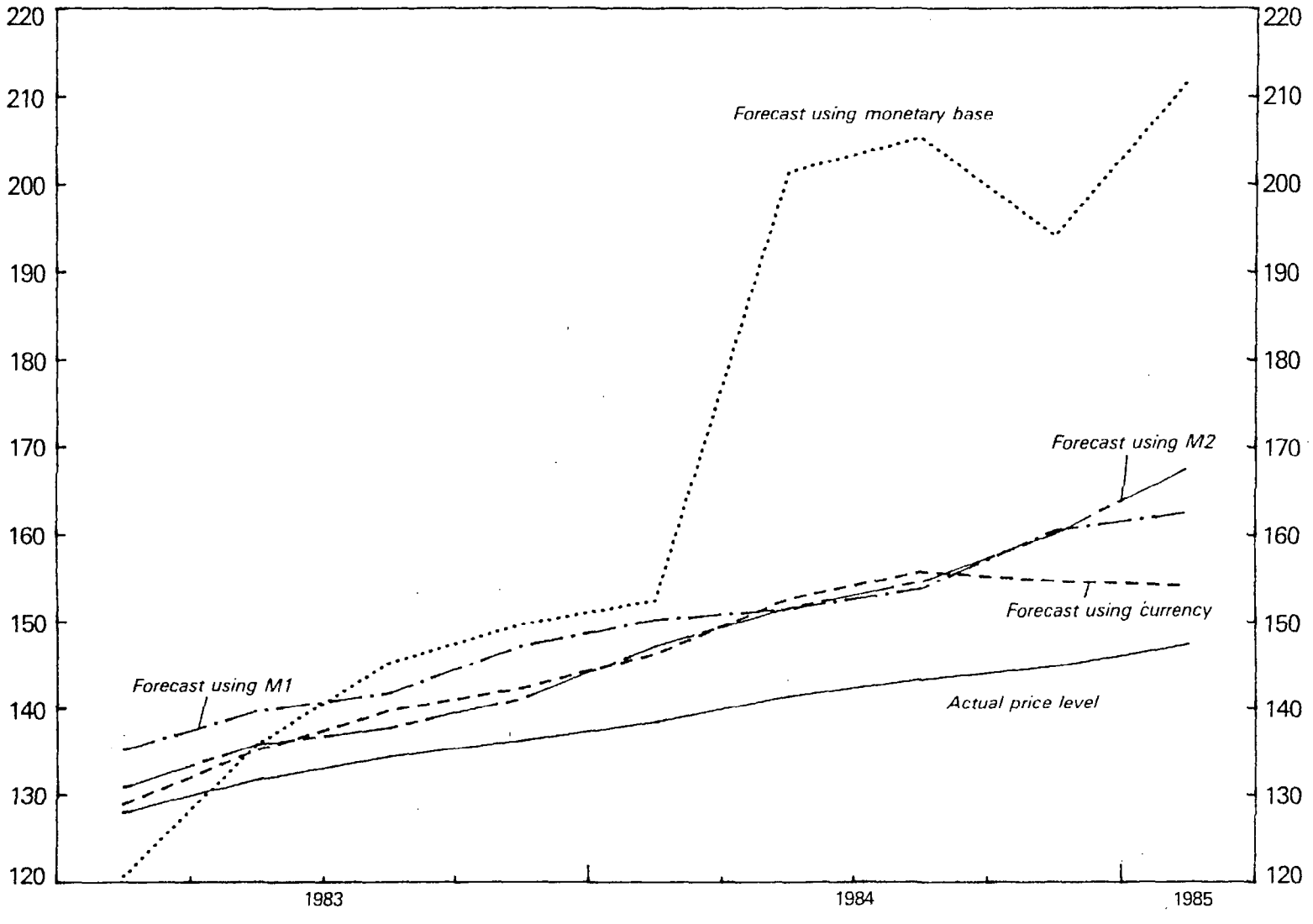
FINLAND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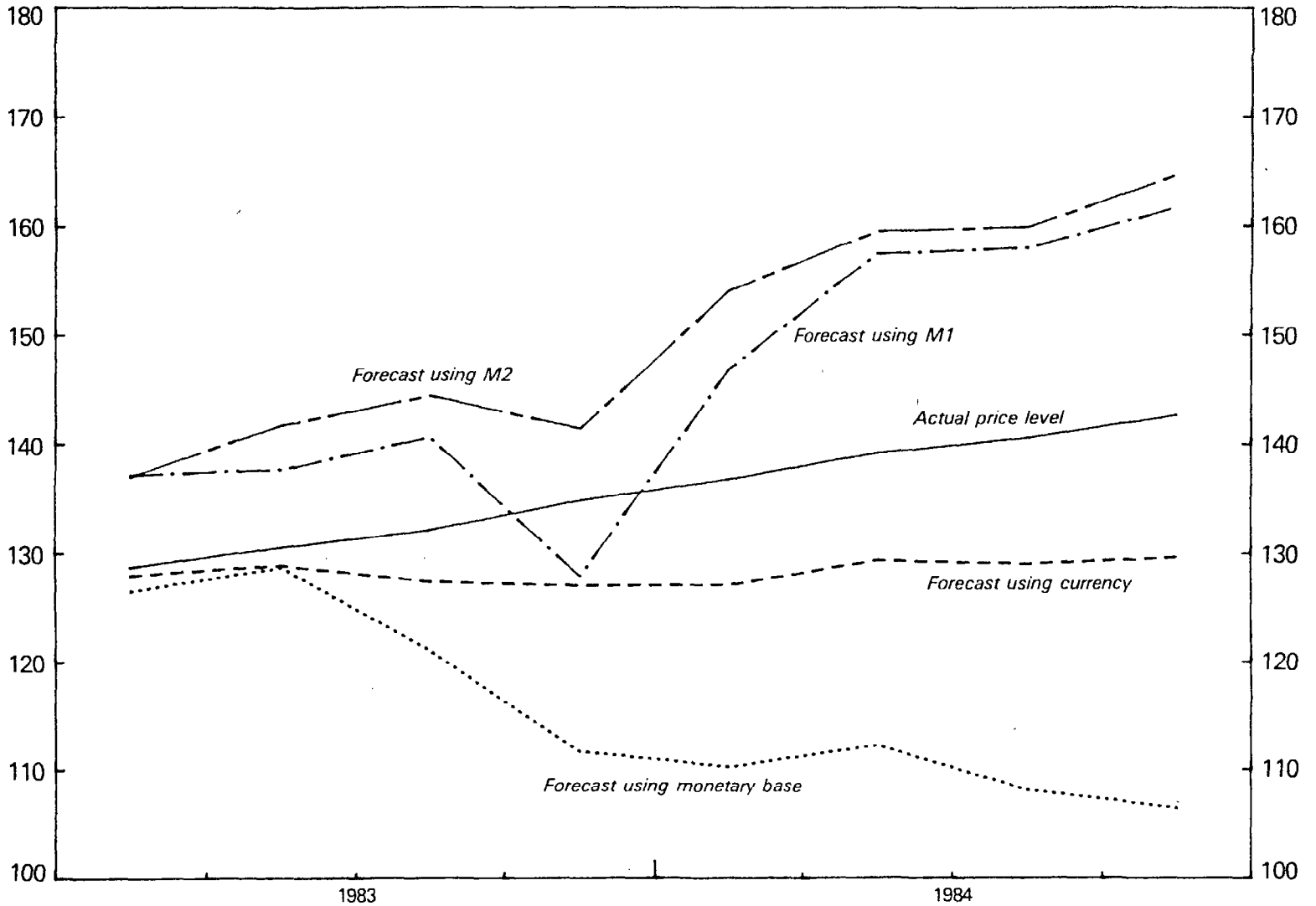
1985
Forecast using monetary base
Forecast using M2
Forecast using currency
Forecast using M1
Actual price level

