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## Money and the Transmission Mechanism in the Optimizing IS-LM Specification

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## **Money and the Transmission Mechanism in the Optimizing IS-LM Specification**

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### **Abstract**

This paper discusses criticisms of the IS-LM framework in the macroeconomic literature of the last 40 years, and how the modern optimizing version of IS-LM addresses those criticisms. It is argued that many of the criticisms had been addressed by best-practice traditional IS-LM. Relative to this traditional setup, the optimizing IS-LM version gives full recognition to the intertemporal nature of households' saving decisions. Like traditional IS-LM, however, the optimizing version remains vulnerable to the monetarist critique: by recognizing an insufficient number of distinct assets, the IS-LM framework tends to understate the value of money as an indicator for monetary policy.

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## 1. Introduction

Macroeconomic discussions in the 1980s and 1990s frequently concluded that traditional IS-LM analysis was flawed, in ways that made it irreconcilable with modern macroeconomic theory. Policano (1985, p. 396), for example, contended that “the current research approach casts serious doubt on models... where the IS/LM framework forms the basis of the demand-side,” while Hamilton (1989, p. 113) characterized modern economic theory as being conducted “in a general equilibrium setting that seems far removed from IS-LM.” The last few years, however, have seen significant dissension from these conclusions,<sup>1</sup> with Kerr and King (1996), Rotemberg and Woodford (1997), and McCallum and Nelson (1999a) offering small-scale macroeconomic models which are grounded in optimizing behavior, but which are similar in spirit to the IS-LM approach. In particular, McCallum and Nelson (1999a) labeled the “optimizing IS-LM specification” a pair of equations for aggregate demand behavior, which they derived from a dynamic stochastic general equilibrium model.

This paper discusses criticisms of the IS-LM framework in the macroeconomic literature of the last 40 years, and how the modern optimizing version addresses those criticisms. For concreteness, however, I offer the following definition of an IS-LM system, which guides the discussion in the rest of the paper. A macroeconomic analysis follows an IS-LM approach if the model’s structure includes two equations (which in general will be both dynamic and stochastic): an equation describing aggregate real spending behavior in terms of financial variables; and a money demand equation relating the real quantity of money demanded to scale and opportunity-cost variables. This definition is sufficiently strict to rule out many macroeconomic systems. True, as Brunner and Meltzer (1993, p. 78) note, “[a]ny system of  $n > 2$  equations involving an interest rate and output can be reduced to two equations,” one of which describes the demand for output; but my definition of IS-LM requires that an IS relation for total output is presented *explicitly*. I do not require that only a single interest rate appear in the IS equation, but do exclude analyses where the only description of aggregate demand behavior is as a disaggregated block of equations for separate expenditure categories. Thus, none of the following qualify as having IS-LM features by my criterion: textbook models of the Keynesian multiplier that separate consumption from investment spending; highly disaggregated macroeconometric models; and most general equilibrium models.<sup>2</sup>

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<sup>1</sup> An early dissent was that of Stanley Fischer (1987, p. 247): “There is no necessary inconsistency between IS-LM type models and maximizing models...” See also footnote 6 below.

<sup>2</sup> For example, Sargent’s (1987, Chapter II) exposition of the aggregate demand side of the “Keynesian model” as a system of consumption and investment equations, would not qualify as IS-LM analysis as

The emphasis on model structure in this definition also implies that I treat “IS-LM” as a pair of equations that are intended by their user to be policy-invariant (i.e., the elasticities can be held constant while treating alternative monetary policies). These equations are silent on whether prices are sticky, flexible, or fully rigid, and on whether monetary policy uses the nominal interest rate or the nominal money stock as its policy instrument. Those issues depend instead on the specification in the model of the economy’s price-adjustment equation (Phillips curve), and of monetary policy behavior. Reduced-form representations for output and money balances that are obtainable after imposing the assumption of a particular monetary policy rule or price-setting behavior, are not IS-LM equations by my criterion.

With this definition in mind, consider the pair of equations regarded by McCallum and Nelson (1999a, p. 297) as representative of “traditional” IS-LM analysis. Suppressing constants (or, equivalently, regarding real variables as expressed in deviations from their steady-state values), these equations are:

$$y_t = b_1 r_t + v_t \tag{1}$$

$$m_t - p_t = c_1 y_t + c_2 R_t + \eta_t, \tag{2}$$

where  $y_t$  is log output,  $m_t$  is the log nominal money stock,  $p_t$  is the log price level,  $R_t$  is the nominal short-term interest rate on securities, and  $r_t$  is the corresponding real rate:

$$r_t = R_t - E_t \pi_{t+1}, \tag{3}$$

where  $\pi_t$  is the inflation rate (defined as  $\pi_t = p_t - p_{t-1}$ ), and  $E_t[\bullet]$  denotes the rational expectation based on period- $t$  information. Finally,  $v_t$  and  $\eta_t$  are exogenous disturbances, and the parameters satisfy  $b_1 < 0$ ,  $c_1 > 0$ ,  $c_2 < 0$ . My discussion will focus on cases where  $R_t$  is above zero and accompanied by a value of  $c_2$  that is finite in absolute value. These assumptions ensure that central bank actions that raise the nominal money stock will be effective in expanding nominal aggregate demand. This perspective on IS-LM, which regards the “liquidity trap” only as a degenerate special case rather than the center of the analysis, is, as De Vroey (2000) stresses, very much an inheritance from the development of IS-LM analysis by Modigliani (1944).<sup>3</sup>

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defined here, but his subsequent approach of “collapsing [the equations] into a system of two equations in [output] and [interest rates]... by substitution” (1987, p. 53) does fall into the IS-LM framework.

<sup>3</sup> Samuelson (1976) argues that such a perspective is “[c]ontrary to the view of 1939 Keynesians and the stubborn 1959 view of many English economists...” The “stubborn 1959 view” is that of the Radcliffe Report (1959), whose position I discuss in detail in Section 4.

McCallum and I argued that formal analysis using a dynamic stochastic general equilibrium model justified a log-linear IS-LM formulation with the money demand equation unchanged from equation (2), and with the IS equation (1) modified to:

$$y_t = b_1 r_t + E_t y_{t+1} + v_t. \quad (4)$$

Other work using optimizing analysis has justified variants of equation (4),<sup>4</sup> but formulation (4) is probably the most commonly used version of the optimizing IS equation in the literature.<sup>5</sup> The recent IS-LM revival has followed Koenig (1989, 1993a, 1993b) in building an aggregate IS equation from the standard Euler optimality condition for consumption that appears in forward-looking models, and in stressing that the effect of optimizing behavior is to make current spending decisions depend on expected future output.<sup>6</sup> This is evident from the fact that the only modification of the traditional IS equation (1) produced by the explicit maximizing analysis is the introduction of the  $E_t y_{t+1}$  term (with unit coefficient).

The above definitions of the IS-LM framework—traditional and optimizing—have a material effect on the coverage of this paper. My focus on IS-LM as a description of aggregate demand represents a significant departure from King’s (2000) discussion of “the new IS-LM model: language, logic, and limits.” King (2000, p. 48) defines the “new IS-LM model” as the combination of the optimizing IS-LM specification (2)–(4) and a forward-looking “New Keynesian Phillips curve.” Accordingly, King’s discussion focuses on price-setting behavior in New Keynesian models, and on the policy recommendations that arise from the combined IS-LM/Phillips curve setup. Since my IS-LM definition is silent on the specification of the Phillips curve, a focus on price-setting behavior is not germane to my discussion of the optimizing IS-LM apparatus. And while the policy implications of modern optimizing models form an important issue, almost all of those that King draws from the modern model arise

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<sup>4</sup> For example, Kerr and King (1996) and Woodford (1996) use variants of equation (4) with no IS shock; while Rotemberg and Woodford (1997) have a more complicated setup where decision lags matter for spending decisions, implying that the previous period’s expectations of variables appear in the IS equation.

