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Price Stickiness, Buffer-Stock Money, and Persistent Fluctuations in Output and Real Balances

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PRICE STICKINESS, BUFFER-STOCK
MONEY, AND PERSISTENT
FLUCTUATIONS IN OUTPUT AND REAL
BALANCES*

by

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May, 1985

Abstract

A simple macro model incorporating a little price stickiness is compared
to a basic new-classical model. It is argued that the former system
while still yielding standard policy ineffectiveness results, more
easily explains persistence in fluctuations in real variables, notably
real balances, without being more complicated. It therefore should be
taken seriously as embodying a viable alternative to new-classical
macroeconomics.

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correspondence about some of the issues discussed here, and to
Jurgen Eichberger, Joel Fried, Zvi Hercowitz, Peter Howitt, Lars Jonung,
Hans-Werner Sinn, and Michael Parkin for comments on an earlier draft. None
of the above, however, is thereby implicated in my errors.
Although it is not quite true that the macroeconomics of the so-called "neo-classical synthesis" was devoid of microeconomic foundations, because a great deal of attention was paid by people working within that tradition to the maximising bases of individual behaviour relationships, it was almost devoid of market-theoretical foundations. So long as the arbitrary postulate of price stickiness appeared to be logically necessary for the explanation of the real world phenomenon of unemployment, a macroeconomics based upon it was bound to remain dominant; but it is hardly surprising that, when Robert E. Lucas, Jr. (1972) (1973) showed that it was possible to reconcile output and employment fluctuations with the operation of a system of competitive continuously clearing markets, he laid the foundations for a revolution in macroeconomics.

The new-classical macroeconomics which Lucas created reintroduced two postulates to the area, one formerly discredited, and one simply forgotten, namely clearing markets and rational expectations.¹ The rational expectations notion has probably been the main reason for its attractiveness, because it provides the basis for the policy ineffectiveness propositions which have proved so popular among those practically oriented macroeconomists who have faced up to the difficulty of explaining the abject failure of conventional stabilisation policies from the 1960s onwards.²

The assumption of competitive markets kept continuously cleared by flexible prices is less attractive, in particular to those same policy oriented macroeconomists. The reason for this is simple enough. Output and

¹

²
employment not only fluctuate in the real world, but the fluctuations in question persist over time. Price stickiness is one way of explaining both the existence and the persistence of such fluctuations, and though new-classical models can easily be extended to deal with persistence, there is a certain ad hoc element to the necessary extensions. Price stickiness is an ad hoc assumption too, of course, but the superiority of a macro-theory built upon price flexibility becomes less clear-cut as ad hoc elements are introduced into it.  

Similar difficulties have recently been noted in the context of the aggregate demand for money function. Real world economies seem to be characterised by persistence over time in the value of real balance holdings, over and above what can be explained by continuity in the behaviour of the arguments of the long-run demand for money function. Price stickiness once more provides a means of explaining this observation; but it can be reconciled with the new-classical model by extending that framework to encompass the influence of systematic measurement error on the outcome of empirical work. Here again, we are confronted with the need to choose between two ad hoc assumptions if we are to be able to proceed with any applied work in macroeconomics: price stickiness on the one hand, and systematic measurement error on the other.  

Just as the rational expectations idea is the most attractive feature of new-classical theory, so is the error learning hypothesis the least appealing characteristic of the macroeconomic model which grew out of the neo-classical synthesis; but it is this hypothesis, embedded in the expectations augmented Phillips curve, which was used to impart price stickiness, and hence persistence of economic fluctuations, to that model. Not only is error
learning frequently incompatible with maximising behaviour on the part of individual agents, but any model which relies upon it is susceptible to systematic policy control of its real variables. It is hardly surprising that many macroeconomists have been willing to swallow the relatively minor ad hoc adjustments needed to square new-classical theory with important stylised facts, rather than embrace this older alternative.  