DENMARK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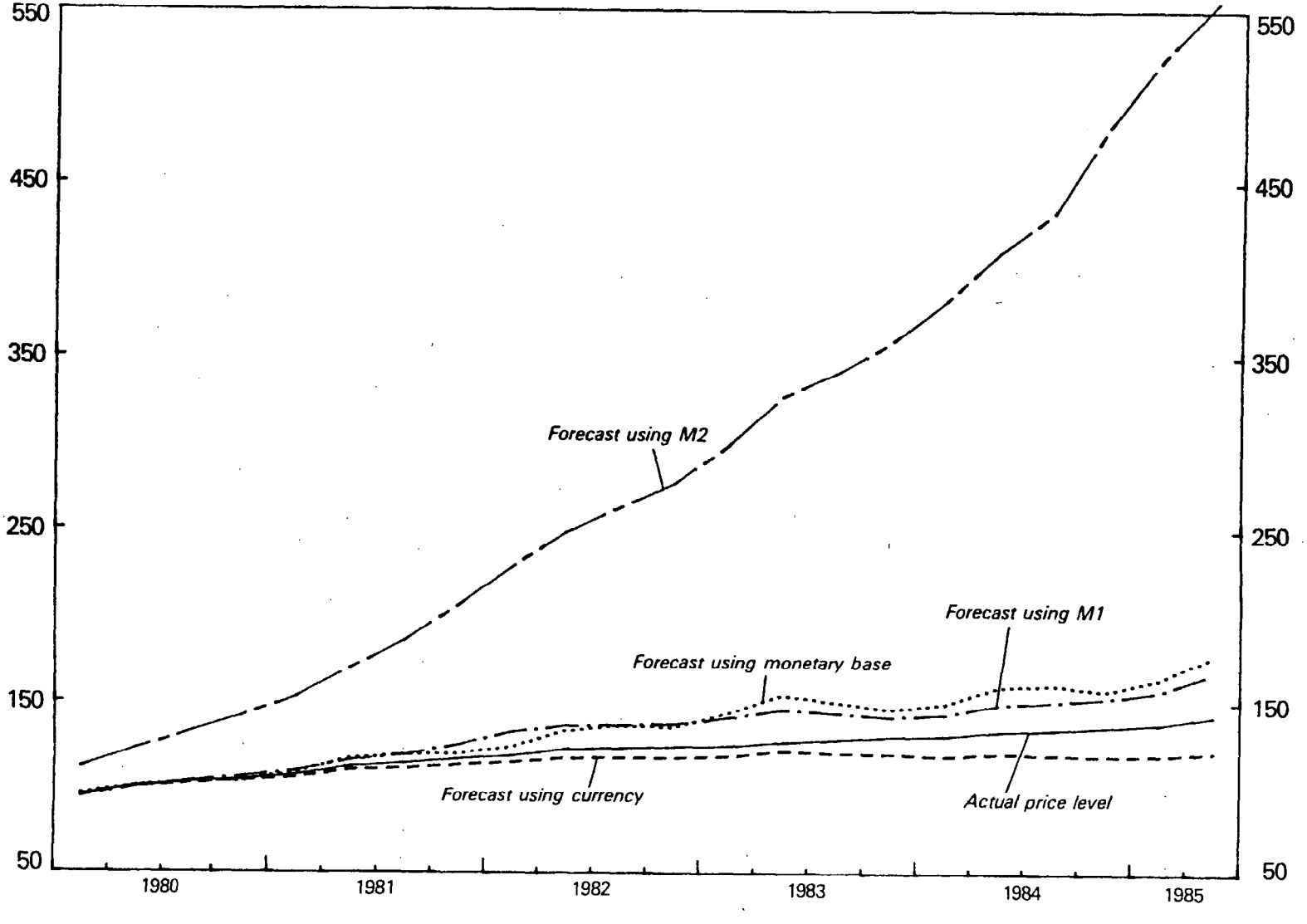
Forecast using M2
Forecast using M1
Actual price level
Forecast using currency
Forecast using monetary base

UNITED KINGDOM



omitting the last several observations (whose parameters are then used to forecast the price level in later periods). There are several items of interest in this Table. The equations seem to fit the data quite well (by the common, if inappropriate, criteria of R-squares) no matter which monetary aggregate is used. (The standard errors of the equations are not, of course, comparable across the different aggregates. The sum of squared errors (SSE) are reported in the tables.) There are, however, some interesting differences. The "b"s (income elasticities, if there were no compounding effects of secular technological changes) seem to be greater for the conventional monetary aggregates (M1 & M2) than for currency. This could be for two reasons. First, the volume of credit may be highly correlated with real activity, as measured by real income, and the fraction of credit channeled through commercial banks, and included in bank deposits, would be so too. Second, technological changes may allow the public to use less currency than before, resulting in the higher estimated coefficients for the broader aggregates. The true income elasticity of currency demand is therefore likely to be be higher than that estimated.

The interest elasticities also show some systematic differences across the different aggregates. The estimated "c"s are more negative for M1 than for M2. This is to be expected if demand deposits pay no interest but the aggregates in M2 do. Shifts from non-interest bearing to interest bearing accounts affect M1 (hence a highly negative interest elasticity) more than M2 (which includes many interest bearing accounts). Similar reasoning would lead one to expect the interest elasticity of currency to be larger still (in absolute value) but it does not appear to be the case. Perhaps the neglected effects of secular technological change are responsible.

If the price level is determined by currency and the volume of bank intermediation does not affect it, the demand for "money" is correctly specified only when currency is used and not when agglomorations of currency and wealth held through banks are used. If the true structural parameters are unchanged over time, the estimated coefficients of an ill-specified equation could be unstable. So the estimated coefficients of currency demand are less likely to shift over time than are the estimated coefficients of the other aggregates.