<sup>5</sup> The usual caveat about deducing the chronology of research from publication dates applies with force to the optimizing IS-LM literature. My (1999a) paper with McCallum, for example, was released as an NBER Working Paper in 1997, and circulated in 1996 in manuscript form (with one such version cited in Fuhrer, 1997). Both Kerr and King (1996) and McCallum and Nelson (1999a) give as their source for the derivation of the IS function McCallum (1995), which is composed of 1994 lecture notes.

<sup>6</sup> Beside Koenig’s contribution, other 1980s work should be noted. Fane’s (1985) “derivation of the IS-LM model from explicit optimizing behavior,” Aiyagari and Gertler’s (1985, p. 41) “intertemporal... flexible price IS-LM model,” and Rankin’s (1987, p. 66) “‘choice-theoretic’ IS-LM model” all feature relations labeled IS-LM obtained from finite-horizon (overlapping generations) optimizing models. In all cases, the relation labeled “IS” includes endogenous variables beside output and interest rates, and so its applicability is limited mainly to comparative-static exercises.

from his *Phillips curve* specification rather than the new aspects of the optimizing IS-LM specification. Therefore, policy recommendations play only a minor role in my discussion of IS-LM in this paper.<sup>7</sup>

My focus is instead on the *transmission mechanism* in the optimizing IS-LM specification—the role that this aggregate demand specification plays in governing the response of prices and output to monetary policy actions and real shocks—and how this mechanism compares to that in traditional IS-LM work. A convenient way of organizing the analysis is to follow one aspect of the discussion of McCallum and Nelson (1999a). Relative to other discussions of optimizing models for monetary policy, our paper had the distinguishing feature of an explicit comparison of the optimizing IS-LM specification with traditional IS-LM approaches. Our aim was to separate valid from invalid criticisms of older IS-LM work, and in so doing, to obtain a modern version of IS-LM that was less susceptible to the earlier criticisms. In that light, we considered a list of six key criticisms of traditional IS-LM analysis. With the order rearranged, the six objections to IS-LM in the literature that we contemplated were:

- (i) IS-LM analysis presumes a fixed, rigid price level;
- (ii) It does not distinguish between real and nominal interest rates;
- (iii) It permits only short-run analysis;
- (iv) It treats the capital stock as fixed;
- (v) It does not recognize enough distinct assets;
- (vi) It is not derivable from explicit maximizing analysis of rational economic agents.

In our discussion of these criticisms, McCallum's and my coverage of the IS-LM literature was necessarily brief, given the other objectives of our paper. In the present paper, I provide a far more in-depth discussion of each criticism, and a more detailed analysis of the relationship between traditional IS-LM and the optimizing IS-LM specification.<sup>8</sup> On criticisms (i) and (ii), discussed in Section 2, I examine several issues not covered by McCallum and Nelson (1999a), including the integration of price-level

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<sup>7</sup> The IS-LM side of a model does have a significant impact on the choice between interest-rate and money growth rules, as Poole (1970) showed. But while Poole's analysis has been generalized in several directions—e.g. to include a variable price level, an output/output gap distinction, and interest-rate feedback rules—these extensions mainly involve changes to the aggregate-supply and policy-rule specifications, so the advent of the optimizing IS-LM equation does not make a critical difference to Poole's results. One basis on which Brunner and Meltzer (1993) questioned Poole's results, namely its dependence on the IS-LM's two-asset structure, is related to the discussion in Section 4 below.

<sup>8</sup> As it does not form part of the list that McCallum and I formed, I will have little to say about the issue of whether traditional IS-LM analysis accurately reflected Keynes' (1936) *General Theory* (on which see e.g. Patinkin, 1990, Darity and Young, 1995, and De Vroey, 2000).

analysis into the IS-LM paradigm. On issues (iii) and (iv), which are the subject of Section 3, I discuss a variety of claims in the literature made about IS-LM dynamics. In Section 4, which covers issues (v) and (vi), I provide a detailed discussion of the large monetarist literature criticizing IS-LM. This literature was only briefly discussed by McCallum and Nelson (1999a); the analysis here offers a much more thorough treatment of the issue, building on the comparison that I presented in Nelson (2003) of the monetarist literature with the optimizing IS-LM approach. I draw conclusions about the merits of the monetarist structure in light of both empirical evidence and modern optimizing macroeconomic theory.

Throughout the paper, my discussion draws on a variety of sources not used by McCallum and Nelson, including much archival material not available until recently. For example, several Federal Reserve banks, among them those of Minneapolis, Richmond, and St. Louis, now provide on their web sites the historical back runs of their working papers and journal publications, including material published during the debates in the 1960s and 1970s on rational expectations, monetarism, and the microfoundations of macroeconomics. This material, which is typically not stored by economics libraries, contains many discussions of IS-LM relevant to this paper. In addition, in discussing the monetarist criticism of IS-LM, I make use of Karl Brunner's position papers over 1973–1987 for the Shadow Open Market Committee, many of which were never reprinted in journals or collections. I also draw on contributions by Milton Friedman and Paul Samuelson to magazines like *Newsweek* and *The Economist*. This material supplements the academic debate on monetarist views of the transmission mechanism, and a substantial portion of it has never been reprinted.

## **2. Objections (i) and (ii): “IS-LM analysis presumes a fixed, rigid price level” and “It does not distinguish between real and nominal interest rates.”**

The first criticism of IS-LM that I discuss, namely that “IS-LM analysis presumes a fixed, rigid price level,” has appeared frequently in both textbooks and journals. McCallum and I rejected it as a valid criticism. The basis for this rejection is implicit in the definition of IS-LM that I presented in the introduction to this paper. As stressed there and also in Johannes' (1980) defense of IS-LM, the IS-LM framework describes the *aggregate demand* portion of a macroeconomic model and does not, by itself, constitute a complete model of the behavior of money, output, prices, and the nominal interest rate.

It is true that Hicks' (1937) original derivation of his "IS-LL" curves was under the assumption of fully rigid nominal wages, while even some modern textbook treatments (e.g. Auerbach and Kotlikoff, 1995, p. 314) give the impression that the derivation of IS and LM relations requires the assumption of a rigid price level. But analysis of the flexible-price (and wage) equilibrium was an important element of the IS-LM analysis of Modigliani (1944), Metzler (1951), and Patinkin (1951); and, incorporating these developments, sophisticated use of IS and LM equations from the 1950s onward was compatible with a variety of assumptions about price adjustment. Use of IS-LM *diagrams*, as opposed to *equations*, may involve more restrictive assumptions, but even so (as I argue in Section 3) these restrictions are essentially restrictions on the dynamics of the IS and LM relations, rather than assumptions about nominal inflexibility.<sup>9</sup>

The fact that both flexible-price and sticky-price IS-LM variants existed by the 1950s need not necessarily invalidate another allegation made about traditional IS-LM analysis, namely that "one of the most significant weaknesses of the simple IS-LM framework is that prices and output cannot change simultaneously" (Policano, 1977, p. 233). But again, such a criticism seems misplaced. If valid, it would imply that IS-LM analysis is inconsistent with an upward-sloping aggregate supply curve. Such a curve implies short-run reactions of both prices and output to monetary policy actions, and is consistent both with Phillips curve analysis and Lucas (1973)-style aggregate supply functions. Since, as argued above, algebraic representations of IS-LM *are* consistent with a variety of Phillips curve specifications, Policano's criticism is invalid for IS-LM *equations*. Vercelli (1999, p. 206) dates the use of Phillips curve specifications in combination with IS-LM to the late 1960s, and an early example is Sargent (1972). Perhaps Policano's criticism is intended more to apply to IS-LM *diagrams*. It is certainly easier to represent models with more than two-period dynamics in difference equations than in diagrams, and I do not advocate the use of IS-LM diagrammatic analysis. But it is notable that Lucas (1973, p. 327) certainly regarded the "standard IS-LM diagram" as consistent with an upward-sloping aggregate supply curve, and derivations of this have become commonplace in textbooks.<sup>10</sup>

The allegation that the IS-LM specification confuses nominal and real interest rates is closely related to how suitable IS-LM analysis is in situations of a variable price level. The nominal/real rate distinction is one that arises when price-level movements take the

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<sup>9</sup> The discussion of Solow (1984, pp. 16–18) does appear to presume that some kind of wage-stickiness assumption is necessary in drawing the LM curve. Closer to the spirit of the present treatment is his statement that for analyzing macroeconomic behavior in conditions of variable wages and prices, "IS-LM is... only part of the right model" (1984, p. 17).

