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# THE LIQUIDITY TRAP AND THE PIGOU EFFECT: A DYNAMIC ANALYSIS WITH RATIONAL EXPECTATIONS

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## Abstract

A Keynesian idea of considerable historical importance is that, in the presence of a liquidity trap, a competitive economy may lack--despite price flexibility--automatic market mechanisms that tend to eliminate excess supplies of labor. The standard classical counterargument, which relies upon the Pigou effect, has typically been conducted in a comparative-static framework. But, as James Tobin has recently emphasized, the more relevant issue concerns the dynamic response (in "real time") of an economy that has been shocked away from full employment. The present paper develops a dynamic analysis, in a rather standard model, under the assumption that expectations are formed rationally. The analysis permits examination of Tobin's suggestion that, because of expectational effects, such an economy could be unstable. Also considered is Martin J. Bailey's conjecture that, in the absence of a stock Pigou effect, Keynesian problems could be eliminated by expectational influences on disposable income.


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## I. Introduction

For several decades, students of macroeconomic theory have learned about the "Keynes vs. the Classics" debate of the late 1930's and early 1940's. The basic issue is beautifully summarized in James Tobin's recent Jahnsson lectures, as follows. In the <u>General Theory</u>, Keynes "denies the existence of self-correcting market mechanisms which would eliminate excess supplies of labor and other productive resources... in a competitive economy.... He does not say merely that this process may take a very long time; he says that it does not work at all" (1980a, pp. 1-2). Keynes's argument relies, as Tobin emphasizes, on "the possibility that the full employment equilibrium real interest rate...is below zero" (p. 5) or below some other floor resulting from the famous liquidity trap.[1] "That is a possibility which, it seems, cannot be excluded by <u>a priori</u> restrictions on technology and taste" (Tobin, 1980a, p. 5).

The classical counterargument relies, of course, on the Pigou effect--on the stimulus to aggregate demand that is provided by increases in aggregate private wealth that result, given a constant nominal stock of outside money, from the decline in the price level brought about by the excess supplies. Most writers of textbooks, treatises, and articles have agreed that Pigou's argument (1943) (1947) carried the day.[2]

Tobin (1975) (1980a) has emphasized, however, that the usual discussion takes place in a comparative-static framework. But what is relevant, he suggests, is the dynamic response of a system that has been shocked away from full employment.[3] In his words, "the question applies to real time and to sequential processes. Therefore the static long-run 'Pigou effect' does not entitle anyone to give a positive answer" to the question: "does the market economy, unassisted by government policy, possess effective mechanisms for eliminating general excess supply of labor and productive capacity?" (1980a, p. 18). Now this suggestion seems quite appropriate:

the actual policy-relevant issue does concern the behavior of an economy as time passes, not a comparison of static equilibrium positions. Thus discussions of the latter would seem to miss the interesting point--implicit in the Keynes-Pigou dispute--almost entirely.

In his 1975 paper, Tobin developed one dynamic analysis of the relevant issue. The bulk of his discussion presumes, however, that critically important expectations of future inflation rates conform to the adaptive expectations formula, while the remainder of the discussion presumes extrapolation of current values of the price level or inflation rate. Thus, expectations are not constrained, in Tobin's analysis, to be rational. Consequently, it is possible that his results are dependent upon the existence of some particular pattern of systematic and costly expectational errors.[4]

The main purpose of the present paper, accordingly, is to conduct a dynamic analysis of the workings of the Pigou effect, in an economy with a full-blown liquidity trap, under the assumption of rational expectations. The analysis therefore constitutes an alternative to that offered by Tobin. In addition, it provides an answer to whether it is possible (with rational expectations) for full employment to be attained despite a liquidity trap by way of flow effects on disposable income. This possibility, which does not rely upon the Pigou effect, has been emphasized by Martin J. Bailey (1971, pp. 79-80).