Nevertheless, the association between the price stickiness assumption and the error learning hypothesis is historical, not logical. In this paper I shall set out a basic new-classical model and compare it with an alternative modification of a basic Walrasian framework, which incorporates a minimal element of price stickiness but does not use error learning. I shall also show that this alternative modification enables the model to explain the persistence effects in output and real balances alluded to above, without simultaneously rendering it susceptible to systematic policy manipulation. I hope that, in doing so, I can make price stickiness a little easier to swallow as a premise for macroeconomic analysis.

II

The economy which we shall analyse is simple indeed. It is inhabited by households who produce and consume non-durable goods, and, as an adjunct to their trading activity, hold money, the only asset. Population and other resource endowments are given, and there is no economic growth. Time is divided into weeks, within which consumption, production, and money holding decisions are formulated and executed. The technology used to produce output is such that where prices are free to vary, the supply of goods is a rising function of their relative price. The goods in question are heterogeneous,
and output in the economy is measured as an appropriate index number. The supply of nominal money is exogenously given and its quantity is determined at the beginning of each week. For the individual agent, the general price level is exogenous, and so he varies his real balances by acquiring and disposing of nominal balances in exchange for goods. When they are not holding the quantity of real balances which they require, agents of course attempt to adjust them towards their long-run target level by varying their volume of planned expenditures, the target level in question being determined as a function of permanent income, which in this economy is a constant.  

The foregoing assumptions will be maintained throughout the following analysis. What will vary is the pricing process with which economic activity is co-ordinated. Let us begin with the simplest case in which fully fledged Walrasian mechanisms are allowed to work. Specifically, the economy operates "as if" the prices of all goods were costlessly set by an "auctioneer" at their market clearing levels, and "as if" every agent had full and costless knowledge of all of those prices.

Clearly, in this case, with given tastes and technology, the level (and structure) of output will be constant period after period at its "permanent" level; and, perhaps not quite so obviously, the general price level will move in strict proportion to the quantity of nominal money. Even if only partial, rather than full, adjustment of cash balances towards their long-run equilibrium characterises the individual's plans, this will not have observable consequences for market behaviour in this version of the model or indeed in any version in which all prices are set "as if" by an auctioneer. When all prices are flexible, variations in the general price level change agents' real balances for them without any activity on their part. Any plans
by the aggregate of agents to adjust their real balances, and such plans will exist whenever there is a discrepancy between actual and long-run target money holdings, will, in a Walrasian economy, cause the price level to vary so as to restore real balances to their desired long-run level before production or trading takes place. 7

As is well known, the basic new-classical model departs from the system I have just described by introducing a stochastic element into the behaviour of relative prices and the absolute price level, and in withholding from agents full information about the money prices of goods, other than those which they plan to sell, at the time at which their production plans are made and executed. Hence, agents must form estimates of the general price level when they make their plans about quantities, and they do so in a two stage process. First, they form a rational expectation of the general price level ruling in the current period based upon all the information available to them up till the end of the previous period. Since they know that the price level is determined by the interaction of the supply of nominal money and the demand for real balances, this expectation is based on rational forecasts of both magnitudes. They then modify this expectation in the light of information conveyed to them by the money price of their own output, to generate an estimate of what might helpfully be called the currently perceived price level, and use the resulting estimate in computing the relative price on which they base their production decisions.

Presumably, though the point is not usually made in textbook expositions of new-classical theory, this currently perceived price level must also form the basis for agents' conversion of their demand for real balances into a figure for target nominal money holdings, unless they gear their nominal
demand for money to the selling price of their own output. If they do the latter, then the demand for nominal balances will, in the aggregate, vary in proportion to the current price level. It is the latter, simpler hypothesis which we mainly use here. 8

A log linear version of the above simple new-classical system may be written as follows, where $y^*$ is the permanent component of the logarithm of income, $y$ its transitory component, $m$ the logarithm of nominal money, $E_m|I_{-1}$ the nominal money supply that agents at the end of period $-1$ rationally expected to circulate during the current period, given information available up to the end of period $-1$, $p$ the logarithm of general price level, $E_p|I_{-1}$ a rational expectation of $p$ formed at the end of period $-1$, and $E_p|I$ that expectation as modified by current information, or, as we have termed it, the currently perceived price level.