<sup>10</sup> Lucas (1973, p. 327) noted that an "explicit derivation of the price-output relationship from the IS-LM framework is given by Frederic [actually Fredric] Raines" in an unpublished 1971 manuscript.



form not just of once-and-for-all shifts, but of more pervasive movements that lead to fluctuations in the private sector's anticipations of future inflation. It is therefore a distinction that is essential for the analysis of realistic monetary-policy and price-setting rules. Mayer (1972, p. 541) notes that "the IS-LM diagram fails to distinguish between real and nominal interest rates," but this criticism of the IS-LM diagram does not carry through to algebraic versions of IS-LM, which either in their traditional form (1)–(3) or in the optimizing form (2)–(4), easily allow for the real rate/nominal rate distinction. Even graphical representations of IS-LM dynamics can be generalized to allow for a distinction between real and nominal interest rates (Bailey, 1962; Mundell, 1963; Patinkin, 1990, pp. 129–132), although the vertical axis must then keep track of two distinct rates.

Leeper and Sims (1994, p. 84) make a more serious allegation than Mayer, arguing that even the algebraic form of IS-LM does not recognize the Fisher relation. Their contention is that "the general equilibrium versions of Keynesian models... usually fall back on the IS-LM framework, without even a clear distinction of real and nominal interest rates." It is true that algebraic versions of the IS-LM model appeared in journals well into the late 1970s which held the price level constant both in the short and the long run, and also treated nominal and real interest rates as identical (e.g. Van Order, 1978). But the best practice had an "IS-LM framework in which the demand for money balances is affected by nominal interest rates and the demand for goods by real interest rates" (Bean, 1983, p. 813). Even Karl Brunner, a strong critic of the specification of assets in IS-LM analysis (see Section 4 below), acknowledged in 1980 that "[s]tandard Keynesian analysis assigns different interest rates to the IS and LM relation" (Brunner, 1980, p. 11). Not only was such a specification—real rates mattering for output demand, nominal rates for the opportunity cost of holding real money<sup>11</sup>—standard by 1980, it seems to me the only defensible formulation, and, as noted above, continues today in the optimizing IS-LM specification.

There is therefore no inconsistency between IS-LM analysis and modeling the price level, inflation, and expected inflation, endogenously. While assumptions about wage behavior did underlie the early work of Hicks (1937), IS-LM analysis *per se* does not rely on restrictive assumptions about wage or price-setting behavior. Accordingly, criticisms that IS-LM analysis presumes a fixed, rigid price level, and does not distinguish between real and nominal interest rates, are invalid. Both best-practice algebraic work with traditional IS-LM equations, and the modern optimizing IS-LM

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<sup>11</sup> I consider in Section 4 the important question of whether the only rates in the IS and LM relations should be short-term rates on financial securities.

specification, allow for the price level to be variable and endogenously determined by the interaction of the model's IS-LM block with the monetary policy rule and the Phillips curve.

### **3. Objections (iii) and (iv): “It permits only short-run analysis” and “It treats the capital stock as fixed.”**

Let me first discuss the criticism that IS-LM “permits only short-run analysis.” Influenced by the pioneering work of Hicks (1937), which in Solow's (1984, p. 16) words took “the IS and LM curves to refer to a unit period within which the nominal wage could be taken as fixed,” some interpreters of the IS-LM framework have regarded it as suitable for analysis of only the short-run effects of policy actions and of private-sector shocks. Vercelli (1999, p. 210), for example, observes that “[t]he assumption of the short period, typical of first-generation IS-LM models, implies that the model cannot be applied to too long a series of data (exceeding, say, one year).”

As we have seen, however, the presumption that IS-LM analysis relies on an assumption of rigid nominal wages or prices is misplaced. Accordingly, both applications of the traditional IS-LM specification, such as Sargent (1972), and the optimizing IS-LM specification of today, are intended to cover periods during which nominal variables adjust. McCallum and I viewed the optimizing IS-LM specification as “designed for quarterly time series data over sample periods of many years duration (for example, ten to fifty years)...” (1999a, p. 299), and, consistent with this perspective, later (1999b) estimated the IS-LM system (2) and (4) on U.S. quarterly data for 1955–1996. Accompanied by some version of an expectations-augmented Phillips curve, the resulting system has properties that make it reasonable for monetary policy analysis on quarterly data. For example, a permanent, exogenous increase in the nominal money stock leads in these models to effects of monetary policy on output and the real interest rate wearing off over time, but has a permanent and equal percentage effect on nominal money balances and prices.<sup>12</sup>

The distinction between short-run nonneutrality and long-run monetary neutrality is, however, a weak requirement of the IS-LM framework, and does not absolve it from criticism on other dynamic grounds. IS-LM could be judged inadequate on criteria that relate to its applicability to intertemporal decisions regarding real resources.

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<sup>12</sup> The effect on the nominal interest rate is also temporary, but would be permanent if the shock type was changed to one that permanently raises nominal money *growth*. In that case, inflation, anticipated inflation, and (via the Fisher effect) the nominal interest rate would be increased permanently. The framework therefore captures the phenomenon mentioned by King (1993, pp. 77–78).

Tobin (1979, p. 218), for example, argues that the “the common IS/LM apparatus” has a “temporary and short-run character,” owing to the absence of asset stocks from the IS and LM functions. In his words (1979, p. 219): “The only precise way to justify the Keynesian procedure is to regard the IS/LM model as determining the values of variables at a point in time. Then this model must be regarded as a slice, in time of measure zero, of a continuous-time dynamic model.” A harsher judgement along the same lines has been made by Wallace (1980, p. 70), who contends that “the macroeconomic paradigm that flows from Keynes['] (1936) *General Theory* via Hicks (1937) consist[s] of nothing more than interpreting each term in a time series as the outcome of a separate, static, nonstochastic experiment.”

In judging the validity of these criticisms, it is important to distinguish saving and investment decisions. First, consider saving decisions. The traditional IS-LM framework typically builds up to an output-demand equation from a postulated consumption function like equation (7) below. Such a specification typically cannot be justified rigorously from a household problem of utility maximization subject to an intertemporal wealth constraint. Therefore, viewed from the perspective of modern macroeconomics, traditional IS-LM is guilty of inadequate recognition of intertemporal issues. This criticism, however, does not apply to the optimizing IS-LM specification. As discussed presently, this specification bases its IS equation on a household consumption Euler equation like (8) below. Such a condition arises from an explicit household dynamic optimization problem, and so does recognize intertemporal issues rigorously. Accordingly, the optimizing IS equation does not rest on the point-in-time interpretation given by Tobin above. Instead, it can be used as a description of decades of quarterly data.