It should be stressed, before we begin, that interest in the issues under consideration is not dependent upon any notion that John Maynard Keynes personally believed that actual economies were likely to experience liquidity trap situations. The issues have been, whatever Keynes wrote or failed to write, of great importance in the development of economic theory and doctrine. That they were not taken up in recent reviews by Lucas (1981) and Grossman (1982) is understandably due to the preoccupation of those writers with more current matters. But prime concern for topics of the day does not imply that a discussion of such historical significance should be left in an unsatisfactory state.

## II. Basic Specification

Given the purpose of this study, it would be desirable to use an analytical framework--a model--that is reasonably orthodox, analytically tractable, and also similar (except for its expectational behavior) to the one used by Tobin. Fortunately, it will be possible to satisfy all of these criteria to a considerable extent, though some deviation from Tobin's specification of aggregate supply will prove to be necessary.

The first main ingredient in our model is an aggregate demand function. In his paper, Tobin (1975) posited that the real quantity demanded is negatively related to the price level and positively related to both the expected inflation rate and real output. In addition, he assumed that the rate of change of output is positively dependent upon the difference between demand and output. So that explicit solutions can be obtained, it will be useful to have discrete-time, log-linear versions of similar relations. Consider, then, the following equations:

$$(1) \qquad e_t = b_o + b_1[r_t - (E_t p_{t+1} - p_t)] + b_2(m_t - p_t) + b_3 y_t + V_t$$

$$(2) \qquad y_t - y_{t-1} = \lambda(e_t - y_{t-1}) \qquad 0 < \lambda \leq 1.$$

Here $e_t$, $y_t$, $m_t$, and $p_t$ denote logarithms of (aggregate) quantity demanded, output, the (outside) money stock, and the price level--all for period t--while $r_t$ is the nominal rate of interest. Also, $E_t p_{t+1} = E(p_{t+1}|\Omega_t)$ is the conditional expectation of $p_{t+1}$ given the information set $\Omega_t$, which includes values of all aggregate variables in periods t, t-1, .... Thus, $E_t p_{t+1} - p_t$ is the rationally expected inflation rate. Finally, $V_t$ is a serially uncorrelated stochastic disturbance.

Equation (1) can be thought of as a log-linear IS function in which consumption plus investment demand is related to the real rate of interest, real money balances, and real income. Government spending and tax variables are absorbed into the constant term, $b_o$, as are other influences not germane to the issues at hand.

Equation (2) may be viewed as reflecting adjustments of output, in response to supply-demand discrepancies, of the type posited by Tobin.[5] Alternatively, one could suppose that output and quantity demanded are always equal, in which case $e_t$ would be interpreted as the value toward which period t's quantity demanded, $y_t$, adjusts.

In either case, since our concern is with a situation in which a liquidity trap prevails and no policy responses are forthcoming, it is appropriate to treat both $r_t$ and $m_t$ in (1) as constants.[6] Then we can combine equations (1) and (2), obtaining

$$(3) \quad y_t = \beta_o + \beta_1(E_t p_{t+1} - p_t) + \beta_2(m - p_t) + \beta_3 y_{t-1} + v_t$$

where $\beta_o = \lambda(b_o + b_1 r)/\psi$, $\beta_1 = -\lambda b_1/\psi$, $\beta_2 = \lambda b_2/\psi$, $\beta_3 = (1 - \lambda)/\psi$, and $v_t = \lambda V_t/\psi$ with $\psi = 1 - \lambda b_3$. We presume that $\beta_2 > 0$ and $\beta_3 > 0$. The main properties of Tobin's demand function will then be duplicated if we also take $\beta_1 > 0$. We shall provisionally do so, but it should be noted that this condition might not hold. As emphasized by Martin J. Bailey, there is an effect of expected inflation on disposable income due to capital losses or gains on real money balances (1971, pp. 79-80) that works in the opposite direction from the expected inflation component of the real interest rate. Tobin assumes that the latter effect is stronger; Bailey's argument carries no implication regarding relative magnitudes.

