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Introduction

The experience of the last few years has laid to rest, at least temporarily, certain myths about the relationship between monetary policy and inflation in Canada. It is much harder to argue now than it was, say in 1990, either that inflation is not primarily a monetary phenomenon subject to decisive influence from monetary policy, or that sustained real economic expansion is incompatible with price level stability. But there are still certain issues that — even though they are of second-order importance relative to those just mentioned — need further attention. In particular, there is far more widespread agreement that monetary policy works than about how it works. Is some measure of the quantity of money in circulation a key causative variable, or is the behaviour of bank credit the critical factor? Or is it the level and structure of interest rates that really do the work, with financial aggregates playing a supporting role as indicators of the stance of policy, but having no independent behavioural significance?

In this paper we address some of the issues involved here. Specifically we develop some implications of what is usually known as the "buffer stock approach" to monetary analysis in the context of a financial system in which the monetary authorities use a short-term interest rate as their policy instrument.1 We show how this approach, inasmuch as it stresses the importance of credit-market behaviour for the creation of money, differs from the more conventional treatment of money as a passively adjusting endogenous

1. For an account of the "buffer-stock" idea see Chapter 3 of Laidler (1990).
variable under such a policy regime. We also present the results of some preliminary
empirical work that are, at least, not inconsistent with the buffer stock interpretation of
Canadian data.

Two Views of Money Stock Determination

What we would characterise as the conventional view of money supply determination,
when the central bank focuses on short-term interest rates as a central link in the
monetary control mechanism, may be set out in terms of an IS-LM plus Phillips curve
framework. The Phillips curve determines the current value of the inflation rate, and
therefore the price level, as a function of the level of real aggregate demand relative to
some measure of the economy's capacity output, and of inflation expectations.
Expectations probably depend mainly upon the history of inflation, though there is room
here for "rational" responses to policy announcements and actions too. As to the IS curve,
it summarises relationships which have real aggregate demand depending upon current
and lagged values of output, the stance of fiscal policy, those mysterious factors affecting
private sector confidence which Keynes called "animal spirits", and — crucially for matters
under discussion here — the level of real interest rates.

The LM curve summarises the interaction of the supply of and demand for money.
A conventional demand for money function will include among its arguments some
measure of real income and/or wealth, the price level, and some representative short-term
nominal interest rate. The latter variable may be decomposed into a real component and
a nominal premium reflecting inflation expectations. Moreover, it is usual to distinguish between the just described long-run demand for money function, and a short-run relationship in which the long-run function is supplemented by distributed lags of its arguments, often summarised by the addition of a lagged dependent variable to its right-hand side. To go on to treat the supply of nominal money as an exogenous variable yields the conventional textbook LM curve.

More realistically, the nominal money stock may be thought of as the outcome of interactions among the non-bank public, the banking system, and the central bank, with the latter using its control over the size of its own nominal balance sheet to set the value of some strategically important short-term interest rate. Under such a policy regime, the quantity of money in circulation is conventionally portrayed as responding endogenously, indeed passively, to the demand for nominal money. At any moment the IS curve has a certain location and slope; given the rate of interest set by the central bank, the money stock adjusts to produce an LM curve that intersects the IS curve at that rate of interest. The adjustment in question may be instantaneous in the absence of lagged values of variables in the demand for money function, or distributed over time in their presence.

Even if the money stock were a passively endogenous variable, it is conceivable that a central bank might be legally or politically constrained to operate a regime of targeting

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2. The view of the process whereby the money stock is generated which we have just described is essentially that to which Karl Brunner and Allan Meltzer long ago (e.g. 1964) attached the label "money market hypothesis". See also fn. 3.
money growth. According to the conventional view, to control the money supply, that central bank should, in turn: estimate the demand for money function; observe the current and whatever lagged values of real income and the price level are included in that function; substitute these values, along with its target for the money stock, into the demand function; and solve the resulting expression for — and then set — the nominal rate of interest. The money stock would then adjust to demand and, barring forecasting errors or unexpected shifts of the function, would move along the path chosen for it by the bank.

Even if the central bank was not constrained to target money growth — and it would be hard to justify doing so in a world in which monetary policy exercises its influence on the economy solely through variations in interest rates — it might still find the money stock a useful indicator of the current stance of monetary policy. After all, accurate monetary statistics appear long before those on, say, nominal national income, and the fact that the latter variable presumably figures strongly as a (pen-)ultimate target of monetary policy might imply that money growth can usefully play the role of an early warning device. Under such a policy regime, a growth rate of money in excess of that apparently compatible with the desired time path of nominal income would point to the desirability of an upward movement in nominal interest rates, and money growth below that rate would point toward lower rates.

The difference between this regime, and one of money growth targeting, would be of degree only. Under targeting, excessive nominal money growth would require an increase
in the nominal interest rate, while, with money growth playing the role of a leading indicator, other information would presumably be taken into account before policy would respond.

The view that the stock of money is a passively adjusting endogenous variable makes it impossible to attribute any directly causative significance to the well known fact that the quantity of money (or rather its growth rate) is a leading indicator of real output and, with a somewhat longer time lag, of inflation too. In order to account for these latter relationships within the framework just outlined, it is necessary to argue that whatever factors cause output and inflation to vary also affect money, albeit more rapidly. In such circumstances, it is natural to entertain the possibility that variations in the quantity of money which depart from the value predicted by an estimated demand for money function reflect shifts — perhaps short-term, or perhaps more permanent — in the economy's demand for money function. It is also natural to find such an interpretation particularly credible when the signals given by money growth conflict with those emanating from other indicators, whatever these may be.