A test of coefficient constancy is conducted following Chow. An F-statistic examines whether the sum of squared residuals, corrected for degrees of freedom, is in accord with the null hypothesis that the estimated coefficients are unchanged over time. 1/ The null is rejected in only a few instances. This suggests that "money demand" equations are very tolerant and that almost any aggregate used "fits" well.

1/ The data chosen to break the series is the same as that from when the forecasts are made.

Table 2. Estimates of Money Demand

$$\ln(\frac{M}{P})_t = a_0 + a_1 S_1 + a_2 S_2 + a_3 S_3 + b.\ln y_t + c.\ln(1 + i_t) + d.\ln(\frac{M}{P})_{t-1} + u_t$$

	a_0	a_1	a_2	a_3	b	c	d	R^2	F(6,n-7)	h	SSE 1/	
United Kingdom: Q3 1973 to Q2 1985 (48 obs)												
Base	-0.209	-0.040	-0.093	-0.034	-0.080	-0.392	0.991	0.984	424.98	1.272	25.336	
(S.E.)	(0.669)	(0.012)	(0.012)	(0.011)	(0.131)	(0.168)	(0.033)					
t-stat	-0.31	-3.40	-7.51	-2.99	0.61	-2.34	29.69					
Currency	-0.318	-0.002	-0.011	0.019	0.088	-0.463	1.000	0.976	277.97	0.813	8.064	
	(0.352)	(0.007)	(0.007)	(0.006)	(0.058)	(0.096)	(0.032)					
	-0.91	-0.29	-1.61	3.05	1.52	-4.81	31.07					
M1	-0.562	-0.009	-0.001	0.009	0.298	-0.749	0.901	0.957	151.93	0.543	12.925	
	(0.256)	(0.008)	(0.008)	(0.008)	(0.059)	(0.120)	(0.036)					
	-2.19	-1.07	0.12	1.20	5.08	-6.22	24.86					
M2	-0.777	-0.011	-0.014	0.009	0.192	-0.042	1.002	0.968	209.23	3.616	23.246	
	(0.321)	(0.011)	(0.011)	(0.010)	(0.077)	(0.163)	(0.031)					
	-2.42	-1.08	-1.35	0.91	2.49	-0.26	32.73					
Fitted Q3 1973 to Q4 1979 (26 obs); forecast to Q2 1985 (22 quarters)												
Base	-0.713	-0.059	-0.116	-0.039	0.163	-0.431	1.029	0.956	69.02	1.150	12.14	0.94
	(1.158)	(0.018)	(0.017)	(0.015)	(0.203)	(0.269)	(0.082)					
	-0.62	-3.21	-6.92	-2.56	0.80	-1.60	12.61					
Currency	-0.431	0.000	-0.010	0.021	0.149	-0.477	0.973	0.899	28.04	0.519	6.735	0.17
	(0.646)	(0.013)	(0.012)	(0.011)	(0.101)	(0.218)	(0.085)					
	-0.67	0.03	-0.80	1.94	1.48	-2.19	11.50					
M1	-0.202	-0.021	-0.013	0.006	0.188	-0.835	0.918	0.919	35.80	-1.021	6.756	0.79
	(0.505)	(0.013)	(0.012)	(0.011)	(0.096)	(0.206)	(0.068)					
	-0.40	-1.56	-1.09	0.59	1.96	-4.05	13.44					
M2	-1.240	-0.015	-0.015	0.011	0.216	-0.426	1.063	0.934	44.55	1.923	13.529	0.62
	(1.346)	(0.020)	(0.019)	(0.016)	(0.203)	(0.306)	(0.096)					
	-0.92	-0.73	-0.80	0.69	1.07	-1.39	11.09					

* Chow test: $\frac{(SSE_L - SSE_S)/22}{SSE_S/(26-7)}$ is F(22.19) with critical value 2.13 at 5 percent significance level;

3.08 at 1 percent significance level.

Table 2. (cont'd.) Estimates of Money Demand

	a_0	a_1	a_2	a_3	b	c	d	R^2	F(6,n-7)	h	SSE 1/	
Denmark: Q1 1972 to Q4 1984 (52 obs)												
Base	-0.391	-0.021	-0.033	-0.010	0.055	-0.802	0.873	0.884	56.96	1.820	127.111	
(S.E.)	(0.562)	(0.021)	(0.021)	(0.021)	(0.138)	(0.233)	(0.060)					
t-stat	-0.699	-0.992	-1.586	-0.462	0.395	-3.433	14.505					
Currency	-0.309	-0.006	-0.009	-0.006	0.050	-0.292	0.944	0.863	47.43	1.569	17.016	
	(0.228)	(0.008)	(0.008)	(0.008)	(0.044)	(0.087)	(0.056)					
	-1.359	-0.740	-1.205	-0.810	1.131	-3.378	16.828					
M1	-2.602	-0.021	0.004	-0.012	0.581	-0.876	0.648	0.900	67.48	0.029	39.778	
	(0.538)	(0.012)	(0.012)	(0.012)	(0.117)	(0.155)	(0.092)					
	-4.839	-1.834	0.302	-1.063	4.954	-5.634	7.049					
M2	-1.097	-0.007	0.002	-0.008	0.270	-0.582	0.914	0.957	167.47	0.707	16.768	
	(0.285)	(0.008)	(0.008)	(0.008)	(0.068)	(0.090)	(0.053)					
	-3.856	-0.861	0.271	-1.103	3.939	-6.495	17.100					
Fitted Q1 1972 to Q4 1982 (44 obs); forecast to Q4 1984 (8 quarters)												
Base	-1.374	0.029	-0.043	-0.010	0.280	-1.122	0.864	0.877	44.08	1.072	109.71	0.73
	(0.823)	(0.023)	(0.023)	(0.023)	(0.193)	(0.301)	(0.064)					
	-1.669	-1.221	-1.829	-0.439	1.457	-3.699	13.512					
Currency	-0.657	-0.007	-0.011	-0.006	0.117	-0.379	0.917	0.856	36.69	1.353	15.875	0.33
	(0.412)	(0.009)	(0.009)	(0.009)	(0.076)	(0.115)	(0.069)					
	-1.595	-0.792	-1.213	-0.635	1.533	-3.308	13.249					
M1	-2.039	-0.039	-0.008	-0.021	0.452	-0.753	0.617	0.870	41.12	1.524	13.811	8.70
	(0.399)	(0.008)	(0.008)	(0.008)	(0.087)	(0.113)	(0.081)					
	-5.116	-4.627	-0.996	-2.560	5.183	-6.655	7.625					
M2	-0.663	-0.018	-0.003	-0.011	0.171	-0.501	0.921	0.940	96.79	1.443	8.550	4.45
	(0.265)	(0.007)	(0.006)	(0.007)	(0.063)	(0.084)	(0.051)					
	-2.498	-2.768	-0.514	-1.643	2.703	-5.970	18.001					

* Chow test: $\frac{(SSE_L - SSE_S)/8}{SSE_S/(44-7)}$ is F(8, 37) with critical value 2.20 at 5 percent significance level;

3.05 at 1 percent significance level.