$$m_s = m_d = \delta_o + \delta_1 y^* + p$$  \hspace{1cm} (1)

$$y = \nu(p - E_p|I)$$  \hspace{1cm} (2)

$$E_p|I_{-1} = E_{m_s}|I_{-1} - (\delta_o + \delta_1 y^*) = E_{m_s}|I_{-1} - m_{s-1} + p_{-1}$$  \hspace{1cm} (3)

$$E_p|I = (1-\theta)p + \theta E_p|I_{-1}$$  \hspace{1cm} (4)

Substituting (4) into (2) produces a more commonly used form of the new-classical aggregate supply curve,

$$y = \mu(p - E_p|I_{-1})$$  \hspace{1cm} (2a)

where $\mu \equiv \nu \theta$
Four clarifying comments are in order here. First $v$ is a structural parameter derived from the economy's aggregate production function. Second, Equation (4) is Lucas' (1973) formulation and the assumptions about information needed to generate it are described there. Third, the demand for money function contains no opportunity cost variable. This simplifying assumption may be defended by postulating that money bears interest in this economy at a competitive rate which incorporates inflation expectations. Finally, note that, with full current information, and, therefore $\theta = 0$, this model reduces to the simple Walrasian constant output system.

If we permit the actual supply of money to deviate from that expected at the end of period $-1$, while withholding full information from individual agents about the current value of the general price level, we get the following reduced forms to describe output and real balances.

$$y = u(m - \bar{m}_s|I_{-1})$$

$$\frac{m}{s} - p = \delta_0 + \delta_y y^*$$

Thus, this simple new-classical model explains output fluctuations as being caused by unanticipated fluctuations in the money supply, without giving up the assumption of price flexibility and clearing markets; but it does not, in the absence of further extension, predict any persistence of fluctuations in output, nor does it predict systematic deviations of actual money holdings from their long-run desired level. \(^9\)

Now let us describe an alternative modification of the basic Walrasian model which introduces an element of price stickiness. Specifically, we postulate that two kinds of sellers operate in the system, producing goods
that are imperfect substitutes for one another: those who set their prices for the current period at the end of the previous period, and who stand ready to sell any amount of output at those prices; and those who may vary their prices in response to demand pressures during the current period. Thus, instead of all producers having upward sloping supply curves as before, only the latter group now show this characteristic. This assumption replaces the new-classical postulate that agents do not have contemporaneous access to information about the general price level. In what follows, they are permitted to know that variable's value. With a little price stickiness thus introduced into the system, we may no longer take it for granted that the economy is always on its long-run demand for money function. We must instead allow for the possibility that a discrepancy at the beginning of any week between the actual quantity of money in circulation and the amount which agents wish to hold on average in the long run will give rise to an actual finite rate of flow of expenditure on goods and services, over and above usual spending plans, which are thought of as depending on (and indeed being equal to) permanent income.

It may help the reader to grasp the formal properties of this version of our basic model if we first describe intuitively the outcome of a specific experiment in the system. Consider a particular week following one in which all price expectations were fulfilled and in which the economy was, therefore, in full equilibrium at permanent income; let expectations about current prices, which are, it should be recalled, binding on some producers, have been formed; and then let the nominal money supply be unexpectedly increased. With prices initially set at their expected levels, there will exist an excess supply of real balances, giving rise to a planned increase in agents' rate of
flow of expenditure proportional to that excess supply. "Buffer-stock" effects linking the supply and demand for money to expenditure such as were analyzed in Laidler (1984) will come into play.

This extra expenditure induced by the excess supply of money in turn will be distributed between producers whose prices are fixed and those who are able to vary prices. The former will, by assumption, supply any extra output demanded, but the latter group will raise the relative and hence the money prices of their output in order to reduce the demand facing them. In doing so, they will set in motion two effects. First, the overall increase in the demand for goods will be damped down as real balances are reduced, and its composition will be switched towards the output of fixed price producers.