Tobin’s message that an IS curve *diagram*, plotting output against the real interest rate, entails a suppression of dynamics, does carry through to the optimizing version of the IS curve. To express equation (4) in a two-dimensional diagram, one must suppress not asset stocks, but the expectation of future output. A diagrammatic representation must assume that expected output is constant; or, better, the behavior of expected future output should guide the drawing of the slope of the IS curve; or, best of all, the “interest rate” on the vertical axis of the plot should not be the current real short-term rate, but instead a long average of current and expected future real short rates.<sup>13</sup> The complications involved, however, reaffirm that for analysis of modern models, difference equations like (4) are more flexible tools than diagrams.

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<sup>13</sup> Solving equation (4) forward reveals that output can be written as a function of current and expected real short rates if the IS shock is held constant.

Now consider the modeling of investment. Here, Tobin’s stress on the absence of asset stocks from the IS equation becomes relevant. While an infinite-horizon optimizing model actually provides justification for the exclusion of explicit asset-stock terms from the consumption equation, investment decisions are another matter. There is an undeniable connection between the physical capital stock and investment, and so, in principle, the capital stock should be a state variable that appears in the economy’s aggregate IS equation. Nevertheless, McCallum and Nelson (1999a) argued that, as an approximation, the role of the capital stock can be neglected in deriving an IS equation for monetary policy and business cycle analysis. Dupor (2001) criticizes our advocacy of this approximation. After quoting from our argument, Dupor argues (2001, p. 107) that “[our] reasoning misses the overwhelming rationale for modeling investment—investment is a significant fraction of GDP. The fact that quarterly investment is more than four times as volatile as consumption in the post-war U.S. [data] provides ample motivation for modeling investment!”

Neither of the arguments in the quotation from Dupor’s paper justifies his conclusion that investment should be modeled endogenously. First, note that a log-linearized resource constraint for a closed private economy is:

$$y_t = s_c c_t + s_i i_t, \tag{5}$$

where  $s_c$  and  $s_i$  are steady-state shares of consumption and investment in GDP, and  $c_t$  and  $i_t$  represent log-deviations in the time series of consumption and investment from their trend values. With equation (5) as one building block, several derivations of the traditional IS equation (1) are possible. One approach, as in Bailey (1962, pp. 29–32), is to assume that the consumption function has income as its sole argument, while the assumed investment function has the real interest rate as its sole argument. But an alternative derivation, which is somewhat closer in spirit to the approach underlying the optimizing IS equation (4), is to start from a consumption function like:

$$c_t = b_c r_t + b_y y_t + e_{ct}, \tag{6}$$

where  $b_c < 0$ ,  $b_y \geq 0$ , and  $e_{ct}$  is an exogenous term. The IS equation (1) then emerges by postulating that it is valid to model investment as though it is not a separate expenditure category.<sup>14</sup> This amounts to the assumption that  $i_t = \gamma c_t + e_{it}$ , where  $\gamma > 0$  and  $e_{it}$  is a

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<sup>14</sup> Although not allowed for in Bailey’s derivation, the dependence of consumption on the interest rate appeared early in U.S. developments of Keynesian theory; see e.g. Darity and Young (1995, p. 37) and B. Friedman (1976, p. 355). McCallum (1989, pp. 78–82) is an example of a textbook presentation that derives a relation like (1) in a manner similar to that described here.

stationary exogenous shock process. Note that this assumption neither denies that  $s_i$  in equation (5) is large (and so is in complete agreement with the empirical regularity that Dupor argues is the “overwhelming rationale” for modeling investment explicitly), nor that investment is highly volatile. Furthermore, setting a value of  $\gamma$  greater than 1.0 generates an IS equation that satisfies the property that investment is more volatile than consumption. Such a parameter choice would also imply that investment is more interest-elastic than consumption. One could alternatively keep total output at the same interest elasticity as consumption spending while making investment volatile, by setting  $\gamma$  to unity and the variance of the investment shock  $e_{it}$  to a high value.

McCallum and I started instead from the optimization-based consumption equation,

$$c_t = b_c r_t + E_t c_{t+1} + e_{ct}, \quad (7)$$

and proposed a specification of investment behavior slightly more general than that above. Specifically, we proposed  $i_t = \gamma c_t + e_{it} + \xi_t$ , where  $\xi_t$  is an exogenous random walk. Positive values for  $s_i$ ,  $\gamma$ , and the variances of the  $e_{it}$  and  $\xi_t$  innovation processes can all be permitted, and all lead (when combined with equations (5) and (7)) to the aggregate IS equation (4). Thus, both in traditional IS-LM analysis and the optimizing version, the restrictions imposed on the treatment of investment are consistent with volatile and cyclical investment behavior. In addition, with the optimizing IS-LM specification, the forward-looking nature of investment is captured by using the household consumption condition to model the whole of private aggregate demand.

The decision underlying IS-LM analysis not to treat investment completely endogenously is, therefore, perfectly consistent with a recognition of the contribution of investment to aggregate-demand fluctuations, and of the interest-elastic character of investment. As Tobin (1979) noted, what is being suppressed is not investment variation but, instead, the connection between investment and the capital stock. Such an abstraction, however, seems to be an innocuous assumption for the purposes of monetary policy and business cycle analysis. As McCallum and I observed, the capital stock is empirically an acyclical variable, so it remains valid to treat it as constant (or growing smoothly) even while recognizing that investment is both volatile and cyclical. A typical quarter or year’s investment has such a small impact on the total stock of physical capital that the link between the two series can be neglected. None of this is to deny that, in a study of economic growth, recognition of the endogeneity of the capital stock is mandatory. But for the study of monetary policy issues, it seems legitimate to neglect the connections between investment and the supply side in specifying the

aggregate demand side of the model, while taking potential GDP as an exogenous process that appears in the economy's Phillips curve.

A different criticism of the treatment of dynamics in IS-LM specifications that has appeared in the literature is that IS-LM ignores not the long run, but the *short* run. Such a perspective appears to be the basis for Hendershott and Horwich's (1974, p. 389) statement that "[t]he IS-LM schedules cannot provide a framework for dynamic analysis because they implicitly assume that total income supplied and demanded are always equal."<sup>15</sup> I would argue, however, that Hendershott and Horwich's criticism is misplaced. An analysis in which the goods market clears every period, or, equivalently, there is continuous intersection of the aggregate demand and aggregate supply curves, in no way implies the absence of dynamics. In the case where IS-LM is supplemented by an augmented Phillips curve, dynamics—in the sense of protracted deviations of output and the real interest rate from their flexible-price values—are present. The fact that aggregate supply equals aggregate demand does not mean that output is equal to potential; on the contrary, output is demand-determined in the short run, with firms hiring whatever inputs are needed to ensure that the amount of output supplied is equal to the quantity demanded. And even in a flexible-price version of the model, where output does equal potential every period, there can be dynamics in the responses of output to real shocks.

Turning to Wallace's objection that IS-LM is nonstochastic, it is seemingly echoed by Poole's (1982, p. 68) statement that "the IS-LM framework is not very convenient for thinking about stochastic issues." But this criticism surely applies more to geometric IS-LM analysis than analysis with equations. Poole (1970) is an example of a stochastic analysis in a traditional IS-LM framework,<sup>16</sup> and many of the restrictions that were part of Poole's setup can be relaxed without sacrificing an analysis of stochastic issues in an IS-LM environment.

I conclude that while a legitimate criticism of older IS-LM analyses was their insufficient and inadequately rigorous dynamics, the current optimizing IS-LM analysis does accurately build in intertemporal considerations. Failing to model the capital stock's behavior, on the other hand, is not a critical shortcoming. As well as having rigorously founded dynamics, the optimizing IS-LM specification can be made

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<sup>15</sup> This perspective may also have motivated Modigliani's (1944, p. 46) statement, prior to presenting his prototype IS-LM analysis, that his model was "concerned with the determinants of equilibrium and not with the explanation of business cycles..."