Table 2. (cont'd.) Estimates of Money Demand

	a_0	a_1	a_2	a_3	b	c	d	R^2	F(6,n-7)	h	SSE 1/	
Finland: Q1 1978 to Q1 1985 (29 obs)												
Base	-2.076	0.128	0.112	0.093	0.744	0.095	0.792	0.958	84.76	0.837	96.378	
(S.E.)	(1.427)	(0.062)	(0.050)	(0.056)	(0.486)	(0.639)	(0.131)					
t-stat	-1.455	2.081	2.242	1.647	1.529	0.149	6.028					
Currency	0.923	-0.006	0.107	0.013	0.059	-0.346	0.696	0.896	90.45	1.563	3.318	
	(0.221)	(0.009)	(0.007)	(0.008)	(0.055)	(0.132)	(0.088)					
	4.178	-0.627	1.464	1.642	1.071	-2.630	7.898					
M1	0.229	0.008	0.009	0.039	0.122	-0.304	0.864	0.947	65.26	3.120	7.713	
	(0.280)	(0.015)	(0.012)	(0.012)	(0.105)	(0.180)	(0.107)					
	0.818	0.528	0.719	3.158	1.161	-1.692	8.083					
M2	-0.104	-0.001	-0.015	0.312	-0.115	-0.043	1.086	0.993	538.15	1.579	2.059	
	(0.158)	(0.012)	(0.009)	(0.010)	(0.100)	(0.093)	(0.074)					
	-0.662	-0.070	-1.656	0.032	-1.147	-0.460	14.728					
Fitted Q1 1978 to Q4 1982 (20 obs); forecast to Q1 1985 (9 quarters)												
Base	-1.080	0.093	0.038	0.051	0.503	-0.781	0.806	0.956	46.73	2.382	40.168	2.02
	(1.383)	(0.060)	(0.053)	(0.057)	(0.468)	(0.725)	(0.131)					
	-0.781	1.542	0.727	0.899	1.074	-1.076	6.135					
Currency	1.123	-0.008	0.001	0.005	0.033	-0.627	0.677	0.932	63.90	-0.086	1.965	0.99
	(0.239)	(0.011)	(0.009)	(0.009)	(0.064)	(0.170)	(0.091)					
	4.701	-0.690	0.130	0.497	0.524	-3.694	7.443					
M1	0.624	0.010	0.013	0.044	0.120	-0.423	0.787	0.900	19.41	3.933	5.619	0.54
	(0.495)	(0.018)	(0.015)	(0.016)	(0.131)	(0.270)	(0.163)					
	1.261	0.564	0.898	2.788	0.921	-1.567	4.834					
M2	0.526	0.018	0.002	0.021	0.102	-0.137	0.863	0.990	217.59	2.013	0.918	1.80
	(0.270)	(0.013)	(0.010)	(0.011)	(0.118)	(0.112)	(0.104)					
	1.947	1.426	0.216	1.975	0.862	-1.218	8.317					

* Chow test: $\frac{(SSE_L - SSE_S)/9}{SSE_S/(20-7)}$ is F(9, 13) with critical value 2.71 at 5 percent significance level;

4.19 at 1 percent significance level.

Table 2. (cont'd.) Estimates of Money Demand

	a_0	a_1	a_2	a_3	b	c	d	R^2	F(6,n-7)	h	SSE 1/	
Argentina: Q1 1978 to Q1 1985 (29 obs)												
Base	16.882	-0.022	0.005	0.141	-1.732	-0.007	0.803	0.799	14.56	0.208	728.228	
	(7.925)	(0.095)	(0.099)	(0.099)	(0.775)	(0.086)	(0.128)					
	2.130	-0.229	0.050	1.426	-2.234	-0.084	6.268					
Currency	-7.010	0.026	-0.039	-0.054	0.440	-0.145	0.439	0.859	22.32	3.177	96.764	
	(3.370)	(0.035)	(0.037)	(0.037)	(0.300)	(0.033)	(0.143)					
	-2.080	0.739	-1.045	-1.490	1.466	-4.369	3.058					
M1	3.149	0.029	-0.026	-0.017	-0.339	-0.087	0.907	0.894	30.822	2.693	133.860	
	(3.748)	(0.040)	(0.042)	(0.042)	(0.349)	(0.037)	(0.117)					
	0.840	0.718	-0.613	-0.410	-0.972	-2.323	7.734					
M2	-2.703	0.027	-0.010	-0.001	-0.128	-0.155	0.478	0.959	84.71	2.217	26.879	
	(1.515)	(0.018)	(0.019)	(0.019)	(0.148)	(0.022)	(0.084)					
	-1.784	1.492	-0.545	-0.040	0.866	-7.017	5.662					
Fitted Q1 1978 to Q4 1982 (20 obs); forecast to Q1 1985 (9 quarters)												
Base	6.150	-0.064	0.002	0.135	-0.798	0.469	0.596	0.797	8.52	0.498	429.639	1.04
	(9.756)	(0.117)	(0.118)	(0.123)	(0.925)	(0.237)	(0.180)					
	0.630	-0.547	0.013	1.097	-0.863	1.978	3.311					
Currency	-3.855	0.006	-0.065	-0.062	0.146	-0.243	0.450	0.823	10.10	3.003	40.706	1.99
	(4.033)	(0.039)	(0.040)	(0.037)	(0.341)	(0.058)	(0.170)					
	-0.956	0.156	-1.631	-1.681	0.428	-4.162	2.641					
M1	6.340	-0.009	-0.047	-0.019	-0.619	-0.121	0.980	0.752	6.57	3.862	95.993	0.57
	(6.635)	(0.058)	(0.057)	(0.055)	(0.588)	(0.098)	(0.194)					
	0.955	-0.148	-0.823	-0.355	-1.052	-1.240	5.045					
M2	-0.406	0.003	-0.027	0.009	-0.078	-0.229	0.521	0.945	36.886	2.161	9.922	2.47
	(1.411)	(0.018)	(0.018)	(0.018)	(0.137)	(0.031)	(0.070)					
	-0.287	0.187	-1.493	0.519	-0.568	-7.283	7.396					

* Chow test: $\frac{(SSE_L - SSE_S)/9}{SSE_S/(20-7)}$ is F(9, 13) with critical value 2.71 at 5 percent significance level;

4.19 at 1 percent significance level.