If there were no fixed price sellers, then the attempts of flexible price firms to raise their relative prices would, of course, be frustrated, and with each firm having full knowledge of the current price level, the latter variable would be forced up until the excess supply of money which caused the initial increase in demand for goods was completely eliminated. We would be back in a full Walrasian system just as we would be in the new-classical model if we allowed agents contemporaneous access to correct information about the general price level. So long as there are some fixed price sellers in the system however, the process will stop short of this point. The price level will increase less than in proportion to the increase in the quantity of nominal money. An excess supply of real balances and its associated rate of flow of expenditure (and hence of output) will therefore persist and be observed.

The mechanisms which have just been described represent an alternative way of escaping from the constant output prediction that characterises the
full Walrasian version of our basic system. Fixed price firms are a "Keynesian" substitute for the less than full information about the current price level upon which the new-classical model relies to generate output fluctuations, and there is another parallel between this and the new-classical system that is worth noting. Both models are "equilibrium" systems in the sense that all agents are able to execute all plans which they formulate, but both depart from full Walrasian equilibrium in permitting the ex post outcomes of those plans to differ from the ex ante intentions of agents. In the new-classical model agents supply more output because they believe that their own relative price has risen, but after the event discover their belief to have been false. In the sticky price model agents plan to run down their cash balances by increasing expenditure, but ex post in the aggregate succeed in doing so only to the extent that the general price level rises.

Though the sticky price model generates similar results about the capacity of monetary shocks to generate output fluctuations to those yielded by the new-classical framework, it yields different predictions about other factors. Just how different these predictions are depends upon which version of the two alternative forms of the rational expectations hypothesis, embodied in equation (3) above, we utilise. These two are equivalent in the new-classical model but not here. In the new-classical case it was always true that

\[ p = m_s - (\delta + \delta y^*) \]  \hspace{1cm} (7)

Here it is not, but

\[ E_p I_{-1} = E_m I_{-1} - (\delta_0 + \delta y^*) \]  \hspace{1cm} (3a)

and

\[ E_p I_{-1} = E_m I_{-1} - m_{s-1} + p_{-1} \]  \hspace{1cm} (3b)
are only equivalent expressions if equation 7 is true.

Our sticky price model thus comes in two versions depending upon which of the above we choose, and we will discuss the economic interpretation of the differences here in due course. For the moment, note that the model's other equations are as follows

\[ m_d = \delta_o + \delta y^* + p \]  
\[ y = \alpha (m - m_d) \]  
\[ p = \beta y + \beta p |I_{-1} \]  

Equation (9) is, of course, analytically equivalent to equation (2a), but is written as it is here to emphasize that the mechanisms linking output and price fluctuations in this system, described above, differ from those underlying the new-classical aggregate supply curve. Combined with equation (3a) this model yields the following reduced forms for output and real balances

\[ y = \frac{\alpha}{1+\alpha\beta} (m - Em|I_{-1}) \]  

and

\[ m - p = \frac{\delta}{s} + \delta y^* + \frac{1}{1+\beta\alpha} \frac{(m - Em|I_{-1})}{s} \]  

Combined with equation (3b) it implies instead

\[ y = \frac{\alpha}{1+\alpha\beta} (m - Em|I_{-1}) + \frac{1}{1+\beta\alpha} \frac{y}{s} \]  

and

\[ m - p = \frac{\alpha\beta}{1+\alpha\beta} (\delta + \delta y^*) + \frac{1}{1+\alpha\beta} \frac{(m - p)}{s-1} \]  

\[ + \frac{1}{1+\alpha\beta} \frac{(m - Em|I_{-1})}{s} \]
Though the interpretation of its parameters is rather different, equation (10a) is essentially indistinguishable from (5). This simple fact shows that empirical evidence to the effect that only "unanticipated" money affects output does not enable us to distinguish between a new-classical flexible price model and one incorporating price stickiness. On the other hand, (11a) differs from (6) in having an "unanticipated" money term on its right-hand side. Though this latter difference might give us some basis for distinguishing between the two versions of our basic model by referring to empirical evidence, it is a minor matter in the light of the properties of equations (10b) and (11b). As is immediately apparent these are characterised by just the type of persistence effects which we would like any satisfactory macro model to generate. Output's deviations from its permanent level are positively serially correlated in equation (10b), even though only unexpected money supply variations have real effects. In this model, because the monetary authorities cannot vary the money supply more frequently than agents in the private sector can vary their prices, standard policy-ineffectiveness results still hold. Moreover, equation (11b), the reduced form for real balances, contains a lagged dependent variable whose positive, and fractional, coefficient enables us to identify the parameters of the long-run demand for money function.