<sup>16</sup> Indeed, Patinkin (1990, p. 126) credits Poole (1970) with "introducing stochastic elements into the IS-LM model."

explicitly stochastic, allowing standard behavioral interpretations of the IS and LM disturbance terms.

#### **4. Objections (v) and (vi): “It does not recognize enough distinct assets” and “It is not derivable from explicit maximizing analysis of rational economic agents.”**

This section discusses the two features of IS-LM that have been the source of greatest debate in the literature. The representation in traditional IS-LM analysis of all non-money assets by a single interest-bearing security has been the subject of scathing criticism by monetarists, especially Karl Brunner, who condemned IS-LM’s “emasculated representation of financial markets” with its reliance on “the never-never land of a two-asset world.”<sup>17</sup> Criticisms of the traditional IS-LM framework on the grounds that it is not based on an optimizing framework have been made by King (1993), Danthine (1997), and the authors quoted in the introduction.

Though considered separate criticisms by McCallum and Nelson (1999a), these two criticisms of IS-LM are closely related. The issue of IS-LM’s treatment of assets leads naturally to a consideration of whether IS-LM is consistent with the behavior of maximizing private agents; both issues bear on the implications of forward-looking behavior for the specification of the LM function. The microfoundations of the LM function can be the principal focus here, as Section 3 has already discussed key aspects of the optimizing foundations of the IS function.<sup>18</sup> The question of whether IS-LM represents enough distinct assets is so intertwined with the “monetarist” criticisms of IS-LM that it is worthwhile to center the discussion in this section on the latter.<sup>19</sup> So I begin by discussing the monetarist critique of IS-LM; then outline the relation of this critique to various Keynesian perspectives; and reconsider the monetarist critique in light of more recent empirical work.

As Parkin (1979, p. 435) observed: “Monetarists have for many years been complaining that the IS-LM framework does not adequately capture their views.” The key questions are *why* monetarists viewed the transmission mechanism in the IS-LM specification as inadequate, and *how* their suggested alternative conveyed increased significance on the money stock. Parkin’s own assessment of the monetarists’ critique was negative: “The trouble has been that they have not known what to write down in its place,” and he

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<sup>17</sup> The two quotations are from Brunner (1983, p. 26) and Brunner (1969, p. 271).

<sup>18</sup> In particular, replacing equation (1) with the optimizing IS equation (4) can be seen as an acknowledgment of the importance of intertemporal considerations for spending decisions.

<sup>19</sup> As Bordo and Schwartz (2003) note, much of the pre-1970 monetarist literature did not discuss IS-LM explicitly, but differences from IS-LM were implicit in the outline of the transmission mechanism.

contended that this state of affairs continued until the mid-1970s. On the surface, such a conclusion is supported by Friedman's (1974, p. 33) use of "the IS curve of Hicks's famous IS-LM analysis... [and] Hicks's LM curve..." However, Friedman also noted (1974, p. 29) that "the same symbols can have very different empirical counterparts, so that the algebraic statement can conceal" substantially different views regarding the transmission mechanism. In addition, Friedman later (1976, pp. 315–316) clarified his position as follows: "In my attempt to communicate, I have tried for example to present monetarist analysis in IS-LM terms, even though recognizing that this was a cumbersome theoretical structure for this purpose..." In fact, the cornerstones of the monetarist critique of IS-LM can be found in the outlines of the transmission mechanism of monetary policy by Brunner, Meltzer, Friedman and Schwartz in the early 1960s, all of which built on the money demand theory outlined in Friedman (1956).

Regarding why monetarists thought IS-LM was inadequate, one channel which should be ruled out is that operating through wealth effects, in the sense of the Pigou-Patinkin real balance effect: the stimulus to consumption spending due to the addition to real financial wealth produced by an increase in real base money. Textbook treatments occasionally attribute to Friedman and other monetarists the view that real balance effects are very important influences on aggregate demand behavior, and even Patinkin (1974, p. 131) viewed Friedman's position on the transmission mechanism as "an alternative statement of the real-balance effect." The real balance effect was *not*, however, emphasized by monetarists. Friedman (1976, p. 317) stated, "I have never myself thought that wealth effects of changes in the quantity of money, or of price changes which altered the real quantity of money, were of any empirical importance for short-run economic fluctuations,"<sup>20</sup> while Brunner (1973, p. 523) endorsed the widely accepted view that the "real balance effect" contributes quite negligibly to monetary transmission, and argued that the monetarist literature had "removed the real balance effect from the central position assigned it by Patinkin's analysis" (1970, p. 5).

Appending the IS-LM framework with a real balance effect therefore does not capture monetarist views.<sup>21</sup> The monetarist position instead implies, as Brunner (1989, p. 212)

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<sup>20</sup> Rogers and Rymes (2000, p. 79) find it "extraordinary" that Friedman could simultaneously deny the empirical importance of wealth effects, yet endorse them as an escape from a Keynesian liquidity trap. The compatibility of the two positions should become clear below: the Keynesian liquidity trap refers to a case where the scope for monetary ease via substitution effects has been exhausted; Friedman and other monetarists did not find any historical episode (including the 1930s) where all substitution channels had been exhausted.

<sup>21</sup> Two elements of possible confusion should be noted. First, some discussions, including Laidler (1982, p. 46), use "real balance effect" to describe the monetarist substitution effects discussed presently rather than the Pigou-Patinkin wealth effect. Secondly, some advocates of these broad substitution effects (e.g. Brunner, 1971, p. 45; Meltzer, 1977, p. 164) mentioned that those channels involved some effects that could be considered wealth effects, but which were not of the Pigou-Patinkin variety.



put it, a “substitution-based transmission mechanism.” This mechanism had two planks.<sup>22</sup> The first was the insistence that a broad set of (nominal) asset yields should appear in the money demand or LM relation (Friedman, 1956). According to this view, the relevant opportunity-cost variables in the money demand function are not just the rate on short-term financial securities, but—reflecting the many alternatives that households have to holding money—also long-term security yields, equity returns, and the implicit yield on consumer durables. The second plank was that a multiplicity of (real) interest rates and asset prices appear in the IS equation, and that “market rates... [are] only a small part of the total spectrum of rates that are relevant” (Friedman and Schwartz, 1982, p. 58). Taken together, these positions implied that expansions of the real money stock would be felt in the reaction of many asset yields; and that the behavior of the interest rate on short-term securities would provide an inadequate summary of the reaction of asset prices to changes in monetary policy, and so of the effect of monetary policy actions on aggregate demand.<sup>23</sup>

The theoretical merits of this view of the transmission mechanism rest on the plausibility of Friedman’s position that the money demand function should be broad-based. His work was not based on microeconomic foundations, but early discussions of the LM function by users of dynamic general equilibrium models seemed supportive of Friedman’s proposal. Bryant and Wallace (1979, p. 2), for example, argued that “[a]ny sensible model of individual behavior would make current portfolio decisions depend on views about the future and, in particular, on views about future fiscal and monetary policy.” This suggested that an LM function like (2), which gives real money demand as a function only of current values of real income and the short-term rate, was inconsistent with optimizing behavior.

But more detailed work on the money demand function implied by intertemporal choice theory has legitimized the use of the standard LM equation. Using an infinite-horizon optimizing model, Lucas (1988) derived a money demand relation that (in its linearized and stochastic version) takes the form of equation (2), and explicitly rejected the position that asset yields beside the short rate should appear in the function. His

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<sup>22</sup> Brunner (1970, p. 4) observes: “The first description of this price-theoretical approach to the transmission mechanism was made almost simultaneously by P. Cagan [1958], Milton Friedman [1961a], James Tobin and myself...” Of these, Cagan’s work mainly built on Friedman’s 1956 description of the form of the money demand function, rather than discussing the implications for the transmission mechanism of monetary policy. In addition, it should be noted that Brunner and Friedman’s most definitive expositions of the transmission mechanism were in their collaborated work: e.g. Brunner and Meltzer (1963, 1972, 1993), Friedman and Schwartz (1963, pp. 59–63; 1982). The relation of this work to Tobin’s will be discussed shortly.