Table 2. (concluded) Estimates of Money Demand

	a_0	a_1	a_2	a_3	b	c	d	R^2	F(6,n-7)	h	SSE 1/	
Brazil: Q1 1976 to Q3 1984 (35 obs)												
Base	-0.819	-0.014	-0.083	-0.036	0.147	-0.256	0.870	0.992	580.60	1.729	18.002	
(S.E.)	(0.676)	(0.018)	(0.014)	(0.013)	(0.090)	(0.044)	(0.036)					
t-stat	-1.211	-0.782	-6.023	-2.888	1.635	-5.849	23.991					
Currency	-1.716	-0.023	-0.127	-0.063	0.255	-0.304	0.786	0.982	259.32	0.978	32.329	
	(0.814)	(0.024)	(0.019)	(0.017)	(0.105)	(0.053)	(0.052)					
	-2.107	-0.978	-6.778	-3.714	2.438	-5.770	15.037					
M1	-0.319	-0.050	-0.069	-0.040	0.089	-0.235	0.883	0.994	733.07	2.358	20.097	
	(0.616)	(0.018)	(0.014)	(0.014)	(0.079)	(0.047)	(0.038)					
	-0.519	-2.818	-4.867	-2.943	1.133	-5.013	23.220					
M2	0.526	-0.041	-0.049	-0.031	0.013	-0.156	0.778	0.967	138.87	4.858	31.226	
	(0.768)	(0.022)	(0.018)	(0.017)	(0.100)	(0.052)	(0.067)					
	0.685	-1.815	-2.779	-1.828	0.125	-3.013	11.532					
Fitted Q1 1976 to Q4 1982 (28 obs); forecast to Q3 1984 (7 quarters)												
Base	-0.429	-0.031	-0.094	-0.034	0.859	-0.225	0.929	0.978	153.47	1.590	11.606	1.65
	(0.806)	(0.021)	(0.015)	(0.013)	(0.107)	(0.060)	(0.043)					
	-0.532	-1.493	-6.447	-2.689	0.803	-3.731	21.788					
Currency	-1.063	-0.043	-0.143	-0.067	0.166	-0.235	0.844	0.952	69.14	0.255	16.200	2.99
	(0.868)	(0.023)	(0.018)	(0.015)	(0.111)	(0.064)	(0.066)					
	-1.225	-1.836	-8.171	-4.450	1.493	-3.687	12.827					
M1	0.019	-0.058	-0.070	-0.043	0.041	-0.193	0.900	0.976	145.12	2.116	16.429	0.67
	(0.919)	(0.022)	(0.016)	(0.015)	(0.113)	(0.065)	(0.053)					
	0.021	-2.641	-4.226	-2.828	0.357	-2.992	16.888					
M2	-0.883	-0.018	-0.041	-0.035	0.185	-0.280	0.813	0.967	104.13	3.032	13.159	4.12
	(0.782)	(0.021)	(0.015)	(0.014)	(0.102)	(0.061)	(0.053)					
	-1.129	-0.845	-2.725	-2.593	1.821	-4.584	15.388					

1/ 10^{-3}.

* Chow test: $\frac{(SSE_L - SSE_S)/7}{SSE_S/(28-7)}$ is F(7, 21) with critical value 2.49 at 5 percent significance level; 3.64 at 1 percent significance level.

VIII. Conclusions

The empirical results, though for a small set of countries, are interesting. It appears that the demand for the narrow monetary aggregates (the monetary base or currency with the non-bank public) are well behaved functions and that the preference for the broader monetary aggregates (M1 or M2) are not justified on empirical grounds. Furthermore, it appears from the superiority of the out-of-sample forecasts, that the price level is more closely related to the nominal quantity of currency with the non-bank public than to any of the other monetary aggregates. The poor showing of the monetary base unadjusted for changes in reserves shows how important these adjustments are.

The preference for currency with the non-bank public on empirical grounds would have been more convincing had the Chow test for parameter constancy found currency demand to be stable over time while demands for the other aggregates were not. The statistical techniques used in this paper, however, have been kept simple and a more thorough examination of parameter stability would be a task for future research.

The findings should reassure those who, for the theoretical reasons outlined in the earlier sections, see the price level "anchored" by the outside nominal variable, the monetary base, even as it would disturb those who have focused on the broader aggregates. The results, however, do not (and indeed, no empirical result can) prove to a skeptic's satisfaction that it is currency that "determines" the price level and not some aggregate that includes bank deposits. Empirical work indicates correlation and perhaps the stability over time of such correlations. It does not imply causation, which can only be deduced from theory. If one is not persuaded by the theory, one could argue that the strong showing of currency in the tests here was because authorities passively adjusted currency stock in response to changes in the price level.

It is difficult to believe that each of the countries in the sample acted in this manner. In the United Kingdom it appears that over much of the period in question, the authorities focused on M3 and not on the base, and certainly not on currency with the non-bank public. 1/ The empirical results are all the more striking if authorities sought to alter the broader aggregates based on the actual, or expected, price level or other variables such as income.

If one accepts the theoretical arguments in this paper and the empirical findings that do not contradict them, there are important implications for policy. When countries approach the Fund with their

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1/ When faced with their disparate growth rates, the monetary authorities in the United Kingdom tried one monetary aggregate after another in succession. They finally settled on the monetary base, which they call M0, but is is unclear if they actually target it.

problems, growth in M1, M2 or broader measures of "liquidity" is viewed with great concern as being inflationary. If these aggregates do not necessarily affect the price level, restricting their growth may hinder bank intermediation and unintentionally hurt firms that rely solely on commercial banks for their finance. This paper would suggest that currency with the non-bank public should be closely watched when trying to curb inflation.

In countries with fixed exchange rates and unimpeded capital movements, the monetary base is not under the control of the monetary authorities. Currency with the non-bank public would also not be under the control of the authorities and the domestic price level will reflect changes in the price level abroad.

In countries where the exchange rate is flexible, the nominal quantity of the monetary base can be easily and accurately controlled through an open market operation. M1 or M2, in contrast, is not directly under government control. Currency in the hands of the non-bank public cannot be precisely controlled by the government if there are reserve requirements on banks; but if fluctuations in bank intermediation are minor, or if a direct tax is substituted for banking reserves (which is certainly feasible, though unorthodox), controlling the nominal quantity of the base will translate to control of the nominal currency stock with the public.

A second instrument of government policy is the reserve requirement. Currency may be drained from the public, as it were, by raising the reserve ratio. The reserve requirement, however, is a tax on bank intermediation and if there are substitutes to banks, these will thrive at the expense of banks, resulting in welfare losses through resource misallocations. A well-known proposition in public finance is to tax items with inelastic demands or supply; and substitute intermediaries make the demand for bank deposits elastic in the long run. So raising the reserve requirement is perhaps best used only for a short while (if the demand for bank deposits is inelastic in the short run) and when banks will not be driven out of business by the tax.