To the extent that the shifts in question are thought to be short-term, they require no policy response; to the extent that they are longer-term, establishing their implications for policy requires that the demand for money function be re-estimated. Thus, the view of money stock determination which sees the quantity of money as a passively endogenous variable naturally produces a tendency for any central bank which uses it as a leading indicator to react sluggishly to unexpected swings in money growth.
In our view, the analysis of money-stock determination underlying the foregoing analysis is flawed. We would argue that, even under an interest rate control regime, factors influence the money stock that are independent of money demand, and exert a sufficiently strong influence on its behaviour that they ought not to be neglected. Specifically — for a given state of consumer and business confidence — the short-term interest rates most directly under central-bank control affect not just the public’s willingness to hold money, but also its willingness to borrow from the banking system, and chequable bank deposits are created and destroyed as a by-product of such credit-market activities. In turn, such deposit creation and destruction may set up disequilibria between the public’s long run demand for money and the quantity of money in circulation.\footnote{Here we are invoking what Brunner and Meltzer referred to as the "credit market hypothesis" of the money supply process. For a full account of their views on money supply generation, its relationship to credit market activities, and the transmission mechanism of monetary policy which closely resembles that presented here, see Brunner and Meltzer (1993).}

Proponents of what we have termed the conventional view would probably agree with us up to this point; but they would argue that, in a modern financial system, unwanted deposits can be easily converted into other bank liabilities that do not form part of the money stock, or can be used to extinguish debts to the banks; while a shortfall of money holdings can be made good through similar channels. Thus they would argue that the disequilibria to which we have drawn attention will be transitory, and quickly eliminated by way of transactions within the financial sector; that they would have no impact on the
level of aggregate demand for goods and services; and that they could therefore safely be ignored in discussion of monetary policy's transmission mechanism.\footnote{This is why, we believe, that the analysis presented by Howitt and Laidler (1979) failed to convince proponents of the conventional view. In that model, money was simply the balance sheet counterpart of credit.}

We do not deny the logical possibility that this way of looking at things is valid, but there is also a logical possibility that it is not. Specifically, the literature on money's role as a "buffer-stock" argues that the disequilibria in question will impinge upon particular individuals who, in addition to the opportunities presented by financial markets, also face the option of eliminating the disequilibria by altering their rates of flow of expenditure on goods and services. Furthermore, this literature points out that, to the extent that the latter option is chosen, these disequilibria are eliminated for those individuals, but not for the non-bank public as a whole. They are merely passed on to some other agent or agents, whose behaviour will be affected in turn. No doubt some agents will try to make the desired adjustment to their money holdings by way of transactions with the banking system, thus eliminating not only their own, but a portion of the economy-wide discrepancy between the demand and supply of money. Unless or until all of that economy-wide discrepancy is removed by such transactions, however, it will continue to affect aggregate demand and, therefore, output and prices too.\footnote{There is an extensive empirical literature dealing with these issues. Here, in particular, the pioneering efforts of Bergstrom and Wymer (1974) and Jonson, Moses and Wymer (1976) should be mentioned. Closer to home, The Bank of Canada's Small Annual Model (see Rose and Selody, 1985) paid considerable attention to asset disequilibria as influences on expenditure flows.}
To put these matters in the language of IS-LM analysis, the "buffer stock" approach argues that the economy may from time to time find itself "off" its LM curve, and that one of the factors capable of shifting the IS curve is the discrepancy between the demand for money and the quantity of money in circulation. This variable will, from time to time, be equal to zero — but only when the economy is "on" its LM curve.

This buffer stock interpretation of money supply behaviour has implications both for the empirical anomaly facing what we termed "conventional" analysis of the process determining the money stock — namely, money's leading indicator properties — and for the policy significance of fluctuations in the money stock that are not forecast by the demand for money function. Under the buffer stock approach, money-supply fluctuations affect aggregate demand, and so money's leading indicator role has immediate and obvious causative significance; and unforecast fluctuations in money growth, though they may still stem from shifts in the demand for money function, may also stem from variations in the public's willingness to take credit from the banking system at a given rate of interest. Unforecast changes in money growth arising from the latter source would, of course, require immediate offsetting variations in the interest rate to prevent them having effects on the future course of output, employment, and prices.

Our account of how buffer-stock effects come into play under a policy regime that focuses on the interest rate pays attention to the behaviour of bank credit. It is important to note, however, that the buffer stock approach is not simply a somewhat odd way of formulating the hypothesis that the volume of bank credit per se, rather than the quantity
of money, is the critical financial aggregate. This latter hypothesis, which we associate in particular with the work of Ben Bernanke and Alan Blinder (e.g. 1988) and Benjamin Friedman (e.g. 1983), is important and interesting in its own right, but it is quite distinct from both of the views of monetary policy described above. In particular, it stresses that the quantity of credit which the banking system makes available to would-be borrowers has a direct effect on their spending, independently of the impact of credit creation on the quantity of money. We do not deny the potential significance of such mechanisms, but they are not the ones stressed by the buffer-stock approach. They are first-round effects, and the buffer-stock approach places primary emphasis on the subsequent consequences for demand as primary borrowers spend the proceeds of their loans, thus creating disequilibria between the actual and desired money holdings of the public at large.