Some specification regarding aggregate supply is needed to complete the model. The one used in Tobin's analysis[7] is an accelerationist Phillips Curve that relates the inflation rate linearly to the expected inflation rate (with a coefficient of unity) and positively to the "Okun gap," output minus capacity output. If it is the current output gap that is relevant, a log-linear version could be written as

$$(4) \quad p_t - p_{t-1} = \gamma(y_t - \bar{y}) + E_{t-1}(p_t - p_{t-1}) + U_t \qquad \gamma > 0,$$

where $U_t$ is another serially uncorrelated stochastic disturbance. An equation of this form is, as many authors have noted, formally equivalent to the "Lucas supply function" used by Sargent and Wallace (1975) in their well-known paper. Thus (4) could as well be written as

$$(5) \qquad y_t - \bar{y} = \alpha(p_t - E_{t-1}p_t) + u_t \qquad \alpha > 0,$$

where $u_t = -U_t/\gamma$ is also a white noise disturbance. Thus, it is apparent that the use of this equation, which implies that prices are fully adjustable within each period, is to some extent not in the spirit of Tobin's "Keynesian version of price dynamics" (1975, p. 198). On the other hand, it could be argued that a "classical" specification is in fact appropriate for the supply portion of the model, since Keynes's contention was that automatic adjustments to aggregate demand will not take place in a liquidity trap situation even in a purely competitive, flexible-price economy. In any event, we shall begin our analysis with a generalization of (5) and then go on, in a later section, to consider alternative specifications that imply less complete price flexibility.

Given, then, that we are going to begin with a version of (5) let us adopt a generalization in which the previous output gap appears as an additional explanatory variable, as follows:

$$(6) \qquad y_t - \bar{y} = \alpha_1(p_t - E_{t-1}p_t) + \alpha_2(y_{t-1} - \bar{y}) + u_t \qquad \alpha_1 > 0$$
$$1 > \alpha_2 \geq 0.$$

Here the presence of $y_{t-1} - \bar{y}$ and the magnitude of $\alpha_2$ may be justified by the existence of adjustment costs--resource losses brought about by <u>changes</u> in the rate of output. For a detailed discussion in the context of a rational expectations model, see Sargent (1979, ch.16).[8]

## III. Analysis

We now turn to consideration of the dynamic behavior of $y_t$ and $p_t$ in the model described by equations (3) and (6) plus the assumption of rational expectations. We begin by solving for the values of the "undetermined coefficients" $\pi_{ij}$ in the reduced-form equations:

$$y_t = \pi_{10} + \pi_{11}y_{t-1} + \pi_{12}v_t + \pi_{13}u_t \tag{7a}$$

$$p_t = \pi_{20} + \pi_{21}y_{t-1} + \pi_{22}v_t + \pi_{23}u_t. \tag{7b}$$

Once these values are obtained, we will easily be able to consider whether or not the implied behavior for output is such that $y_t$ tends automatically to approach $\bar{y}$ as time passes--i.e., whether the system is stable. Also, an issue of the determinacy of $p_t$ will arise.

The first step is to note that

$$\begin{aligned} E_tp_{t+1} &= \pi_{20} + \pi_{21}y_t \\ &= \pi_{20} + \pi_{21}(\pi_{10} + \pi_{11}y_{t-1} + \pi_{12}v_t + \pi_{13}u_t). \end{aligned} \tag{8}$$

Then substituting (7a), (7b), and (8) into (3) we obtain

$$\begin{aligned} \pi_{10} + \pi_{11}y_{t-1} + \pi_{12}v_t + \pi_{13}u_t &= \beta_o + \beta_1[\pi_{20} + \pi_{21}(\pi_{10} + \pi_{11}y_{t-1} + \pi_{12}v_t + \pi_{13}u_t)] \\ &\quad - (\beta_1 + \beta_2)[\pi_{20} + \pi_{21}y_{t-1} + \pi_{22}v_t + \pi_{23}u_t] + \beta_2m + \beta_3y_{t-1} + v_t. \end{aligned} \tag{9}$$