The ability of monetary authorities to control the monetary base, or currency in the hands of the non-bank public, depends upon the exchange rate regime. In either case, though, the paper has argued, both on theoretical and empirical grounds, that it is these narrow aggregates, and not the broader monetary aggregates like M1, M2 or M3, that determine the price level.

APPENDIX

A Simple Model of Money and Credit

Different models focus on different aspects of the economy and the one below examines the distinction, described in the text, between currency, bank deposits and other financial instruments. Real income and the monetary base are exogenous while currency with the public and demand deposits are endogenous. M1 is therefore endogenous too. In the short run, the price level is held constant (exogenous) and the interest rate both real and nominal) is endogenous. In the long run, the price level is endogenous while the real interest rate is exogenous; nominal and real interest rates are linked through Irving Fisher's classic equation.

The Model: Description

1) $B = B_P + B_R$

2) $B_P = P.f(y,i)$

3) $B_R = x.D$

4) $D = g(W,ix;S)$

equation (1) divides the exogenously given nominal stock of the monetary base B, between currency with the non-bank public B_P, and commercial bank reserves with the Central Bank B_R.

Equation (2) has the demand for the real stock of currency with the non-bank public to be a function of the real income y (a proxy for aggregate transactions) and nominal returns on alternate assets. The nominal short term interest rate is used in place of these expected returns. In economies where a well functioning market for bonds does not exist, the rate of change of the price level or the rate of increase of the domestic price of foreign currency may be used instead of the nominal interest rate. The partial derivatives $f_y > 0$ and $f_i < 0$.

Notice that the demand for currency is not a function of wealth, but of income and this emphasises the transactions demand. In the final analysis this is not crucial because, as will be seen in equation (6), non-human wealth is itself a function of income.

Equation (3) has the demand for the monetary base by commercial banks (reserves) to be a fraction x, of bank deposits D, without distinguishing between the various deposits with different reserve requirements. Any

surplus funds can be held as interest bearing securities rather than as excess reserves and so none exist. The reserve ratio x, is constant but can be changed by the government.

Equation (4) has bank deposits to be a function of non-human wealth W, and of ix, the tax on banks because of non-interest bearing reserves. Bank deposits serve both as a medium of exchange and as a store of value (yielding an explicit return and/or providing underpriced services) and wealth emphasises its portfolio aspects. Wealth, in turn, depends upon income and no important result will change if income is introduced directly in the function. Greater wealth will result in more bank deposits and $g_W > 0$.

The higher the nominal interest rate, the greater will be the tax on banks and bank deposits will decline as people shift their wealth to other (untaxed) securities. Thus, $g_{ix} < 0$ or, with x a constant, $g_i < 0$.

A shift variable is included in equation (4) which will allow the effects of technological changes that increase bank intermediation.

The remaining equations complete the model.

(5) $W = B_p + D + T + N$

(6) $W = P.h(y,r)$

(7) $i = r + Pe$

Equation (5) has the total (nominal) non-human wealth to be the sum of currency with the non-bank public B_p, bank deposits D, other securities T (which includes equity in banks, and other firms, commercial paper, real estate etc.), and government bonds N. Currency held by banks are owned by the bank depositors or shareholders. Bank deposits held by corporations should be netted out as their holdings are owned indirectly by their shareholders but this is ignored along with other details, to keep the model simple.

Government bonds are included only to illustrate the effects of an open market operation. In order to avoid the complications of capital gains and losses (even if unrealised) due to changing interest rates, these government bonds are assumed to carry a floating (market) interest rate resulting in market value and face value always being the same. Nominal government expenditures to service the debt will, as a consequence, vary with the nominal interest rate but some other expenditure is changed to counteract this interest expense and so a budget deficit is avoided.

Also ignored are future tax liabilities; if these were considered, government bonds will not be wealth and N could be omitted altogether.

Equation (6) has the real value of wealth a function of real income and the real interest rate. The real interest rate varies in the short run (when the price level is fixed) but not in the long run.

Equation (7) is the well known Fisher equation that equates the nominal interest rate to the real interest rate plus the expected rate of change of the price level.

In the short run version of the model, there are six endogenous variables, namely B_P, B_R, i, D, W and T. The exogeneous variables are B, x, y, P, S, N and r. Equations (1) through (6) are sufficient to solve the model.

In the long run version, the price level is allowed to vary also making for seven endogenous variables. Equations (1) through (7) describes the model.

People have traditionally added currency with the non-bank public with bank deposits and M1 is introduced in equation (8).

(8) $M = B_P + D$

APPENDIX

The long-run version of the model is

		Endogenous	Exogenous
(1)	$B \equiv B_P + B_R$	B_P, B_R	B
(2)	$B_P = P.f(y,i)$	i, P	y
(3)	$B_R = x.D$	D	x
(4)	$D = g(W,ix;S)$	W	S (Shift Variable)
(5)	$W \equiv B_P + D + T + N$	T	N
(6)	$W = P.h(y,r)$		r
(7)	$i = r + Pe$		Pe
(8)	$M = B_P + D$	M	

The solution is

$$\begin{vmatrix} 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & -Pf_i & -f \\ 0 & 1 & -x & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & -g_W & -xg_{ix} & 0 \\ 1 & 0 & 1 & 1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & -h \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{vmatrix} \begin{vmatrix} dB_P \\ dB_R \\ dD \\ dT \\ dW \\ di \\ dP \end{vmatrix} = \begin{vmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & Pf_y & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & D & 0 & 0 & 0 & 0 \\ 0 & 0 & ig_{ix} & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & Ph_y & 0 & Ph_r & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 \end{vmatrix} \begin{vmatrix} dB \\ dy \\ dx \\ dr \\ dPe \\ dN \\ dS \end{vmatrix}$$

$$\underline{A}\,\underline{X} = \underline{B}\,\underline{Y}$$

$$A^{-1} = \frac{1}{f+xg_w h}\begin{bmatrix} f & xg_w h & -f & -xf & 0 & -xfg_w & x(Pf_i g_w h - xfg_{ix}) \\ xg_w h & -xg_w h & f & xf & 0 & xfg_w & -x(Pf_i g_w h - xfg_{ix}) \\ g_w h & -g_w h & -g_w h & f & 0 & fg_w & -(Pf_i g_w h - xfg_{ix}) \\ -f-(g_w-1)h & (g_w-1-xg_w)h & f+(g_w-1)h & -(1-x)f-xh & (f+xg_w h) & -(g_w-1-xg_w)f & Pf_i h\{(1-x)g_w-1\}-xg_{ix}\{(1-x)f+xh\} \\ h & -h & -h & -xh & 0 & f & -(Pf_i+x^2 g_{ix})h \\ 0 & 0 & 0 & 0 & 0 & 0 & f+xg_w h \\ 1 & -1 & -1 & -x & 0 & -xg_w & -(Pf_i+x^2 g_{ix}) \end{bmatrix}$$