Historical Antecedents of Modern Views

The buffer stock approach is something of a minority taste in contemporary literature. It nevertheless has a formidable lineage: as Milton Friedman has argued (1987), it amounts to no more than a modern formalisation of ideas which have been central to the quantity theory of money tradition for close to two centuries. The view that if the central bank controls the interest rate it will influence the rate at which bank credit

6. As is indicated by the preliminary programme for this conference, which referred to the topic of this paper as "the Laidler-Robson approach". We are flattered, but the approach is much older. Milton Friedman and Anna Schwartz seem to have been the first to use the phrase "buffer stock" to characterize it (in Friedman and Schwartz 1963).
is created and that, to the extent that credit creation involves the simultaneous creation of monetary liabilities, these will have second- and subsequent-round effects on expenditure would not have appeared novel to the Bullion Committee.\textsuperscript{7} In 1810, that Committee described the interaction of bank lending and money creation — albeit in an institutional setting where the typical commercial bank was a note-issuing entity — thus:

In the first instance, when the advance is made by notes paid in discount of a bill, it is undoubtedly so much capital, so much power of making purchases, placed in the hands of the merchant who receives the notes.... But as soon as the portion of circulating medium, in which the advance was thus made, performs in the hands of him to whom it was advanced this its first operation as capital, they fall into the channel of circulation as so much circulating medium, and form an addition to the mass of currency.... If the whole sum of discounts continues outstanding at a given amount, there will remain permanently out in circulation a corresponding amount of paper; and if the amount of discounts is progressively increasing, the amount of paper, which remains out in circulation over and above what is otherwise wanted for the occasions of the public, will progressively increase also, and the money prices of commodities will progressively rise. (Bullion Committee (1810), as reprinted in Cannan 1919, p. 50.)

A good deal of the subsequent history of monetary economics, at least down to the 1920s, can be thought of as a succession of attempts to clarify and fill in the details of the account of monetary policy’s transmission mechanism set out in this passage.

In the 1930s, the focus of monetary economics shifted from price-level determination to the determination of the levels of real income and employment. Once the capacity of variations in investment to generate new saving by way of output variations was

\textsuperscript{7} The Select Committee on the High Price of Gold Bullion, set up by the U.K. House of Commons under the Chairmanship of Francis Horner to enquire into the causes of inflation and exchange depreciation in 1808 and 1809. The Committee’s Report, mainly written by Horner and Henry Thornton, has long been recognized as a landmark in the development of monetary economics. It is most accessible in the reprinted version contained in Edwin Cannan (1919).
recognised, monetary policy analysis began to emphasise the influence of the interest rate on investment, and hence on output. The interaction of credit creation and money growth faded into the background. In the *General Theory*, for example, monetary policy was usually presented as involving exogenous changes in the quantity of money, and consequent changes in interest rates, which in due course affected investment. The interest elasticity of the demand for money was given a crucial role here — indeed, when Keynes came to consider the mechanics of changing the quantity of money by way of open-market operations, he argued that this factor was all-important.

[T]here is a continuous curve relating changes in the demand for money to satisfy the speculative motive and changes in the rate of interest.... Indeed, if this were not so, 'open market operations' would be impractical. (Keynes 1936 p. 197.)

It was a corollary of this position — not developed by Keynes himself, but soon picked up by some of his followers — that monetary policy, inasmuch as it worked through the effects of the rate of interest on aggregate demand, was best carried out in an operating environment in which the interest rate itself became the policy instrument, with the quantity of money being permitted to adapt itself passively to changes in demand. The following exchange between Richard Sayers and Richard Kahn, during the 1958 deliberations of the Radcliffe Committee, illustrates the dismissive attitude that had by then developed toward the older view.⁸

Professor Sayers: I wonder if we might have your comments on another view

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which has been put to us, for which mystique is not quite the appropriate word: that though it is through rates of interest and the availability of credit and so on that monetary policy works on the level of economic activity, the appropriate way for the monetary authorities to work is not to make up their minds that such and such rates of interest and such and such availabilities of credit are appropriate in particular directions, but to operate in some way on the situation as a whole by increasing the quantity of money when demand needs to be stimulated, and decreasing the quantity of money in other circumstances, leaving it to the market to produce the effects on the particular interest rates?

Richard Kahn: Am I being asked not to apply the word 'mystique' to that view?

Professor Sayers: I think that answers my question. (Committee 1960, Minute 10983, p. 742, italics added.)

In short, what we have called the conventional view of monetary policy was a creation of the Keynesian revolution, and perhaps an unfortunately misleading creation at that. After all, agents do not respond to changes in interest rates solely, or even mainly, with a view to changing their money holdings. If they borrow more from the banks when interest rates fall, that is mainly to finance purchases of goods and services. It is the existence of an interest elasticity of demand for credit, not (as Keynes had it) money, that makes open market operations possible; and, as we have already argued, it is this insight, until the 1930s a commonplace, that underlies the view of monetary policy which we espouse.

It may be that previous views on these matters are of mainly historical interest, and that what we term the conventional view, in neglecting the factors which impinge mainly on the supply side of the market for money, might be providing a useful simplification of a complex set of phenomena. It is, after all, one thing to argue that the banks' credit-
market transactions created money as a by-product and that part of the money thus created remained in circulation, exerting important effects, in a world in which currency and non-interest-bearing chequable deposits were the banks’ dominant liabilities. It is another thing to make the same case in a world in which these items are a relatively minor item on bank balance sheets. It could be — and we suspect that many modern proponents of the conventional approach would take this line — that the scope offered by modern financial institutions for the non-bank public to substitute out of, and hence to extinguish, unwanted money, is so large relative to that available in earlier times, that it is nowadays safe as an empirical matter to abstract from supply-side phenomena in a way that it was not in earlier times.

A More Formal Presentation of the Issues

Anyone wishing to dispute the validity of the nowadays conventional view of money-stock determination faces an immediate difficulty. It is a well established fact of applied economics that, subject to a certain element of instability over time, it does seem to be possible to fit to the data for most countries and aggregates — including M1 in Canada — a short-run demand for money function of the form pioneered by Gregory Chow (1966), but most often associated with Steven Goldfeld (1973). A generic version of this relationship may be written as follows

\[ m - p = \lambda (\delta + \delta^* + \delta_y r + \delta_{y} y - \delta^*_y r) + (1 - \lambda)(m_{-1} - p_{-1}) + e \]

where, using notation to be deployed further below, \( m \) is the log of nominal money, \( p \) the
log of the price level, \( y^* \) the log of capacity or permanent real income, \( y \), the transitory component of the log, of current real income, \( r \) either the log or, in the formulation to be developed below, the level of the nominal interest rate, and \( e \) an error term.