But for this to hold for all realizations of the exogenous disturbances, the $\pi_{ij}$ coefficients must satisfy the following identities:

(10)
$$\pi_{10} = \beta_0 + \beta_1\pi_{20} + \beta_1\pi_{21}\pi_{10} - (\beta_1 + \beta_2)\pi_{20} + \beta_2 m$$

$$\pi_{11} = \beta_1\pi_{21}\pi_{11} - (\beta_1 + \beta_2)\pi_{21} + \beta_3$$

$$\pi_{12} = \beta_1\pi_{21}\pi_{12} - (\beta_1 + \beta_2)\pi_{22} + 1$$

$$\pi_{13} = \beta_1\pi_{21}\pi_{13} - (\beta_1 + \beta_2)\pi_{23}.$$

Next we note that $p_t - E_{t-1}p_t = \pi_{22}v_t + \pi_{23}u_t$ and substitute this, (7a), and (7b) into (6):

(11)
$$\pi_{10} + \pi_{11}y_{t-1} + \pi_{12}v_t + \pi_{13}u_t - \bar{y} = \alpha_1(\pi_{22}v_t + \pi_{23}u_t)$$
$$+ \alpha_2(y_{t-1} - \bar{y}) + u_t.$$

And the latter immediately implies that

(12)
$$\pi_{10} = (1 - \alpha_2)\bar{y}$$

$$\pi_{11} = \alpha_2$$

$$\pi_{12} = \alpha_1\pi_{22}$$

$$\pi_{13} = \alpha_1\pi_{23} + 1$$

The eight identities in (10) and (12) can be solved for the reduced-form coefficients $\pi_{10}, \ldots, \pi_{23}$. Rather than clutter the page with the resulting expressions, let us note the features that are significant for our present investigation.

First, the role of the real-balance term $\beta_2(m - p_t)$ in (3) is crucial. To to be explicit, if we had $\beta_2 = 0$ then the coefficient $\pi_{20}$ would fall out of the first identity in (10) and would then appear in none of the equations in (10) or (12). Thus, in this case the value of $\pi_{20}$ would not be pinned down by the model; the price level would be indeterminate. Furthermore, the first of equations (10) and (12) would each determine (since $\pi_{21}$ is given by the second pair) a value for $\pi_{10}$ and there is nothing in the model to make these values coincide. So there is an internal inconsistency in the model if the real-balance term does not appear. These problems disappear, however, if $\beta_2 \neq 0$.[9] This is the analytical counterpart in the present analysis of Pigou's contention.

Next, the solution for output implied by (10) and (12) when $\beta_2 \neq 0$ is of the form

$$y_t - \bar{y} = \alpha_2(y_{t-1} - \bar{y}) + \xi_t, \tag{13}$$

where $\xi_t$ is a serially uncorrelated linear combination of $u_t$ and $v_t$. Thus, with $|\alpha_2| < 1.0$, the behavior of output will be dynamically stable.[10] In particular, if $0 < \alpha_2 < 1$, as adjustment-cost considerations suggest, the system will be such that $y_t$ tends to return to $\bar{y}$ after being driven away by a disturbance ($u_t$ or $v_t$). In this case the system behaves sensibly and in a manner consistent with the usual comparative-static story.[11]

In fact, there is no absence of self-correcting market mechanisms even if $\beta_2 < 0$; even if, that is, aggregate demand is <u>smaller</u> with a lower price level--perhaps because of distributional effects of the type emphasized by Tobin

(1980a, pp. 9-11). In this model with a relatively "classical" supply function, the role of the Pigou effect has to do only with existence, not stability, of equilibrium.