$$\begin{bmatrix} dB_P \\ dB_R \\ dD \\ dT \\ dW \\ di \\ dP \end{bmatrix} = \frac{1}{f+xg_w h}\begin{bmatrix} f & xPg_w(f_y h - fh_y) & -f(D+ixg_{ix}) & * & x(Pf_i g_w h - xfg_{ix}) \\ xg_w h & -xPg_w(f_y h - fh_y) & f(D+ixg_{ix}) & * & -x(Pf_i g_w h - xfg_{ix}) \\ g_w h & -Pg_w(f_y h - fh_y) & -g_w hD+fig_{ix} & * & -(Pf_i g_w h - xfg_{ix}) \\ -f-(g_w-1)h & P(g_w-1-x)(f_y h - fh_y) & * & * & Pf_i h\{(1-x)g_w-1\}-xg_{ix}\{(1-x)f+xh\} \\ h & -P(f_y h - fh_y) & -h(D+ixg_{ix}) & * & -(Pf_i+x^2 g_{ix})h \\ 0 & 0 & 0 & * & f+xg_w h \\ 1 & -P(f_y+xg_w h_y) & -(D+ixg_{ix}) & * & -(Pf_i+x^2 g_{ix}) \end{bmatrix} \begin{bmatrix} 0 & -xf \\ 0 & xf \\ 0 & f \\ -(f+xg_w h) & -(1-x)f-xh \\ 0 & -xh \\ 0 & 0 \\ 0 & -x \end{bmatrix} \begin{bmatrix} dB \\ dy \\ dx \\ dr \\ dP^e \\ dN \\ dS \end{bmatrix}$$

1. Autonomous shift in demand for bank deposits: Effect of dS alone.

$dB = dy = dx = dr = dPe = dN = 0$

$\frac{dBP}{dS} = \frac{-xf}{f+xg_w h} < 0$ Nominal currency with the public declines as more of it is used as reserves to support an autonomous increase in bank deposits.

$\frac{dBR}{dS} = \frac{xf}{f+xg_w h} > 0$

$\frac{dD}{dS} = \frac{f}{f+xg_w h} > 0$

$\frac{dT}{dS} = \frac{x(f-h)-f}{f+xg_w h} < 0$

$\frac{dW}{dS} = \frac{-xh}{f+xg_w h} < 0$ Nominal wealth declines (real wealth unchanged).

$\frac{di}{dS} = \frac{-x}{f+xg_w h} < 0$ Price level falls.

$\frac{dM}{dS} = \frac{dBP}{dS} + \frac{dD}{dS} = \frac{(1-x)f}{f+xg_w h} > 0$ M1 rises.

Notice that M (or M1) rises but the price level falls.

Such an autonomous shift in the demand for bank deposits may occur where computers make processing changes easier and cheaper or when laws and institutions change allowing banks to expend their scope of service.

2. An increase in the required reserve ratio: Effect of dx.

$dB = dy = dr = dP^e = dN = dS = 0$

		Case A	Case B
		$D > \lvert ixg_{ix} \rvert$	$D < \lvert ixg_{ix} \rvert$
$\frac{dB_P}{dx}$	$= \frac{-f(D + ixg_{ix})}{f + xg_w h}$	< 0	> 0
$\frac{dB_R}{dx}$	$= \frac{f(D + ixg_{ix})}{f + xg_w h}$	> 0	< 0
$\frac{dD}{dx}$	$= \frac{-g_w hD + fig_{ix}}{f + xg_w h}$	< 0	< 0
$\frac{dT}{dx}$	$= \frac{\{D-(1-x)ig_{ix}\}f+\{(g_w-1)D-ixg_{ix}\}h}{f + xg_w h}$		
$\frac{dW}{dx}$	$= \frac{-h(D + ixg_{ix})}{f + xg_w h}$	< 0	> 0
$\frac{di}{dx}$	$= 0$		
$\frac{dP}{dx}$	$= \frac{-h(D + ixg_{ix})}{f + xg_w h}$	< 0	> 0

$$\frac{dM}{dx} = \frac{dB_P}{dx} + \frac{dD}{dx} = \frac{f(1-x)ig_{ix}}{f+xg_w h} - \frac{D(f+g_w h)}{f+xg_w h} < 0$$ if g_{ix} is sufficiently small or x sufficiently large

Clearly, as this and the previous examples show, there are times when M rises and P falls (or vice versa). However, the rate of change of P is always the same as that of B_P, currency with the non-bank public.

3. Currency dropped from a helicopter: Effect of dB alone.

$dy = dx = dr = dP^e = dN = dS = 0$

$$\frac{dB_P}{dB} = \frac{f}{f+xg_wh} \quad > 0 \quad < 1$$

$$\frac{dB_R}{dB} = \frac{xg_wh}{f+xg_wh} \quad > 0 \quad < 1$$

$$\frac{dD}{dB} = \frac{g_wh}{f+xg_wh} \quad > 0 \quad < 1/x$$

Deposits rise by less than suggested by the banking multiplier

$$\frac{dT}{dB} = \frac{(1-g_w)h-f}{f+xg_wh}$$

$$\frac{dW}{dB} = \frac{h}{f+xg_wh} \quad > 0$$

$$\frac{di}{dB} = 0$$

$$\frac{dP}{dB} = \frac{1}{f+xg_wh} \quad > 0$$

$$\frac{dM}{dB} = \frac{dB_P}{dB} + \frac{dD}{dB} = \frac{f+g_wh}{f+xg_wh} \quad > 1$$

Also: $$\frac{dP}{dB_P} = \frac{dP/dB}{dB_P/dB} = \frac{1}{f} = \frac{1}{B_P/P}$$

$$\therefore \quad \frac{dP}{P} = \frac{dB_P}{B_P}$$

percent change in the price level equals percent change in currency with non-bank public

$$\frac{dP}{dM} = \frac{dP/dB}{dM/dB} = \frac{1}{f+g_wh} = \frac{P}{(B_P+Wg_w)}$$

$$\therefore \quad \frac{dP}{P} = \frac{(B_P+D)}{(B_P+Wg_w)} \cdot \frac{dM}{M} = \frac{dM}{M}$$

iff $D = Wg_w$. This would be if $D = W.G(ix)$

Real wealth, $\frac{W}{P}$, is unchanged.

4. An open market operation: $dB = -dN$.

$$dy = dx = dr = dP^e = dS = 0$$

$$\frac{dB_P}{dB} = \frac{f}{f+xg_w h} \quad > 0 \quad < 1$$

$$\frac{dB_R}{dB} = \frac{xg_w h}{f+xg_w h} \quad > 0 \quad < 1/x$$

$$\frac{dD}{dB} = \frac{g_w h}{f+xg_w h} \quad > 0 \quad < 1/x$$

$$\frac{dT}{dB} = \frac{(1-g_w-xg_w)h}{f+xg_w h}$$

$$\frac{dW}{dB} = \frac{h}{f+xg_w h} \quad > 0$$

$$\frac{di}{dB} = 0$$

$$\frac{dP}{dB} = \frac{1}{f+xg_w h} \quad > 0$$

$$\frac{dM}{dB} = \frac{dB_P}{dB} + \frac{dD}{dB} = \frac{f+g_w h}{f+xg_w h} \quad > 1 \quad \text{but} \quad < 1/x$$

The only difference between this and the currency drop is that T changes to counteract any change in N (so as to keep $\frac{W}{P}$ constant).