The fact that this equation and/or minor variations on it such as the "nominal adjustment" version, in which lagged money is deflated by the current rather than the lagged price level, fit the data well gives considerable credibility to the view that, under interest-rate control, the quantity of money is a passively endogenous variable. A demonstration that it is possible to observe such an empirical relationship in an economy in which the quantity of money plays a significant causative role is therefore vital if the buffer-stock view is to be taken seriously as an alternative.

This problem was first explicitly addressed by Alan Walters (1967), who argued that, with nominal money an exogenous variable, there could be no alternative but to interpret the Chow-Goldfeld short-run demand for money function as characterizing price-level adjustment. Subsequent empirical work by Carr and Darby (1981) and Laidler (1980) showed that such an interpretation was at least plausible; and in Laidler (1990, Ch. 4) it was demonstrated that a "real adjustment" form of this equation could be derived as a quasi-reduced-form of an explicit macro-economic model with the parameter \( \lambda \) being a function of the parameters underlying the price-level adjustment mechanisms of the model, rather than, in and of itself, an independent component of the economy's structure. Two inter-related difficulties remain here, however: first, all of the above analyses treated the quantity of nominal money as a purely exogenous variable, directly determined by the
monetary authorities, an assumption that no-one could take seriously as an empirical proposition; and second, further econometric studies, for example Duguay (1983) and MacKinnon and Milbourne (1988), showed that, whatever a Chow-Goldfeld equation might be, it was not simply a price-adjustment equation in disguise.

We will now show that it is possible to modify the model used in Laidler (1990, Ch. 4) to incorporate an interest-rate control regime for monetary policy, while still preserving a subsequent causative role for the quantity of money in influencing real output and the price level — a role that is separate from the direct effects of the interest rate on these variables. The model in question is also compatible with the existence of a nominal-adjustment version of a short-run demand for money function, while simultaneously yielding a quasi-reduced-form equation in which the quantity of money acts as a leading indicator of real output. The model in question also reduces to a conventional IS-LM model with passively endogenous money, if certain of its parameters go to zero, and it thus calls attention to the type of empirical tests that might be used to distinguish between conventional and buffer-stock views of the world.

It should be emphasised that the particular form in which we set out the model — a closed economy with minimal time lags — is dictated by our desire to demonstrate clearly the model’s pedigree in the buffer-stock literature. Our model, therefore, should be treated as an analytic structure designed to clarify the questions at stake in the debate to which this paper seeks to contribute. It was not primarily conceived as a vehicle for econometric research. Some of its shortcomings in this latter regard, and their possible
significance relative to a model well specified enough to produce convincing results, are discussed in the next section.

The model in question may be set out as follows:

\[ m_d - p = \delta_0 + \delta_1 y - \delta_2 r \]  \hspace{1cm} (1)

\[ y = \alpha_1 (m_{t-1} - m_d) + \alpha_2 (p + p^e - p - r) \]  \hspace{1cm} (2)

\[ p - p_{t-1}^e = \beta y \]  \hspace{1cm} (3)

\[ m_s = m_{t-1} - \phi_1 (m_{t-1} - m_d) + \phi_2 (p + p^e - p - r) \]  \hspace{1cm} (4)

where, with units chosen so that the log of capacity or permanent income equals zero, \( m, y, r, \) and \( p \) are defined as they were above, while \( p^e \) is the expected price level. Subscripts appended to this variable indicate the period in which the expectation, which appertains to the subsequent period, is formed; thus \( p^e - p \) is the inflation rate expected at the end of period \( t \) to rule over the period \( t+1 \). \( \rho \) is the real value of the Wicksellian natural rate of interest, defined so that, if the real value of the market rate of interest, \( r - (p^e - p) \) is equal to \( \rho \), monetary policy will be having no influence on the level of aggregate demand in the economy. This variable \( \rho \) should not be thought of as a constant: it is subject to influence from fiscal policy and foreign demand, and will also vary with the state of consumer and business confidence. As it varies, the IS curve will shift, and the desirability of borrowing from the banks to finance new expenditures will also vary.

Apart from minor notational changes of no analytic significance, equations (1) through (4) are identical to those employed in the model set out in Laidler (1990, Ch. 4). Equation
(1) is a long-run demand for money function. Equation (2) is an aggregate demand function which differs from an IS curve in incorporating a term in the economy's excess supply of (or demand for) money. Thus the first term on the right-hand side of equation (2) is crucial in distinguishing this buffer-stock model from a more conventional formulation. Note here that the term \( m_x \) refers to the economy's average demand for a stock of money over the current period, as determined by equation (1); while \( m_{x,t} \) should be interpreted as the stock of money which the economy finds itself holding at the end of the previous period, or equivalently at the beginning of the current one. Agents are thus thought of as attempting to adjust their beginning of period cash holdings to a target level determined during the period by adjusting their rates of flow of expenditure.

Equation (3) is equivalent to an expectations-augmented Phillips curve, as is apparent when \( p_{t-1}^e \) is taken to its right-hand side and \( p_{t-1} \) subtracted from each side.

Equation (4) is intended to capture the endogenous nature of the money stock. The second term on its right-hand side reflects our agreement with proponents of the conventional view of money-stock determination that when agents are "off" their long-run demand for money functions they may attempt to remove this disequilibrium by transacting with the banking system. Our justification for the timing of the money supply and demand variables here is the same as in the case of equation (2). The third term is

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9. In the exogenous money model set out in Laidler (1990, Ch. 4) beginning of period money was indicated as \( m \). In that model, the nominal money stock changed between periods, and remained constant during them. Here it changes during periods, and does not change between them. Hence, the beginning of period money stock is equal to that in circulation at the end of the previous period.
intended to reflect our belief that credit creation, which one might expect to respond to any discrepancy between the nominal interest rate set by the central bank, $r$, and the nominal value of the economy's natural rate ($\rho + p^e - p$) will lead to an increase or decrease in the nominal money stock.