It is interesting to inquire just what it is about equation (3b) which produces the above mentioned results. The answer here is straightforward. The equation in question introduces a little more persistence into our model's price stickiness than does equation (3a). With the latter, price stickiness is purely a within period phenomenon. Last week's prices have no effect on this week's outcome for anything. In the case of (3b), any departure of the
model from full equilibrium last week will have consequences this week, because of the use of the previous week's price level as a base from which to extrapolate expectations about this week's prices, expectations which fixed price producers use to set their actual prices.¹³

Not only does equation (3b) produce more interesting conclusions, however. It is also arguably at least as plausible a formulation as (3a). To begin with, the unconditional expectations embedded in the model by using it are rational. Equation (11b) is a stochastic difference equation which, in the long run, converges on the demand for money function for any systematic behaviour of the money supply that is captured in \( E_m I_{-1} \). There is, that is to say, no room for systematic error in the long run in this model. Equation (3a), of course, provides conditional expectations that are rational as well. It permits no systematic short-run errors to be made. However, to apply equation (3a) agents need to form the same money supply expectations as they do to apply (3b) but they also need to know the parameters of the economy's aggregate demand for money function. The extra degree of rationality in expectations obtained from Equation (3a) would have to be bought at the expense of more investment on the part of agents in acquiring information. In a world where relevant information is costly, rather than being available free of charge, we cannot take it for granted that it will be acquired and used. It may not be worth agents' while to do so.¹⁴

III

It was the purpose of this paper to show that a minimal price-stickiness assumption, divorced from error learning, was sufficient to enable us to explain why output fluctuates in response to monetary shocks, why such output
fluctuations persist over time, and why real balances vary, with positive
serial correlation, around their long-run desired value. This has now been
done, but it is worthwhile drawing attention to certain other desirable
implications of the price stickiness assumption that are implicit in the
foregoing analysis.

First, in the presence of price stickiness, it is, of necessity, the
expectation of the money supply formed at the end of period \(-1\) that appears on
the right-hand side of equation (10b). This is of some interest because, as
Boschen and Grossman (1982) have shown, if agents operating in an otherwise
new-classical system have contemporaneous information about the value of the
money supply, that is enough to prevent correctly measured fluctuations in
that variable having effects on real variables. In the world as it is, such
information is available, but as Boschen and Grossman also show, correctly
measured and announced variations in the money supply do indeed have real
effects. Quite obviously, this observation, difficult to reconcile with
new-classical macroeconomics, can easily be explained in a world in which some
agents set prices on the basis of past information and are unable to change
them even when provided with new data.

Second, in addition to the lagged dependent variable that appears on the
right-hand side of equation (11b), there is also a term in unanticipated
money. Carr and Darby (1981) some time ago argued that such a term should
indeed appear on the right-hand side of a "short run demand for money
function" and justified this claim with an intuitive argument closely related
to the analysis presented above. This analysis shows that equation (11b) is
not a structural demand for money function at all, but rather a reduced form
of a complete macro-model, and to this extent it considerably clarifies Carr
and Darby's arguments. It also provides an explanation of why, in their empirical work, they did indeed find a statistically significant role for unanticipated money to play in an equation very like (11b), as did Laidler (1980). 15

Closely related to the above point, it is well known that the last decade or so has seen considerable instability in the so-called "short-run demand for money functions" upon which the conduct of monetary policy in a number of countries has been based. Such functions are essentially similar to (11b) with the unanticipated money term on the right-hand side omitted. With a given monetary policy regime, one might expect "unanticipated money" to be a serially uncorrelated variable with a zero mean, and in such circumstances its omission would create no problems. However, when the stance of policy is systematically changing, this variable might be expected to be serially correlated and to have a non-zero mean for as long as it takes the general public to learn about the change in question. To omit it at such times will lead to apparent shifts of the intercept of an equation such as (11b), downwards when policy is becoming systematically less inflationary, and vice versa. Thus, perhaps the analysis presented in this paper provides an important clue in the cases of the "missing money" in the United States during early 1970s, the unexpected velocity shift there in 1981–2, and the variations in M2 velocity in Britain in the 1970s recently analyzed by Artis and Lewis (1984). 16