<sup>23</sup> This statement presumes some form of price stickiness in the short run that allows open market operations to affect both the nominal and real values of the money stock in the same direction.

analysis did not assume two assets—a vector of financial securities was present, and physical capital could be added to Lucas’ model without changing his result. Substitution between money and many other assets is *available* to the representative household, but optimizing behavior implies that only substitution between money and short-term securities takes place *in equilibrium*. The reason is as follows. In the standard model, with agents holding money solely for its service of facilitating current transactions, the only relevant opportunity cost variable is the one-period nominal yield. Arbitrage conditions linking the returns on different types of financial assets, and those on financial and real assets, mean that the one-period yield is accurately summarized by the short-term security rate. The uncovered interest parity relationship, for example, ensures that there is no gain from contemplating holding foreign exchange for one period instead of a one-period domestic security. In light of these considerations, Blanchard (1997, p. 191) concluded that a “quite myopic” LM equation like (2) was justifiable even in modern macroeconomic models, and that this was “good news” for conventional textbook analysis.

But if this is good news for conventional analysis, it would appear to be bad news for a broad-based view of the transmission of monetary policy. If the LM function does take the form of equation (2), then the only variation in real money balances not associated with current real income and the short-term nominal interest rate is uninteresting noise—the money demand shock. For a given path of the short rate, it is hard to see how any significance could be attached to the money stock under such circumstances. Equivalently, a policy-induced injection of money would (together with some nominal stickiness) tend to stimulate output through its effect on the nominal interest rate, and so on the real short rate. But any spillover of the monetary injection into other yields such as long-term rates and the exchange rate would be summarized by the path of current and expected short-term rates—exemplifying what Brunner (1974, p. 22) called a “very Keynesian” view of monetary transmission.

The form of the conventional LM function, together with the tight arbitrage relations that underpin both the standard IS-LM framework and modern optimizing models, puts a limit on the implications of the specification of the IS function. One could concede that many yields should appear in the appropriately specified IS equation, yet essentially reproduce results from a two-asset IS-LM framework. Indeed, under some interpretations, even the original IS-LM specification recognized a short rate/long rate distinction. Tobin (1961, p. 35), for example, observed that “the Keynesian interest rate [is] the long-term bond rate” while Brunner’s (1980, p. 11) characterization of the Keynesian IS equation was that “a long-term real rate affects aggregate demand.” The

material effect of this distinction is, by itself, not great, either in traditional IS-LM analysis or in optimizing models. Before the mid-1970s, the adaptive expectations assumption meant that long-term rates were modeled as a distributed lag of the short rate up to an exogenous risk premium. Rational expectations analysis in macroeconomics instead treats long-term rates as a distributed lead of the expected short rate, but again typically treats the risk premium as exogenous. It then remains the case any effect of monetary policy on output can be summarized by the path of the short-term interest rate, effectively restoring a two-asset structure.

The above description, however, makes it clear that the central element of the monetarist criticism of IS-LM is not that IS-LM includes an insufficient number of assets, but that it treats all non-money assets as *perfect substitutes*. Such an assumption is manifested in the presence of the aforementioned arbitrage conditions between assets. The prevalence of the perfect-substitutes assumption in IS-LM is emphasized by the fact that in Metzler's (1951, Section III) exposition, the "interest rate" was the return on equities. In criticizing the perfect-substitutability assumption, moreover, the monetarists appear to have support from the work of Tobin (e.g. 1961, 1982).

But the similarity of Tobin's and the monetarist critique of IS-LM itself creates a puzzle. On the one hand, it is well known that there is an isomorphism between Brunner and Meltzer's and Tobin's specifications of aggregate demand behavior (Brunner, 1971; B. Friedman, 1976).<sup>24</sup> On the other hand, Tobin's framework has also been seen as one that lends support to analyses that are not at all consistent with the monetarist position regarding the significance of the money stock as an indicator. The most extreme case of this is the Radcliffe Report (1959), which is widely agreed to have taken the diametric opposite of the monetarist position (e.g. Friedman and Schwartz, 1982, p. 207), with even Paul Samuelson dismissing "the Radcliffe Committee stupid view that money doesn't matter" (Samuelson, 1969, p. 9). Yet Gowland (1978, p. 5) argues: "The Radcliffe Report took a generally 'Tobinesque' approach to monetary policy..." There thus appears to be a significant anomaly: a common motivation—namely, to enrich the asset specification relative to the IS-LM baseline—has apparently lent support to the monetarist position (that of Brunner-Meltzer and Friedman-Schwartz); a U.S. Keynesian position (Tobin's) which recognizes the importance of monetary policy, but downplays the centrality of money; and an extreme Keynesian

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<sup>24</sup> According to Samuelson (1983, p. 25): "In 1976 when Professor Benjamin Friedman of Harvard wrote down for the monetarists Karl Brunner and Allen [*sic*] Meltzer what their model of monetarism was, it turned out not to be qualitatively distinguishable from a James Tobin Keynesian model." In fact, this equivalence had been noted by Brunner five years earlier: "[I]n spite of the apparent differences in the descriptions, there exist suitable and purely formal manipulations which transform the Brunner-Meltzer frame[work] into the Tobin-Brainard frame[work,] and conversely." (Brunner, 1971, p. 109).

position which discounts or denies the importance of monetary policy for aggregate demand determination (the Radcliffe view). How can these claims be reconciled, and what are the implications for the validity of IS-LM analysis?

To answer the above questions, it is useful to discuss in turn how each camp—the monetarists, Tobin, and the Radcliffians—viewed the implications of imperfect substitutability of assets. For the monetarists, the important effect was on the formulation of the money demand function. The rationale offered in the monetarist literature for the Friedman (1956) money demand function was the role that money could serve as a safe asset when many alternative assets to money were imperfect substitutes. In strict analogy with commercial banks holding higher cash reserves against their less liquid and more risky assets, households might add to their cash holdings in some proportion when they shifted into riskier (e.g. longer-term) obligations. This is clearest in two quotations, one from Friedman in 1971, the other from Friedman and Schwartz (FS) (1982). From Friedman’s 1971 piece:

“As market rates rose above the [legal] maxima [on time deposits], time deposits became less attractive than market instruments. Holders of such deposits tried to shift into Treasury bills, commercial paper and the like. But this involved a loss of liquidity, so part of the shift out of time deposits took the form of an increased demand for demand deposits. As a result, during 1969, M1 rose more rapidly than M2.” (Friedman, 1971, p. 60).

If some of the shift to liquid assets described by Friedman takes the form of movement into currency rather than demand deposits, then this prudential behavior puts yields on riskier assets into the demand function for base money. This provides an underpinning for the persistent monetarist theme that base money expansion should have effects on the *spread* or “risk premium” between short-term securities and other assets.

The prudential behavior described above was, in turn, part of FS’ emphasis on what they called the “temporary abode of purchasing power” function of money.<sup>25</sup> They placed more emphasis on this function than on the transactions role of money, and described how it led to long-term yields mattering for money demand:

“Money balances are held for a variety of possible contingencies, the timing of some of which, such as recurrent trips to the market, is reasonably predictable, the timing of others, such as emergency needs for ready funds, is highly uncertain. In principle, the whole term structure of yields, for all possible holding periods, is relevant to the quantity of money demanded.” (FS, 1982, p. 262).