Note that, in an IS-LM model, discrepancies between the supply of, and long-run demand for, money would not be allowed to influence aggregate demand, so that equation (2) would then reduce to an IS curve. Moreover, in that same conventional model, the third term on the right-hand side of equation (4) would not appear, so that this equation, with (1) substituted into it, could be interpreted as a dynamised LM curve along which, given the exogenously set nominal rate of interest, the stock of money adjusts passively to demand. To put the same point more conventionally, the IS-LM alternative to our buffer-stock model would yield a simple form of the nominal adjustment version of the Chow-Goldfeld demand for money function.

There is not space here to attempt anything approaching a complete analysis of this model, and indeed, anyone wishing to investigate its dynamic properties would, at a minimum, have to endogenize the determination of the expected inflation rate ($p^e-p$) and might also have to consider making the Wicksellian "natural" rate at least partially dependent upon other variables determined within the model.

Even so, it is worth remarking upon one characteristic of its steady state behaviour. It is obvious that in a situation of ongoing fully anticipated inflation, a nominal adjustment equation for money such as (4), when combined with the postulate that the
monetary authorities control the nominal interest rate, predicts that the amount of nominal
cash in circulation will be perpetually below the economy's long-run demand for money,
as given by equation (1).\(^\text{10}\) In turn, a perpetually negative value of \((m_{e,1} - m_d)\) will exert
downward pressure on \(y\); but this is problematic, since \(y\) has to take a value of zero if
actual and expected inflation are to be equal to each other, a \textit{sine qua non} of a steady
state fully anticipated inflation. The solution to this dilemma is straightforward. For a
given value of \(\rho\), the economy's real natural interest rate, the higher the steady state rate
of inflation the lower must be \((r - p^e + p)\), the real rate of interest charged by the banks.
Only in this way can the depressing effect of \((m_{e,1} - m_d)\) on \(y\) be offset. But this means,
in turn, that our buffer-stock model yields the following observation: the lower the long-
run rate of inflation, the higher is the real interest rate that is compatible with sustaining
full employment. In the light of recent worries about higher real interest rates that seem
to have established themselves in the new low-inflation environment, this result is surely
an intriguing one.

Be that as it may, it is straightforward to derive from our model two further
expressions, which can form the basis of a preliminary investigation of its empirical
content. Note first that, with \(\phi_2 > 0\), we still have a form of the nominal-adjustment

\(^{10}\) This effect arises over and above the influence of inflation on the opportunity cost of holding money and hence
on the long-run demand for it. Note also that, in the IS-LM version of the model, with the first term dropped
from the right-hand-side of equation (2) and the second term dropped from the right-hand-side of equation (4),
this effect is nothing more than a curiosity of no further significance. We are aware that one possible
implication of this property of the conventional short-run demand for money function is that its behaviour is
not really consistent with a steady state and that, therefore, it might be subject to the Lucas critique. We do
not, however, take this matter up further here.
version of the Chow-Goldfeld demand for money function,

\[ m_s = \phi_1(\delta_0 + \delta_1 y + \rho_1 r) + (1 - \phi_1) m_{s-1} + \phi_2 \chi \]  

(5)

where we substitute \( \chi \) for \((p + p^e - p - r)\) to simplify the notation. This equation does, however, have an extra term on the right-hand side, which may be thought of as giving economic content to the error term (or, more realistically, one of its components) of the usually encountered form of the equation, and whose mean value, over any substantial time period, is likely to be zero; and it is the money supply, not money demand, that is its dependent variable.

Note also that substitution of (1) into (2) and some rearrangement yields

\[ y = \frac{\alpha_1}{(1 + \alpha_1 \delta_1)} (m_{s-1} - p - \delta_0 - \delta_2 r) + \frac{\alpha_2}{(1 + \alpha_1 \delta_1)} \chi \]  

(6)

In this equation, the money stock is clearly a leading indicator of real income — and, therefore, as shown in (3), of inflation as well.\(^{11}\) The point to stress here is that money's indicator status derives from its being an intermediate variable in the causative chain running from \( \chi \) — and therefore from the policy instrument \( r \), the demand shock variables which influence \( p \), and any factors influencing inflation expectations — to aggregate demand. If the parameter \( \alpha_1 \) were zero, as it would be in a conventional IS-LM model, this equation would immediately reduce back to a conventional IS curve —

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\(^{11}\) Obviously, the particular timing in these relationships is purely a consequence of the simple time structure imposed upon the model. The introduction of further lagged effects to the right-hand side of equation (2), for example, would be a plausible modification, and would complicate the response of income and prices to money.
equation (2) without the first term on the right-hand side — in which there would be no role for the quantity of money.

Note also the complicated role played by the rate of interest in the buffer-stock model, relative to its simpler IS-LM counterpart. Changes in the variable have no fewer than three effects: on the demand for money through equation (1), and hence, for a rise in the rate, a positive effect on aggregate demand; directly on aggregate demand through the second term of equation (2), a negative effect; and finally a further negative effect working through the last term of equation (4) and thence through equation (2). The presumption would normally be that the negative effects dominate.\textsuperscript{12} If, on the other hand, we set the parameters $\alpha_1$ and $\phi_2$ to zero, thus reducing our model to a conventional IS-LM system, two of these three channels for interest rate effects disappear, leaving the interest sensitivity of expenditure along the IS curve as the only link between the monetary and real sides of the system.