It would appear that, when it comes to explaining certain important stylised facts, a little price stickiness goes a long way. It is important, therefore to stress that, in the preceding analysis, this assumption is not simply an extra complication added to an otherwise new-classical model.
Rather it replaces the assumption that agents lack sufficient information to enable them to distinguish between relative price changes and price level shifts. The agents in the sticky price model I have presented have to be econometricians enough to form expectations about next week's money supply, but unlike their counterparts in the corresponding new-classical system, they do not estimate demand for money functions or solve signal extraction problems. Moreover, because agents in the sticky price world do not require the skills to solve the latter problems, there is no need to expect them to be particularly sophisticated econometricians when they forecast money. In short, the sticky price modification of the full Walrasian model is not only more fruitful in predictions than the relative-price - price-level confusion modification which lies at the heart of new-classical macroeconomics. It also has strong claims to be regarded as simpler into the bargain. It should therefore be taken seriously.
FOOTNOTES

1 Of course the clearing markets postulate was never discredited as a basis for the study of allocation and distribution, but from the 1930s onwards it seemed impossible to reconcile it with the existence of unemployment. The rational expectations hypothesis is usually, and correctly, attributed in its modern form to Muth (1961), but it is worth noting that Friedman's (1957) reconciliation of time series and cross-section evidence on the consumption function in terms of the classical errors in the variables model requires permanent income to be a rational expectation of actual income. It was only in his discussion of ratchet effects in aggregate time series evidence, almost a digression from the main thrust of his work on the consumption function, that Friedman introduced the error learning hypothesis. Furthermore the idea, in an informal guise, was a commonplace of the "Austrian" macroeconomics of the early 1930s, associated with such names as Friedrich von Hayek and Lionel Robbins.

2 The "policy ineffectiveness" proposition, as applied to the use of monetary policy systematically to influence real variables, is the work of Sargent and Wallace (1975). Their analysis is, of course, a particular application of the general results developed by Lucas (1976).

3 Thus, in (1973) Lucas "explains" the persistence of real shocks by adding a lagged dependent variable to his aggregate supply curve. Such an addition can be justified in terms of postulates about costs of adjusting real production plans once they are set in motion, but there is little discussion of this matter in (1973).
4 Goodfriend (1985) shows how measurement error can be used to explain systematic positive autocorrelation in the behaviour of real balances. Laidler (1982), Ch. 2, and Gordon (1984), among others, have dealt with the alternative sticky price explanation.

5 All of this left policy oriented macroeconomists who wished to maintain the price stickiness assumption, but who were dubious about the possibility of systematically fine tuning real variables, in a rather awkward corner. However, because clearing markets and rational expectations are over-sufficient arguments against fine tuning, these economists were able to maintain a logically coherent, if somewhat untidy, position on these matters. See Laidler (1982), Chs. 1 and 5 for discussions of this issue.

6 In the literature on the "real balance effect" such slow adjustment is derived from a simple intertemporal choice mechanism. See Archibald and Lipsey (1958), Patinkin (1965) and Jonson (1976) for discussions of this. The empirical literature of the demand for money postulated portfolio adjustment costs, usually quadratic, to obtain the same result. See for example, Chow (1966) or Goldfeld (1973).

7 For demonstrations of this point, see Laidler (1982), Ch. 2 and Lane (1983).

8 To use expected prices in the demand for money function changes the properties of the model in a manner that is difficult to square with empirical evidence, and at this point it is desirable to present the new-classical model in as favourable a light as possible. See however fn. 13 below.