Finally, let us consider what the present model has to say regarding Bailey's (1971, p. 80) suggestion that liquidity trap problems may be eliminated by the effect of expected deflation on disposable income. Since this argument pertains to an economy with no Pigou effect, it might appear that the appropriate way to represent Bailey's case would be with $\beta_1<0$ and $\beta_2=0$. If that were correct, his suggestion would fail since $p_t$ is undetermined and $y_t$ overdetermined when $\beta_2=0$. But in fact $\beta_2=0$ is not implied by Bailey's argument: since the effect in question works by way of capital gains on real money balances, the relevant underlying variable involves the product of expected inflation and real balances. For this variable to be represented in our linearized model, therefore, additional terms in $m_t - p_t$ and $E_t p_{t+1} - p_t$ would have to be added to equation (1). But if that were done, the absence of a Pigou effect would not imply $\beta_2 = 0$ in equation (3): the variable $m - p_t$ would enter nevertheless to reflect the capital gains effect. Thus, it seems that the system described by Bailey is well-behaved when aggregate supply behavior is represented by the Lucas supply function (6).

## IV. Alternative Specification

Let us now consider some potential alternative specifications for aggregate supply, ones that feature less price level flexibility than (6). The first that comes to mind is a modification of the accelerationist Phillips Curve (4) in which it is the lagged output gap that exerts pressure on the rate of price change, as in

$$(14) \qquad p_t - p_{t-1} = \gamma(y_{t-1} - \bar{y}) + E_{t-1}(p_t - p_{t-1}) + U_t.$$

This specification is perhaps more in the spirit of Tobin's suggestion--see his equation (2.2.1). Unfortunately, it carries an implication that makes it, under rational expectations, more classical in effect than (6). To see this, apply the conditional expectation operator $E_{t-1}(\cdot)$ to (14) and note that the result is

$$(15) \qquad 0 = \gamma(y_{t-1} - \bar{y}).$$

Thus, if $\gamma > 0$, as assumed, equation (14) implies that $y_{t-1} = \bar{y}$ for all t; i.e., that output always precisely equals the full-employment value. To find a formulation that expresses an interesting alternative, we must therefore look elsewhere.

Three reasonably obvious possibilities are as follows:

$$(16) \qquad p_t - p_{t-1} = \delta_1(y_{t-1} - \bar{y}) + \eta_{1t}$$

$$(17) \qquad p_t - p_{t-1} = \delta_2(y_{t-1} - \bar{y}) + \sum_{j=1}^{J} \omega_j(p_{t-j} - p_{t-j-1}) + \eta_{2t}$$

$$(18) \qquad p_t - p_{t-1} = \delta_3(\bar{p}_t - p_{t-1}) + \eta_{3t}$$

In these, $\delta_i > 0$ while the $\eta_{it}$ are white noise disturbances, i = 1,2,3. Equation (16) is of course a relation of the "naive" Phillips Curve variety while (17) is (with $\sum_{j=1}^{J} \omega_j = 1.0$) one type of an accelerationist Phillips Curve and (18)--in which $\bar{p}_t$ denotes the price level that would equate aggregate demand in t to $\bar{y}$--is closely related to the specification of the MPS model.[12] None of these specifications is attractive, however, for each is inconsistent with the widely-accepted notion that $y_t - \bar{y}$ cannot be kept <u>permanently</u> high by any aggregate demand policy.[13] That this is the case for (16) is obvious. The same is true for (17) when $\omega_1 = 1.0$ and $\omega_j = 0$ for $j > 1$; then an inflation rate that increases by the amount $\Delta\delta_2$ per period will keep $y_t - \bar{y}$ fluctuating around $\Delta$. More generally, (17) implies that $y_t - \bar{y} = \Delta$ + white noise can be attained by generating an inflation path of the form

$$(19) \qquad p_t - p_{t-1} = \sum_{j=1}^{J} \omega_j (p_{t-j} - p_{t-j-1}) + \delta_2 \Delta.$$