Finally it is worth drawing explicit attention to the fact that our model will also be reduced to an IS-LM system if the disequilibrium terms ($m_{L1} - m_d$) and $\chi$ go to zero (or any other constant value). A tranquil economic environment would presumably generate just such a tendency. It follows that a fair test of the importance of buffer stock effects requires data generated by a certain degree of monetary turbulence. Fortunately, there is no shortage of such turbulence in recent Canadian experience.

\textsuperscript{12} It should be pointed out, however, that it is the first positive effect which underlies the difficulties we encounter in interpreting money growth data when changes in the inflation rate are leading to changes in the opportunity cost of holding money.
The foregoing discussion is far from being a complete exposition of the properties of a buffer-stock model, but enough has been said to establish four of its characteristics. First, it is a model in which money created as a by-product of credit creation by the banks, though an endogenous variable, has an effect on aggregate demand, and hence on output and inflation; money, though endogenous, is not merely passive. Second, closely related, in the buffer stock model, money emerges as an indicator of output and price-level behaviour; the model therefore provides a straightforward interpretation of an important piece of empirical evidence that is awkward to reconcile with a conventional IS-LM model in which money is merely passive. Third, the buffer-stock model is quite compatible with data that generate a nominal-adjustment version of the Chow-Goldfeld demand for money equation. Fourth, and finally, in a buffer-stock model, residuals from this latter equation include the effects of credit creation on the supply of money and hence potentially provide an early warning of developing monetary disequilibrium. Hence they might be an important source of information to policymakers, particularly in turbulent times.

Preliminary Empirical Results

Whether or not any of this is relevant to debates about Canadian monetary policy depends on a buffer-stock model being a more accurate characterisation of the economy than a conventional IS-LM system. The question is an empirical one, and in order to settle it definitively we might want to specify and estimate a complete macroeconometric
model of the Canadian economy. As well as adding the financial variables alluded to
above, this route would require us: (a) to adapt our simple closed-economy expository
framework to the openness of the Canadian economy by adding a block of equations to
capture the influence of overseas variables on aggregate demand, as well as to determine
the exchange rate and trace its influence on domestic prices; (b) to model the
determination of the expected inflation rate, $p^e - p$, as an endogenous variable; and (c) to
device and implement some way of modelling the time path of "capacity" or "permanent"
income $y^*$, so that the variable $y$, which measures deviations of actual from capacity
income — and which plays a key role in our analysis — can be measured. This task
would be, to put it mildly, a daunting one, and well beyond the capabilities of these
authors.

The relevance of buffer stock effects hinges, however, upon the parameters $\alpha_1$ and
$\phi_2$ being positive, rather than zero, and a preliminary investigation of these questions is
feasible without resort to an exhaustive empirical analysis of the whole economy. We use
tests whose outcomes do not depend upon us having to take a position on the
decomposition of output between its capacity level, $y^*$ (which obviously cannot be set
equal to zero in empirical work) and a deviation therefrom, $y$. As far as the demand for
money function itself is concerned, as it figures for example in equation (5), the solution
here is trivial. We simply assume that the permanent and transitory income elasticities of
demand for real balances are equal, so that the log of the overall level of real GDP
replaces our variable $y$. When we come to assessing the influence of buffer stock effects
on aggregate demand, and hence testing for the importance of the parameter $\alpha_1$, matters are only marginally less straightforward. We eliminate $y$ by substituting equation (6) into (3), and solving for $p$, which yields

$$p - p_{-1}^* = \left[ \frac{1}{1 + \beta \alpha_1 + \beta \alpha_2 \delta_2} \right] \left[ \beta \alpha_1 (m_{t-1} - p_{-1}^*) + \beta \alpha_1 \delta_2 (1 + \beta \alpha_1)r + \beta \alpha_2 (1 + \beta \alpha_1) \chi + \beta \alpha_1 \delta_3 \right]$$

This equation, along with equation (5), provides the basis for the empirical work which we shall now describe.

Details of the data which we have used are described in an appendix, but some matters are sufficiently important to the interpretation of our results that they warrant discussion in the text. Only our measurements of the price level — the GDP deflator — and of the money stock — M1 — are straightforward; and in the case of the latter variable, our use of data for the final month of the quarter, rather than the whole period, is unusual, though justified by the mechanics of our model. All of the other variables raise one or another sort of more complicated conceptual problem.

To begin with, the rate of interest appears in various equations of our system, and this variable is the monetary authorities' policy instrument. Bearing this latter point in mind, we have chosen to represent this variable by a short-term interest rate that is strongly influenced by the Bank of Canada's day-to-day operations, namely the rate on one month bankers' acceptances. In some of our preliminary work, not reported in detail here, we also used the overnight money market rate, though nothing of great significance seems
to have hinged upon this choice.\textsuperscript{13} A more complete formulation of a model such as ours would probably use a rate offered on savings deposits or CDs, or yields on money-market instruments, in the demand for money function; while an array of interest rates drawn from across the maturity spectrum might be best for equation (2); and these rates would need to be linked to each other, and to the overnight rate, through a term-structure equation or equations. Absent such a component in our simple model, we simply neglect these complications in what follows.

Second, we must develop a variable for the real "natural" interest rate $\rho$ which appears in both equations (2) and (5). In (5) it stands for the expected real rate of return to be made from funds borrowed from the banking system, while in (2), and therefore (7) it plays the role of a general shift parameter in an aggregate demand curve. Once more, in a simple analytic model, it is a reasonable simplification to treat these two as the same variable; in a more complex system, though one might expect them to be positively correlated with one another, there is no reason for them to be identical. In the preliminary work reported here we have nevertheless treated them as such, and have used the expected real rate of growth of GDP over the subsequent year as their empirical counterpart — a variable that has the advantage of having the dimension of a real interest rate. In the work whose results we present here, a five quarter moving average of this

\textsuperscript{13} As far as the third term on the right-hand side of (5) is concerned, where we are concerned with the cost of funds to the banking system, the overnight rate seems more appropriate, but when it comes to an interest rate for inclusion in the demand for money function (1) or in the aggregate demand equation (2), the overnight rate was not an ideal choice. Our selection here was thus a compromise.
variable was used, rather than quarterly observations. We have also supplemented this choice with a more general index of consumer and business confidence.