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<sup>25</sup> See e.g. Friedman (1961b, p. 263); FS (1970, pp. 106, 125).

Under this view, money is held both as a reserve against holding risky assets and for emergency needs, and the result is that many yields, not a single short-term nominal interest rate, appear as opportunity-cost variables in the money demand function.

Both Brunner (1971, pp. 18–19) and Meltzer (1971) objected to FS' emphasis on the temporary-abode function on the grounds that it did not constitute a property of money distinct from that already discussed in the literature. Meltzer (1971, p. 336) in particular noted that in FS' (1970) discussion, “the ‘temporary abode’ soon becomes the ‘asset’ motive,” and, indeed, FS (1982, p. 24) made no bones about the fact that their temporary-abode function was simply a relabeling of the asset function. Furthermore, the “contingencies” that Friedman and Schwartz refer to in the above quotation parallels the “reserve against contingencies” used to justify the asset motive in Modigliani (1944, p. 51), a paper described by Friedman (1977, p. 12) as “a major element in the so-called monetarist structure.”

Despite the differences in language with FS, the role of money as a reserve asset was an important part of Brunner and Meltzer's framework. For example, Meltzer (1983, p. 351) wrote: “Increased uncertainty about the future discourages investment in real assets and encourages people to hold relatively safe assets such as currency, insured bank deposits and short-term debt.” Like Friedman, Brunner and Meltzer argued that the returns on physical capital and long-term debt should appear in the money demand function (e.g. Brunner, 1969, p. 271; Meltzer, 1963), and, correspondingly, they viewed the risk premia for those assets relative to short-term debt as endogenous and a function of the real stock of money (Brunner, 1989, p. 209; Meltzer, 1983).

The broad-based money demand function that emerges in the monetarist view then gives a significant role to the money stock as an indicator. Though critics of the monetarist literature, Gramley and Chase (1965) provided an accurate characterization of the role of money stressed by monetarists:

“[C]entral bank actions... [affect] money income... not because the money stock has been altered, but because financial variables through which the central bank alters the desired stock of money also affect the public's decisions to purchase goods and services... What is required is that movements in the money stock reflect the influence of central bank actions on the prices and yields of financial assets... Changes in the money stock can then serve as a proxy for the more complex set of variables that enter expenditure functions.” (Gramley and Chase, 1965, p. 1403).

FS (1970, p. 126) and Brunner (1969, p. 273) explicitly endorsed the above characterization of the issue.

Where does Tobin's position fit in? Like the monetarists, Tobin believed that many asset yields mattered for aggregate demand; and that an implication of imperfect substitutability between assets was that differences in yields across assets should not be regarded as exogenous "risk premia," but as endogenous variables—in particular, as functions of the relative quantities of assets supplied (Tobin, 1961, pp. 29–34; 1982, p. 179). But despite acknowledging that imperfect substitutability also meant that many asset yields mattered for money demand (Tobin, 1961, p. 32; 1980, p. 71), Tobin did not regard the indicator role of money as being enhanced by the imperfect-substitutability extension. Rather, he stressed that, by putting more arguments into the velocity function, the extension gave more scope for variation in the numerical value of velocity (Tobin, 1974, p. 89); and that it did not put an explicit term involving money into the structure of the IS equation (Tobin, 1961, p. 35). Tobin's acceptance of the Friedman money demand function and of the endogeneity of risk premia means that expansions of the money stock have effects on the differentials between short rates and other asset yields, but he seems to have judged that this effect was minor. Accordingly, he appears to have regarded the disconnection between short-term rates and other yields implied by imperfect substitutability as weakening the effectiveness of monetary policy. There appears to be no other way of rationalizing his statement that "more modern theory actually weakens the link of monetary policy to aggregate demand" (1974, p. 89).

In ascertaining "Radcliffian" views of the transmission mechanism, it is useful to regard these views as represented by two sources: the Radcliffe Report itself (1959) and Dow's (1964) *Management of the British Economy 1945-60*. Laidler (1989a, p. 1147) judges these the two foremost products of U.K. postwar Keynesian economics. The Radcliffe Committee stated that "the structure of interest rates... [is] the centerpiece of the monetary mechanism"—in itself, a position not different from the monetarist view of transmission. But any connection with monetarism was broken by its view (1959, p. 133) that the velocity of circulation could be "stretched" without limit. Such a view gave no prospect of uncovering a systematic relationship between real money demand and opportunity-cost variables, and so denied the monetarist position that money could be a good proxy for the output-relevant spectrum of yields.

Like Tobin and the monetarists, the Radcliffians also placed great stress on the importance of imperfect substitutability between assets. But, even more so than Tobin, they took imperfect substitutability to imply that monetary policy became ineffective.

For one thing, the Radcliffe Report viewed real aggregate demand as highly inelastic with respect to the short-term real interest rates over which central banks had most influence (1959, p. 174; Laidler, 1989b, p. 23). Imperfect substitutability between assets then broke the link between short-term security rates and the returns on physical assets, further reducing the potency of monetary policy. The possibility, stressed by the monetarists, that monetary expansion could affect the risk premium between assets, was not explored, in keeping with the Radcliffian denial of a well-defined LM function.

Dow's (1964) analysis reached some flawed conclusions about the implications of imperfect substitution between assets. Regarding the conventional interest-rate channel of monetary policy, Dow did acknowledge (1964, p. 314) that a lowering of market interest rates would encourage increased investment in new capital goods relative to the use of the existing physical capital stock. But he appeared to believe that this channel was shut off by the existence of firm-specific capital and the absence of an organized market for secondhand capital goods (1964, p. 319). As Hodgman (1971, p. 772) noted, Dow's conclusion was flawed because the existence of firm-specific capital does not prevent intertemporal considerations, and hence interest rates, from being relevant for a firm's investment decision. In addition, Dow (1964, p. 300) argued that if short-term securities and physical assets became perfect substitutes, monetary policy would lose any influence on real rates on securities, the latter being driven entirely by real factors. In fact, price flexibility, not perfect substitutability of assets, would produce this result. Provided that the Phillips curve specification is one that allows some protracted effects of monetary policy on real variables, then monetary policy can influence the real rate when bonds and capital are perfect substitutes (as they are in the baseline optimizing IS-LM specification).

The different positions of the standard IS-LM specification, the monetarists, Tobin, and the Radcliffe Report can be brought out by writing out the following three-asset model. Time subscripts and shock terms are suppressed to emphasize that specialized versions of the model would include leads and/or lags of each variable.

$$y = d(r, z, \dots) \text{ [IS function]} \tag{8}$$

$$p = p(y, \dots) \text{ [Price-adjustment equation]} \tag{9}$$

$$R = f(r, \pi) \text{ [Fisher equation for short rates]} \tag{10}$$

$$Z = g(z, \pi) \text{ [Fisher equation for third asset]} \tag{11}$$

$$m-p = L(y, R, Z) \text{ [Money demand equation]} \quad (12)$$

$$z = h(r, \zeta(m-p, \dots)) \text{ [Asset arbitrage condition]} \quad (13)$$

The model would be completed by a policy rule for  $m$  or  $R$  and the identity linking the price level  $p$  and inflation  $\pi$ . The model layout is similar to Brunner and Meltzer (1972, p. 415), with the IS equation depending on two distinct real asset yields—here, the real short rate,  $r$ , and a second yield,  $z$ . The model features a Phillips curve-style price-adjustment equation; Fisher equations to generate nominal yields from real yields; and two asset-market equilibrium conditions: the money demand function (depending on both nominal yields) and an arbitrage condition linking the real returns  $z$  and  $r$ . In Brunner-Meltzer and Tobin’s work, the third asset was capital, but one does not need a model with capital for a third asset to be relevant. Other candidates for  $z$  include the real long-term bond rate or the real exchange rate. The  $\zeta$  variable in equation (13) is a risk premium, the part of  $z$  variation that cannot be accounted for by the path of  $r$ .