9 The properties of the model with the expected, instead of actual, price level included in the demand for money function were investigated. See footnotes 12 and 13 below.
10. The existence of such fixed price firms, which are essentially the same as those postulated by McCallum (1980) in his discussion of the role of price stickiness in Macroeconomics, can be justified with reference to the possibility that, for some firms in any economy, the costs of price changes are high relative to those of output changes. It is precisely this type of firm that might set its prices by contracts, and indeed the mixture here between firms which hold their prices constant for the entire week and those which may vary them within the week, is a minimal version of the overlapping contracts idea associated with Fischer (1977), Phelps and Taylor (1977) and Taylor (1979).

Fixed price firms might well meet demand variations out of inventories, rather than current output. Such behaviour would introduce another source of persistence effects into the economy. That it is not discussed here reflects only the fact that it is not necessary to produce such effects, rather than any judgement that inventory fluctuations are unimportant in the real world. Similarly, Keynesian multiplier effects are ruled out of the analysis of the next few pages by the assumption that expenditure depends only on permanent income and excess money holdings. If we let transitory income affect expenditure, these, perhaps empirically important, but in the current context, unnecessary, effects would be present.

11. The discussion here is related to that of Jonson (1976). Note that, if the demand for money depended on the interest rate, and if that variable always kept the supply and demand for money in equilibrium, the above arguments would not go through. Laidler (1984) takes up this issue, and argues that a loanable funds approach to modelling short-run interest rate behaviour enables us to avoid the problem.
12 But this proposition about the equivalence of equations (3a) and (3b) would not be true of the new-classical model if we used the expected, instead of the actual, price level in the demand for money function, or if we made the demand for money depend upon current instead of permanent income. See footnote 13 for further discussion.

13 But, the use of (3b) instead of (3a) in the new-classical model also introduces a little persistence if we modify its demand for money function as well. Specifically, if we make the demand for money depend upon current income we introduce positive autocorrelation into the behaviour of real income over time, but not into the behaviour of real balances. To use the expected price level instead of its actual value in the demand for money function, and then to model expectations with (3b) induces autocorrelation into the reduced form for real balances, but it is of the wrong kind. The lagged dependent variable has a negative coefficient in this case. The relevant reduced form is

\[
\begin{align*}
    m - p &= \frac{1}{\sigma} (\delta + \delta y^t) - \frac{\theta}{\alpha^s} (m - p)_{t-1} \\
    &\quad - \frac{\theta}{\alpha^s} (m - E m | I)_{t-1}
\end{align*}
\]

To use (3a) in this form of the model takes out the term in lagged real balances here, but still leaves a negative coefficient on unanticipated money. On this see Laidler (1982) Ch. 3.

14 To require agents to estimate the parameters of the economy's demand for money function is not onerous in a new-classical world, since there, they are in any event presumed to be capable of solving the signal extraction problem underlying equation (4). However, one of the advantages of the price stickiness assumption is that we do not have to credit agents with any more
ability and knowledge than it takes to look up data on prices and the money supply, form an expectation about the latter, and base a price level forecast on that expectation. Though neither the formulation used nor the purposes to which it is put are the same, the argument here is in the spirit of Akerlof and Yellen (1983). On the other side however, it must be noted that, once the long-run demand for money function has been estimated, agents no longer need monitor the current price level to form expectations. Moreover, since $\delta_0 + \delta_1 y^*$ is the long-run average value of real balances in this system, if we took it as literally true that the economy’s structure never varied, then it could be argued that even agents who started out using (3b) might be expected to learn how to use (3a).

Carr and Darby (1981) argue that unanticipated money should take a unit coefficient, and indeed it comes close to doing so in their work. It takes a fractional coefficient in equation (11b) simply because we allow prices to respond within the week to money unanticipated at its beginning. Carr and Darby implicitly assume a one-period lag before unanticipated money affects prices. It should be noted that, though it happened to appear in print first, Laidler (1980) explicitly acknowledged Carr and Darby’s then unpublished working paper as the source of some of the ideas it investigated.

Laidler (1985) briefly develops this idea but in a model with expectations modelled by error learning. Similar results emerge in that analysis to those presented here, and it is gratifying that, although price stickiness is necessary to produce them, the particular type of price stickiness generated by error learning is not.
REFERENCES