Third, and finally, our equations include an expected inflation rate, in addition to the expected real growth rate. A full scale econometric modelling exercise would treat such variables as endogenous, to be determined within the model, but here we sidestep the difficult theoretical and empirical issues that would arise were we to follow this path by using survey data on expectations. Specifically, our expected inflation rate is the forecast rate of change of the GDP deflator, so that the variable $p^e$ is given by adding this forecast to the current value of the deflator, while $\rho + p^e - p$ is given by the forecast rate of nominal GDP growth. Once again, it is a five quarter moving average of this variable that is used.

We fitted equation (7) to quarterly Canadian data for the period 1977:Q1 to 1993:Q4, and the results of doing so are shown in the first row of Table 1. These results are favourable to the buffer-stock model. In particular, both the money stock and the nominal rate of interest appear with statistically significant coefficients — coefficients which ought to be zero in a conventional IS-LM system. The variable $\chi$ also enters with a statistically significant positive sign. If a confidence index variable, C, is added to the right hand side of (7.1) as an extra shift parameter in the IS curve — an indicator of "animal spirits" — we get the results in the second row of Table 1 (labelled 7.2). As will be evident, this

14. The use of this smoothed series had no effect on the results obtained with equation (7), but it did significantly improve the performance of equation (5).
variable does have extra explanatory power, but leaves other parameter estimates essentially unchanged.  

There is a sense in which our results with equation (7) are almost "too good," for they indicate a statistically significant effect of monetary policy on the price level coming through within one quarter. Two points should be made here, however. First, the dependent variable in equation (7) is the price level relative to its forecast value. If, as is surely uncontroversial, the major effects of monetary policy do not appear until inflation expectations begin to respond to policy's effects, there is no necessary inconsistency between policy having a small but systematic impact well before these quantitatively more important effects come through. Second, the monetary policy variable in this model is the nominal interest rate, and it appears twice in equation (7) with opposite signs. Our model tells us that a third effect of changing this variable, which runs through money creation and is explicitly captured in (5), operates with a distributed lag. Once again, then, there is no reason to suppose that the rapid impact of monetary policy on the price level suggested by these results precludes the existence of larger effects coming through later.

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15. OLS estimation is, of course, only appropriate when the variables involved are stationary. We tested for this using the augmented Dickey-Fuller test, and found that the null hypotheses that a unit root was present could not be rejected at conventional levels of statistical significance for any of the variables involved in equation 7. Given that this test is known to be a relatively weak one, given that it is hard to believe that variables such as \( p-p_e \) or \( \chi \) are not stationary, and given the preliminary nature of our work, we decided to stick with OLS despite these results. The reader is warned that Table 1 might overstate the statistical strength of our hypothesis. It should be noted, however, that the results we report are robust to the inclusion of a time trend in the equation.
We now turn to presenting preliminary evidence on the role of credit creation in determining the time path of the money stock. Here our starting point is the following equation, derived from (5).

\[ m_s = g_0 + g_1(y^* + y + p) + g_2r + g_3\chi \]  

(8)

In an IS-LM model with an exogenous interest rate this equation reduces to a conventional nominal adjustment version of the Chow-Goldfeld short-run demand for money function. Such an equation fitted to quarterly data over the period 1975-(3) to 1993-(2) does not perform too badly as these things go. It yields the results shown in the first row (labelled 8.1) in Table 2. If we add the variable \( \chi \) to the right hand side of the equation, it enters significantly positively, as inspection of the second row (5.2) reveals.

To add the confidence index to this equation, however, does no good. It takes a zero coefficient and the rest of the equation is left essentially unchanged.\(^{16}\)

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\(^{16}\) The reader will note that we use the level on nominal GDP on the right-hand side of the expression for which results are reported in Table 2. We also experimented with entering real income and the price level as separate variables, but found that this made essentially no difference to our results. Also, because the nominal money stock is a strongly trended variable, we cannot so easily dismiss doubts about the appropriateness of using OLS estimators in this case. In order to reduce the problems involved here, we re-estimated these equations using the inverse of velocity, \( m_s/(y^* + y + p) = 1/v \), as the dependent variable, with the following results:

\[
\begin{align*}
1/v &= -0.3177 - 0.0004r + 0.0056\chi \\
&= (0.1270) (0.0020) (0.0029)
\end{align*}
\]

\[
+ 0.8779 (1/v)_{1} \\
&= (0.04367)
\]

\[ R^2 = 0.974, \quad DW = 1.98. \]
So far so good, but there are problems with the above results too, to which the reader’s attention ought to be drawn. First, the evidence on the interest sensitivity of the demand for money contained in Table 2 is not consistent with that contained in Table 1. In equation (8.2), Table 2 the coefficient on \( r \) is not significantly different from zero, implying a zero point estimate for the parameter \( \delta_2 \) of our basic model. In Table 1, \( r \) has a significantly positive coefficient, implying a well determined negative effect of the interest rate on the demand for money. This result seems to be robust with respect to our choice of interest rate variable, since it also turns up when we use the overnight rate, and it is also robust with respect to small changes in our sample period as well.

It should also be noted that conventional wisdom, to which we have, in the past subscribed ourselves, points to a shift in the Canadian demand for \( M_1 \) function at some time in the late 1970s and into the early 1980s.\(^{17}\) In some of our preliminary work, we experimented with various dummy variables to capture this phenomenon. In the context of equation (8), such variables were sometimes significant, but never in the context of equation (7), also, how importantly they figured in equation (8) turned out to be

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Evidently, this result tells the same story as those presented in Table 2. Ultimately, however, it will require the application of a more sophisticated econometrics to confirm the robustness of that story. Once more however, the results here, and those reported in Table 2 are robust to the inclusion of a time trend in the equations that generated them.