Finally we turn to (18). Given the aggregate demand function (6), $\bar{p}_t$ is defined as

$$(20) \qquad \bar{p}_t = (\beta_1 + \beta_2)^{-1}[\beta_o + \beta_1 E_t p_{t+1} + \beta_3 y_{t-1} + v_t - \bar{y}]$$

so that

$$(21) \qquad \bar{p}_t - p_t = (\beta_1 + \beta_2)^{-1} (y_t - \bar{y}).$$

Substitution into (18) then yields

$$(22) \qquad p_t - p_{t-1} = \delta_3(\beta_1 + \beta_2)^{-1} (y_t - \bar{y}) + \delta_3(p_t - p_{t-1}) + \eta_{3t}$$

which amounts to a minor modification of (16). Again a steady inflation will keep output high.

There are, no doubt, other specifications worthy of consideration, but it would be impossible to discuss all of them. Let us turn, accordingly, to one that involves a certain amount of price inflexibility without carrying the implication that demand policy can keep output permanently high. The specification in question, which has been previously used by Barro and Grossman (1976), McCallum (1980), and Mussa (1981), is as follows:

$$(23) \qquad p_t - p_{t-1} = \gamma(y_{t-1} - \bar{y}) + E_{t-1}(\bar{p}_t - \bar{p}_{t-1}) + u_t \qquad \gamma > 0.$$

Here there is but one difference from (14): it is the expected inflation rate for the full-employment price level, $\bar{p}_t$, rather than for $p_t$, that matters. Thus, (23) should have the same sort of general properties as (14), but does not share the undesirable implication expressed in (15).

A few words concerning (23) are perhaps in order. First, note that by using (21) above, (23) could alternatively be written as

$$(23') \qquad p_t - p_{t-1} = \gamma(\beta_1 + \beta_2)\ (\bar{p}_{t-1} - p_{t-1}) + E_{t-1}(\bar{p}_t - \bar{p}_{t-1}) + u_t.$$

In this version one can see that, as stated by Barro and Grossman, "price adjustment results from the summation of two component forces: first, an attempt to correct any existing discrepancy between the current values [of p and $\bar{p}$] and, second, an attempt to anticipate and prevent any potential future discrepancies" (1976, pp. 178-9).

Besides this appeal to plausibility, are there other justifications for equation (23)? Mussa (1981) has attempted to rationalize an equivalent continuous-time specification in terms of profit maximizing behavior by firms that incur significant lump-sum costs from changing prices, while McCallum (1980) has proposed an alternative rationale that appeals to optimizing behavior on the part of worker-firm agents that experience employment adjustment costs and must set prices in advance. These arguments are open to certain objections,[14] but nevertheless seem to place (23) on a firmer basis than most sticky-price specifications. Accordingly, let us now consider the dynamic behavior of output in a model consisting of equations (3) and (23), with rational expectations.

The first step is to rearrange (23) as follows:

$$p_t - E_{t-1}\bar{p}_t = \gamma(y_{t-1} - \bar{y}) + p_{t-1} - \bar{p}_{t-1} + u_t. \tag{24}$$

Next, from equation (20) and its counterpart with $p_t$ and $y_t$ in place of $\bar{p}_t$ and $\bar{y}$, we note that

$$p_t - E_{t-1}\bar{p}_t = (\beta_1 + \beta_2)^{-1}[\beta_1(E_t p_{t+1} - E_{t-1}p_{t+1}) + v_t - (y_t - \bar{y}_t)]. \tag{25}$$

Using (25) and (21) in (24) then yields, after rearrangement,[15]

$$y_t - \bar{y} = \phi(y_{t-1} - \bar{y}) + \beta_1(E_t p_{t+1} - E_{t-1}p_{t+1}) + v_t - (\beta_1 + \beta_2)u_t, \tag{26}$$

where $\phi \equiv 1 - \gamma(\beta_1 + \beta_2)$.