The baseline IS-LM specification (both in its traditional and optimizing form) treats the risk premium between the asset yields as constant or exogenous, and so claims that  $\zeta$  is not, in fact, dependent on real balances  $m-p$ . Correspondingly, the second nominal yield  $Z$  is absent from the money demand function. The whole model then collapses into a two-asset system with the single real interest rate  $r$ .

Monetarists stressed the importance of both the dependence of the risk premium  $\zeta$  on  $m-p$ , and, consistent with this, of money demand on the nominal yield  $Z$ . Candidates for  $z$  include the real long-term bond rate and the real exchange rate. If  $z$  is a *vector* of yields, many of which are hard to observe directly, the monetarists would emphasize the role of monetary growth or real balances as a summary of the behavior of the yields,  $r$  and  $z$ , that matter for aggregate demand.<sup>26</sup>

Tobin’s position, like the monetarists, emphasized the presence of a second asset in the IS equation, and the importance of the wedge  $\zeta$  between the two asset yields. However, in downplaying the role of money, he stressed that  $m-p$  does not appear directly in the IS equation, and instead tended to focus attention on asset yields that appear in the IS equation across a variety of specifications of the asset structure. Tobin (1961, p. 35) claimed that, in models with capital, Tobin’s  $q$  had such a robust or “strategic” role.

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<sup>26</sup> Meyer (1980, p. 463) criticizes monetarists for hypocrisy for arguing that monetary policy acts through relative-price adjustments, yet elsewhere arguing for putting money directly in econometric models of expenditure. But this criticism misses the point that it is money’s role as a stand-in for unobservable yields that justifies its inclusion in econometric equations.



In addition, Tobin's position that imperfect substitutability weakens the impact of monetary policy amounts to the claim that the dependence of the risk premium  $\zeta$  on  $m-p$  can be neglected. With aggregate demand depending on two yields, and the scope for monetary policy to affect the second yield existing only through policy's effect on  $r$ , one can rationalize Tobin's conclusions that "the major conclusions of the Keynes-Hicks apparatus remain intact" (1982, p. 172) and that "I have never understood how Brunner and Meltzer could derive monetarist conclusions... from multi-asset models" (1980, p. 69). Such a view might also account for what Brunner (1983, p. 49) complained was "Tobin's usual lapse into a [two]-asset equation system when discussing output-money interaction." And indeed Tobin and Buiter do seem guilty of the double standard attributed to them by Brunner: despite arguing that two-asset models are "strictly for classroom use only" (1980, p. 90) and not appropriate for analyzing the macroeconomic effects of fiscal policy, they were satisfied in their 1976 paper to evaluate monetarist arguments using a two-asset model. The two positions can be made consistent if Tobin believed that while variations in asset supplies were in general important sources of risk-premia variation, the partial derivatives of risk premia with respect to movements in real base money were very small.

Like the monetarist and Tobinesque views, the U.K. Keynesian or Radcliffian position emphasized the importance of asset prices beside the short rate in aggregate demand determination, and so the importance of  $z$  variation. Relative to the other positions, it treated the dependence of output on short rates, for given  $z$ , as extremely weak. The behavior of  $z$ , in turn, is dominated, according to this view, by the risk-premium term  $\zeta$ . The relation between real money balances and other variables is judged loose and unreliable, implying that it is not useful either to think of  $\zeta$  as being dependent on  $m-p$  or to use a money demand function to understand variation in money balances. With the most important asset prices in the IS function effectively disconnected from central bank actions, and with aggregate demand depending weakly if at all on the central bank's interest-rate policy instrument, the scope for monetary policy to control total spending is virtually dismissed in the Radcliffian view.

The two-asset baseline embodied in IS-LM has, therefore, been criticized by three distinct schools, but only one of these, the monetarist school, has claimed that the restrictive asset specification understates the effectiveness of monetary policy. What are the merits of the monetarist critique of IS-LM, in light of the evolution of macroeconomics and empirical evidence over the last quarter-century? A first observation is that several studies have obtained, on quarterly data for countries like the U.S. and the U.K., correctly signed and statistically significant estimates of the interest

elasticity  $b_1$  in the optimizing IS equation (4). In that sense, the two-asset approximation implied by the IS-LM baseline appears reasonable for some purposes, provided that forward-looking behavior of agents is modeled appropriately. But it is a natural extension of the baseline IS equation, and consistent with the maintenance of the optimizing-agents paradigm, to expand the menu of asset prices that matter for aggregate demand determination.

Such an extension, however, would not fully validate the monetarist critique, because it would not necessarily convey on money an enhanced indicator role. A key question, then, is what evidence there is to support the monetarists' position on money as an index of yield variation. Brunner and Meltzer's (1993, p. 81) appeal on this score to the observation that risk premia differ across assets, does not automatically support the monetarist view, because variable interest differentials are consistent with a purely nonmonetary view of risk premia.

More decisive evidence on the monetarist view instead could take two forms. The first is whether real money balances contain information about output not contained in real short-term interest rates. As I discuss in detail elsewhere (Nelson, 2003), standard modern models, of which the optimizing IS-LM specification, in part imply that money should have no predictive power for output, given real interest rates. But real money base growth does have such predictive power—suggesting that money does have value as an index of the variation in yields that drive aggregate demand. This, in turn, is testimony to the empirical importance of a Friedman-style money demand function; and so an example of where modern analysis could benefit from drawing on earlier theory.

The second form of evidence is from direct estimation of money demand functions. Anderson and Rasche (2001) find that the behavior of U.S. money base velocity in the twentieth century is better accounted for by the long-term nominal interest rate than the short-term rate.<sup>27</sup> Taken together with the well-known problems with modeling long-term interest rates as a function of current and expected short rates, a plausible interpretation of their finding is that the long-term rate enters the money demand function in its own right, not just as a proxy for the path of short rates. And, if the estimated money demand relation is a structural relationship, it would imply that changes in the monetary base have implications for the behavior of long-term rates—implications not captured in the expected path of short-term interest rates. The risk premium, in other words, is a function of the real money stock, in line with Friedman and Schwartz's and Brunner and Meltzer's analysis.

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<sup>27</sup> This follows earlier work by Meltzer (1963).

To sum up, the shift from an *ad hoc* to an optimizing version of IS-LM does not make IS-LM analysis completely immune from the criticism that it recognizes too few distinct assets. This criticism has been voiced in different contexts by monetarists, by Tobin, and by “Radcliffian” U.K. Keynesians. These schools have disagreed on the implications of recognizing multiple assets, but the existing empirical evidence appears to support an important claim of the monetarists: the IS-LM framework tends to understate the value of money as an indicator for monetary policy.

## **5. Conclusions**

This paper has discussed criticisms of the IS-LM framework in the macroeconomic literature of the last 40 years, with the emphasis on how the modern optimizing version of IS-LM addresses those criticisms. The current version of IS-LM is consistent with dynamic, stochastic general equilibrium analysis, and so addresses concerns voiced by Tobin, Wallace, and others about the applicability of IS-LM to environments where intertemporal considerations and uncertainty are important. Like best-practice traditional IS-LM analysis, the optimizing IS-LM specification also allows for an endogenously determined price level and for the distinction between nominal and real interest rates. On the issue of asset-market specification, however, the optimizing version of IS-LM may have adopted too restrictive a position. The baseline optimizing IS-LM specification recognizes only two distinct assets, tending to understate the value of money as an indicator for monetary policy. This shortcoming formed an important basis for the monetarist critique of traditional IS-LM. A priority for future work on the optimizing IS-LM framework is to take account of this critique, and recognize the need for more asset yields in both the IS and the money demand function.

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