\(^{17}\) Charles Freedman (1983) provides the standard account of the impact of the introduction of interest bearing chequing accounts on the demand for \( M_1 \) in Canada. We regard his analysis as highly plausible and, as we note below, we are puzzled by our own difficulties in finding a shift in the demand function for \( M_1 \) at the beginning of the 1980s.
extremely sensitive to the precise way in which we measure \( \chi \). The latter variable, including as it does forecasts of nominal GDP growth was particularly volatile in the early 1980s, so this is not perhaps surprising. However, taken at face value, the results we present in Tables 1 and 2 allow for no shift in the demand for \( M_1 \) function, and equation (7) proved remarkably resistant to any attempts to find one. We do find this puzzling. Moreover, work not reported in detail, in which we performed regressions for a series of 5 year periods moving forward through our sample, confirms that our equations are at their strongest in the early to mid-1980s and deteriorate, sometimes quite dramatically, as data from the 1990s come to dominate their estimation.

Clearly, then, there are matters here that require further investigation with more sophisticated techniques, probably along lines suggested at the beginning of this section of our paper. Suffice it then to re-iterate that we claim nothing more for the results it contains than that they are intriguing, that they are more consistent with an interpretation of recent Canadian data cast in terms of a very simple buffer-stock model than a conventional, but equally simple IS-LM style framework, and that a great deal more work is needed before any reasonable person would express much confidence in them.

Conclusions

It has been our primary aim in this paper to show that the buffer-stock approach to the analysis of monetary policy has analytic content not only in models of exogenous money, where it has been most often deployed in the past, but also in a framework in
which the monetary authorities control an interest rate and the money supply becomes endogenous. Qualitatively speaking, we believe that our claims here ought to be uncontroversial. As we have tried to show with the aid of an elementary macroeconomic model, our differences with exponents of what we have called the conventional view hinge upon whether or not a couple of effects — namely of private sector borrowing from the banking system on the money stock, and of excess cash balances on subsequent spending decisions — are systematically present in the economy and are large enough to matter. Our preliminary empirical results suggest that they might be, and that, therefore a fuller and more careful econometric study of the issue might be worth carrying out.
Data Appendix

This appendix provides a listing of the variables used in this paper, with brief descriptions where necessary, in order of appearance in the empirical work. A diskette containing these series is available from the authors.

\( p \) The price level is the log of the GDP deflator (CANSIM series D20556).

\( p^e \) The expected price level was constructed using quarterly inflation forecasts from the Conference Board of Canada's survey of forecasters. The forecasts used were actually made for the calendar year following the year in which the survey was taken (i.e., the forecast for 1985:Q1 is the mean forecast for the annual average of the GDP deflator for 1986 over the corresponding value for 1985; the forecast for 1985:Q4 is the same). Our use of these figures as quarterly forecasts involves an assumption that the survey participants' forecasts for annual increases can be interpolated over the intervening quarters. Each quarter's expected price level was calculated by inflating the previous quarter's actual level by the previous quarter's inflation forecast.

Because the Conference Board survey was not taken at regular quarterly intervals prior to 1983:Q3, some data prior to that date were estimated on the basis of a regression of forecasts on actual annualized rates of inflation over 2-quarter intervals ending 2 quarters before, on, and 2 quarters after the survey quarter.

\( r \) The interest rate is quarterly averages of the one month bankers' acceptances rate (CANSIM series B14033) reported for the week closest to month-end, shifted forward one month (i.e., the figure for 1985:Q1 is the average of the last full weeks of December 1984, January 1985, and February 1985).

\( m \) The money stock is the log of net M1, for the last month of the quarter, seasonally adjusted (CANSIM series B1627).

\( p \) Forecasts for real GDP growth are from the Conference Board Survey of forecasters. The series used here embodies the same assumptions, and uses the same regression technique for interpolating missing observations, as reported above in connection with the inflation forecasts.

\( C \) The confidence index is a weighted average of the Conference Board’s Index of Consumer Attitudes \((1991 = 1.00)\) and Business Confidence Index \((1977=1.00)\), both seasonally adjusted, with weights of two-thirds and one-third respectively (available from the Conference Board: mnemonics CBISA and IBC).

\( y \) Real income is the log of real GDP (1986 prices), seasonally adjusted (CANSIM series D20463).
References


Committee on the Working of the Monetary System (The Radcliffe Committee) (1960) Minutes of Evidence London, HMSO.


Table 1

Results from Price-level ($p - p_{-1}^e$) equation 1977-(1) - 1993(2).
(Standard errors in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Constant</th>
<th>$r$</th>
<th>$m_{-1} - p_{-1}^e$</th>
<th>$\chi$</th>
<th>C</th>
<th>$R^2$</th>
<th>DW</th>
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<td>0.0428</td>
<td>0.0010</td>
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<td>.299</td>
<td>2.09</td>
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<td>(0.098)</td>
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<td>(0.0093)</td>
<td>(0.0003)</td>
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<tr>
<td></td>
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<td>(0.0003)</td>
<td>(0.0091)</td>
<td>(0.0003)</td>
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Table 2

Results from Nominal Money Stock Equation (1977-(1) - 1993-(2)
(Standard Errors in parentheses)

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<th>Constant</th>
<th>$y^* + y + p$</th>
<th>$r$</th>
<th>$m_{-1}$</th>
<th>$\chi^*$</th>
<th>R</th>
<th>DW</th>
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<td>(0.0008)</td>
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<td>.996</td>
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<td>(0.0461)</td>
<td>(0.0021)</td>
<td>(0.0595)</td>
<td>(0.0027)</td>
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