As in the analysis in Section III, solutions for $y_t$ and $p_t$ will be of the form (7) while $E_t p_{t+1}$ is again representable by (8). Reference to (8) shows, moreover, that $E_{t-1}p_{t+1} = \pi_{20} + \pi_{21}(\pi_{10} + \pi_{11}y_{t-1})$, so we easily obtain

$$(27) \qquad E_t p_{t+1} - E_{t-1} p_{t+1} = \pi_{21}(\pi_{12} v_t + \pi_{13} u_t).$$

Substitution of (27) and (7a) into (26) then yields the identities

$$(28) \qquad \pi_{10} = (1 - \phi)\bar{y}$$

$$\pi_{11} = \phi$$

$$\pi_{12} = \beta_1 \pi_{21} \pi_{12} + 1$$

$$\pi_{13} = \beta_1 \pi_{21} \pi_{13} - (\beta_1 + \beta_2).$$

The identities implied by the demand portion of the model remain the same as before, so the relevant conclusions can be drawn from equations (7), (10), and (28).

In several ways, these conclusions are as in Section III. Again, if $\beta_2 = 0$ -- if the Pigou and capital gains effects are absent -- there will be no solution for $\pi_{20}$ and two for $\pi_{10}$, so again the price level will be undetermined and output overdetermined by the model.

Again, furthermore, output relative to capacity obeys a first-order autoregressive process, in this case

$$(29) \qquad y_t - \bar{y} = \phi(y_{t-1} - \bar{y}) + \zeta_t$$

with $\zeta_t$ white noise. But now dynamic stability depends upon the magnitude of $\phi = 1 - \gamma(\beta_1 + \beta_2)$, rather than $\alpha_2$. Let us first consider the standard case, in which $\beta_1$ and $\beta_2$, as well as $\gamma$, are positive. Given the form of $\phi$, these sign conditions alone do not indicate whether stability will prevail. But the parameters are such that coherent thought about their quantitative magnitudes is possible. Let us suppose that the model's time periods correspond to quarter-years. Then the magnitude of $\gamma$ and $\beta_2$ will be very small, in comparison to 1.0, so $\phi$ will almost certainly be a positive fraction[16]--which, of course, implies that $y_t$ is stable and tends to approach $\bar{y}$ as time passes. Since the model is not recursive, $p_t$ will therefore also be stable.

If either $\beta_1$ or $\beta_2$ is negative, however, it is possible that their sum will be negative, in which case $\phi$ will exceed 1.0 and the system will be unstable. In the present context it is worth noting that both Tobin and Bailey have suggested that $\beta_2$ might not be positive -- because of distributional effects (Tobin) or the dominance of capital gains over Pigou effects (Bailey). Thus, these suggestions give some impetus to the idea that instability might prevail. But given the widely-held belief that distributional, wealth, and capital-gains effects are all quantitatively minor, it seems likely that the sign of $\beta_1 + \beta_2$ will be determined by $\beta_1$ and that $\beta_1$ will be positive because of the depressing effect of the real interest rate on aggregate demand. All in all, then, the analysis of this section provides little support for the idea that instability would prevail if aggregate supply were not perfectly classical.

## V. Conclusion

Our results can be briefly summarized as follows. In a macroeconomic model with a liquidity trap, a Lucas-type "classical" aggregate supply function, and rational expectations, the system is well-behaved and dynamically stable if either the Pigou effect or the capital-gains effect of expected inflation on disposable income is present. If both are absent, the model fails to determine the price level and is internally inconsistent. If the Lucas-type supply function is replaced with a "disequilibrium" specification that relates price changes to the previous level of excess demand and to the expected change in the full-employment price level, the system is again determinate if the Pigou or capital-gains effect is operative. In this case dynamic stability cannot be guaranteed but instability seems rather unlikely.