5. Effect of business cycle: Effect of dy.

$$dB = dx = dr = dP^e = dN = dS = 0$$

$$\frac{dB_P}{dy} = \frac{xPg_w(f_yh-fh_y)}{f+xg_wh} \quad > 0$$

$$\frac{dB_R}{dy} = \frac{-xPg_w(f_yh-fh_y)}{f+xg_wh} \quad < 0$$

$$\frac{dD}{dy} = \frac{-Pg_w(f_yh-fh_y)}{f+xg_wh} \quad < 0$$

$$\frac{dT}{dy} = \frac{P(g_w-1-x)(f_yh-fh_y)}{f+xg_wh} \quad < 0 \text{ if } g_w < (1+x)$$

$$> 0 \text{ if } g_w > (1+x)$$

$$\frac{dW}{dy} = \frac{-P(f_yh-fh_y)}{f+xg_wh} \quad < 0$$

$$\frac{di}{dy} = 0$$

$$\frac{dP}{dy} = \frac{-P(f_y+xg_wh_y)}{f+xg_wh} \quad < 0$$

$$\frac{dM}{dy} = \frac{dB_P}{dy} + \frac{dD}{dy} = \frac{Pg_w(x-1)(f_yh-fh_y)}{f+xg_wh} \quad < 0$$

Nominal M1 declines when real income declines. So does the price level. The nominal stock of currency with the non-bank public increases. Hence, it is crucial to allow for the effects of real income in empirical tests.

APPENDIX

Summary of the Model's comparative statics

The five comparative statics exercises illustrate how the monetary base is allocated between currency with the non-bank public and bank reserves. It also demonstrates the effect of various changes in the exogenous variables on "money" (M1) and the price level. It is shown that they can move in opposite directions.

The clearest indicator of what happens to the price level comes from the nominal stock of currency with the non-bank public. This is equivalent to examining the nominal stock of the monetary base allowing for changes in the quantity demanded as bank reserves.

References

Black, Fisher and Scholes, Myron (1973) "The Pricing of Options and Corporate Liabilities" Journal of Political Economy, Vol. 81, No. 3 (May-June), pp. 637-59.

Fama, Eugene F. (1980) "Banking and the Theory of Finance" Journal of Monetary Economics, Vol. 6, No. 1 (January), pp. 39-57.

_____, (1982) "Inflation, Output and Money" Journal of Business, Vol. 55, No.2, pp. 201-31.

_____, (1983) "Financial Intermediation and Price Level Control" Journal of Monetary Economics, Vol. 12, No. 3 (July), pp. 7-28.

_____, (1985) "Whats Different About Banks?" Journal of Monetary Economics, Vol. 15 (July), pp. 29-39.

Federal Reserve Bulletin (1986) "The Use of Cash and Transaction Accounts by American Families", Vol. 72, No. 2 (February), pp. 87-108.

Friedman, Benjamin M. (1984), "Lessons from the 1979-82 Monetary Policy Experiment," American Economic Review, Vol. 74, No. 2 (May), pp. 382-7.

Friedman, Milton (1956) "The Quantity Theory of Money--A Restatement" in Studies in the Quantity Theory of Money, edited by Milton Friedman. Chicago: University of Chicago Press.

_____, (1968a) "Inflation: Causes & Consequences" in Dollars & Deficits Prentice Hall, Englewood Cliffs, New Jersey.

_____, (1968b) "The Role of Monetary Policy" American Economic Review Vol. 58, No. 1 (March), pp. 1-17.

_____, (1969), "The Optimum Quantity of Money" in The Optimum Quantity of Money and Other Essays (Aldine).

_____, (1977), "Nobel Lecture: Inflation and Unemployment", Journal of Political Economy, Vol. 85, No. 3 (June), pp. 451-72.

_____, (1984), "Lessons from the 1979-82 Monetary Policy Experiment," American Economic Review, Vol. 74, No. 2 (May), pp. 397-400.

_____, (1985) "Monetarism in Rhetoric and Practice" in Monetary Policy in Our Times, Albert Ando et. al., editors, MIT Press.

Goodfriend, Marvin (1985) "Reinterpreting Money Demand Regressions" in Carnegie-Rochester Conference Series on Public Policy, Volume 22 (Spring), pp. 207-42.

Hancock, Diana (1985) "The Financial Firm: Production with Monetary and Nonmonetary Goods", Journal of Political Economy, Vol. 93, No. 5 (October), pp. 859-80.

Hendry, David F. (1985) "Monetary Economic Myth and Econometric Reality", Oxford Review of Economic Policy, Vol. 1, No. 1, pp. 72-78.

Isard, Peter & Rojas-Suarez, Liliana (1986) "The Velocity of Money and the Practice of Monetary Targeting: Experience, Theory, and the Policy Debate," Staff Studies for The World Economic Outlook, pp. 73-114.

Judd, John P. and John L. Scadding, (1982) "The Search for a Stable Money Demand Function: A Survey of the Post-1973 Literature", Journal of Economic Literature, Vol. 20, No. 3 (September), pp. 993-1023.

Keynes, John Maynard (1930) "A Treatise on Money" in two volumes. Republished by the Royal Economic Society 1970.

King, Robert G. and Charles I. Plosser (1984), "Money, Credit, and Prices in a Real Business Cycle," American Economic Review, Vol. 74, No. 3 (June), pp. 363-380.

Laidler, David E.W. (1977) "The Demand for Money: Theory and Evidence" Second Edition, Harper & Row.

Patinkin, Don (1961) "Financial Intermediaries and the Logical Structure of Monetary Theory", American Economic Review, Vol. 51, No.1 (March) pp. 95-116.

Scholes, Myron S (1972) "The Market for Securities: Substitution versus Price Pressure and the Effects of Information on Share Prices," Journal of Business: Vol. 45, No. 2 (April), pp. 179-211.

Spindt, Paul A. (1985) "Money is What Money Does: Monetary Aggregation and the Equation of Exchange", Journal of Political Economy, Vol. 93, No.1 (February), pp. 175-204.

Tobin, James (1963) "Commercial Banks as Creators of 'Money'" in Banking and Monetary Studies, edited by Deane Carson (Richard D. Irwin). Reprinted in Essays in Economics, Vol. 1 James Tobin (Markham Publishing Co., Chicago).