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## Footnotes

1. There is a second strand to the discussion in the General Theory that stresses the importance of unions, relative wage concerns by individuals, and generally the fact that money wages are set in a non-auction marketplace. But, as Tobin points out, this strand "serves better to emphasize the difficulty and slowness of melting frozen wage levels or wage-increase patterns than to establish that they never melt at all" (p.3). It does not buttress Keynes's truly radical claim, that there is no automatic tendency for full employment to be restored *even if* wages do adjust.

2. See, for example, Blaug (1968, p.648) Gordon (1981, pp. 160-3), Sargent (1979, pp. 63-65), and Patinkin (1959) (1965). These authors mention, but do not emphasize, the dynamic considerations with which the present paper is concerned.

3. The discussion here, and in what follows, is not meant to imply that the "full employment" rate of employment or output is constant, smoothly growing, or clearly discernable to econometricians. It might be better to use the term "market-clearing," as in Barro and Grossman (1976). This paper will, however, retain the more traditional terminology.

4. For discussions of the desirability of using rational expectations in macroeconomic analysis, see Lucas (1975) and McCallum (1980).

5. It would be possible to interpret Tobin's continuous-time equations as suggesting $y_t - y_{t-1} = \lambda(e_{t-1} - y_{t-1})$, rather than (1). It seems inappropriate, however, to make output in a period independent of that period's demand influences.

6. This treatment is consistent with Tobin's (1975).

7. Reference is to Tobin's WPK model, not his M model, as the former is the one that he presents as representing aspects of Keynes's theory and in which he detects the possibility of dynamic instability of output.

8. Tobin (1980b) is on record as objecting to the inclusion of lagged output terms in equations like (6). He is of course correct in claiming that the inclusion has no relation (one way or the other) to rational expectations. Whether it has "very thin intrinsic justification" (p. 791) is debatable. In what follows, the exclusion of $y_{t-1} - \bar{y}$ would not alter the main theoretical conclusions but would impart a characteristic to the model--absence of unemployment persistence--that seems counterfactual.

9. This last conclusion is similar to those reached by Bailey (1971, pp. 51-54) and Sargent (1979, p. 63) in static contexts.

10. The same is true for $p_t$. Since the model is not fully recursive, the autoregressive parts in ARMA representations are the same for both endogenous variables and stability depends only upon the autoregressive components.

11. This statement ignores the possibility of "bubble" or "bootstrap" paths, involving solution equations more general in form than (7), that can occur in dynamic models with rational or irrational expectations. The issues raised by this possibility of multiple solutions are only weakly related to those of concern in the present paper. For an extensive discussion, see McCallum (1981).

12. On this point, see McCallum (1979).

13. The following discussion presumes that demand management (monetary and fiscal policy) can be used to generate arbitrary price level paths.

14. The assumptions in McCallum (1980), for example, imply that it is prohibitively costly to change prices within a period, but relatively costless to do so across periods. In addition, it presumes that period length is determined exogenously.

15. Unlike the analogous equation (25) in McCallum (1980), expression (26) does not support the controversial "policy ineffectiveness" proposition: monetary policy rules may affect the magnitude of $\pi_{21}$ in (27) below and thereby the variance of $y_t - \bar{y}$. This difference results from differing assumptions regarding information

available to agents in forming expectations about $p_{t+1}$ that are relevant to perceptions of the real interest rate. For some discussion of the relevant issue, see McCallum (1980, pp. 736-8).

16. Even if the time periods are years, the values of $\gamma$ and $\beta_2$ will be small relative to 1.0. A value for $\gamma$ of 0.1, for example, reflects the well-known rule-of-thumb that "the cost of a 1 point reduction in the basic inflation rate is 10 percent of a year's GNP" (Okun, 1978, p. 348). While rational expectations analysis leads one to doubt the validity of Okun's estimate of the unemployment costs of a policy <u>change</u>, it does not suggest that the implied "estimate" of $\gamma$ is seriously wrong.