WHITHER ISLM

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Abstract. ISLM inhibits attention to expectations in macroeconomics, going against the spirit of Keynes's own approach. This can lead to mistaken policy conclusions and to unnecessarily weak responses to classical critiques of Keynesian modeling. A coherent Keynesian approach, accounting for endogenous expectations, implies very strong effects of monetary and fiscal policy and leads to greater attention to the role of the government budget constraint in making the effects of monetary policy conditional on prevailing fiscal responses, and vice versa.

1. Introduction

Keynes considered expectations a central factor in macroeconomic dynamics. Much of his discussion of them treats them as volatile but exogenous ("animal spirits"), but in places he elaborates on the importance of particular types of endogenous expectations. Since the equations he wrote down did not include an explicit role for expectations, the ISLM codification of Keynesian orthodoxy could plausibly ignore them, and did so. This not only distorted Keynes's thinking, it ironically weakened Keynesian orthodoxy in the face of the rational expectations critique. The standard Keynesian position came to be that expectations, or at least endogenous expectations, were not as important as the RE critics made them out to be. This was a substantively

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weak position in itself, and it had the further weakening effect of keeping Keynesian attention away from developing a strong response to Keynes's new classical critics.

The fact is that it is possible to develop general equilibrium models with endogenous expectations and price and wage stickiness that are completely in line with the way Keynes thought about the economy. Such models deliver the Keynesian conclusion that monetary and (under some conditions) fiscal policy have powerful real effects and that there is no automatic tendency of the economy toward optimal behavior in the absence of good monetary and fiscal policy. The models are not subject to some of the standard criticisms of Keynesian models as incomplete or internally inconsistent. But we do not arrive at these models by modifying or modernizing ISLM. They represent a different approach to modeling entirely.

ISLM continues to be used, especially in undergraduate teaching, because sophomores and juniors—and their professors—can understand it and because it claims to give answers to interesting and important questions. But an appealing, teachable, falsehood is still a falsehood. Finding equally teachable simplifications that are not so distorted is not easy, but we need to proceed in that direction.

2. Critique of ISLM and ASAD

The most common intermediate textbook approach to Keynesian modeling has an investment function that depends on an interest rate and output, but not explicitly on expected future values of anything. It is part of an IS sector derived entirely in real terms. This means the IS curve relates the *real* rate of interest to output, while of course in the standard derivation the LM curve relates the *nominal* rate to output. The combined IS and LM curves imply a single number—output or labor—as a solution, reflecting what is known as aggregate demand. Aggregate demand then feeds in to the Phillips Curve, which generates wage and/or price dynamics, without any explicit feedback into the ISLM part of the model. The rational expectations critique of Keynesian modeling is often taken to be focused on the Phillips Curve, and sophisticated textbook modeling often explicitly allows for rational expectations, or at least long-run rational expectations, in the Phillips Curve. It is much less common for textbook modeling to allow for an explicit real/nominal interest rate distinction[1], and still less so for there to be explicit treatment of the role of expectations in forming the real rate.

The set of modeling choices that lead to this standard setup seems hard to justify. If money illusion, lack of foresight, and decision-making inertia are important in macroeconomic dynamics, it seems more likely that they are important in labor markets than in the majority (value-weighted) of investment and savings decisions. One would think therefore that the first place to examine the implications of forward-looking behavior would be in savings and investment decisions, and that "irrational" inertial elements in labor-market behavior might be well worth retaining.

These modeling choices are nonetheless understandable. It is essential to Keynesian reasoning about the business cycle that adjustment of the capital stock is costly, so that a rise in the marginal product of capital can lead to a sustained rise in investment. This implies that the expected growth rate of the relative price of capital goods is an essential determinant of investment. There will be no way to write down the real rate of interest as a function of K, L, and I based on production technology and firm optimization alone. When this fact is augmented by the need to distinguish real from nominal rates, we are confronted with an essentially multivariate rational expectations system. Even today graduate students in economics are often not taught how to handle such systems as part of their core training in macroeconomic theory.

[1]Dornbusch and Fischer (1990) include an appendix discussing a version of ISLM that distinguishes real and nominal rates, but the resulting model, as it does not include other forward-looking aspects of investment and consumption, is ill-behaved.

The prospect of explaining such systems to undergraduates with only a shaky grasp of calculus is daunting.

Besides the fact that the ISLM framework mishandles expectations, there is reason to regret the mental habit of breaking models into IS, LM, and AS sectors. Both for econometric and analytic purposes, the reason for breaking a model into "structural" blocks is that it is useful to consider perturbations in one block while the other blocks hold constant.[2] This may be because we think historical stochastic disturbances in the separate blocks are more or less unrelated, because we contemplate taking policy measures that affect one block but not others, or some mixture of these reasons. In academic exercises we do move around the IS, LM, and AS curves independently. But what is the basis for thinking such exercises useful?

These blocks do not correspond to the behavior of distinct groups of economic agents. In discussing IS, Keynesian modelers do distinguish the behavior of firms, who control production technology, from that of workers, who control labor supply and consumption, and this distinction is clearly justifiable. But the arbitrage condition relating bond interest rates to money holdings that goes in to the LM curve is generated by the behavior of some mixture of firms and workers. What reason is there to think that the disturbances to this block will be distinguishable from those to the IS block? The same goes for AS. Despite their names, the Keynesian AS/AD distinction carries nothing like the microeconomic SS/DD distinction between technological and taste influences on equilibrium. Keynesian "AS" describes price and wage setting behavior, and this behavior involves the same workers and firms that are making investment and consumption decisions and monitoring their real balances.

It is standard to assume that the block distinctions do correspond to components of the economy that can be separately disturbed by monetary and fiscal policy actions.

[2] This is an old point, made precisely by Hurwicz (1962), for example.

Only the IS block contains G and T variables that are thought of as controlled by a fiscal authority, while only the LM block contains M, controlled by a monetary authority. Monetary policy intervention is modeled as a shift in LM, fiscal policy intervention as a shift in IS. A Keynesian model that takes endogenous expectation formation seriously will still contain a block that, in terms of raw variable counts and which variables appear where, will look in these respects like ISLM. Indeed some writers take modern models with forward-looking components and label the components with ISLM terminology. But in models with careful dynamics, these equations are differential or difference equations with forward-looking terms. They cannot be used to produce relationships among current levels of variables that correspond to IS and LM. Furthermore, the absence of M from the IS block depends on ignoring the existence of the government budget constraint as a separate relationship connecting monetary and fiscal variables.

Ideally at this point the paper would go into a discussion of how to get the ideas of Keynesian economics across to a non-technical audience. There are existing approaches to this, and I have some ideas of my own, but it is far from a solved problem.

Instead we proceed directly to laying out a complete Keynesian model with endogenous expectations, observing in what respects it emerges as familiar and unfamiliar.

3. A Coherent Keynesian Model

The actors in this model are a representative consumer-worker-investor, a representative firm, and a government that sets fiscal and monetary policy. The worker saves in the form of bonds and money and receives dividends as equity-holder in the firm. The firm hires workers and invests to maintain or increase its capital stock. It borrows and lends in the same bond market that workers participate in. Investment and consumption goods are not perfect substitutes, so the capital stock does not adjust instantly in response to shifts in the marginal product of capital.

Both firms and workers are dynamic optimizers. The distinction between the Keynesian model as presented here and a classical version of the same model is that both workers and firms consider employment L not to be under their direct control, so that firm and worker first-order conditions (FOC's) with respect to L do not take their places among the model's behavioral equations. Instead there is a Phillips Curve and a Markup Equation. The former makes nominal wages rise when workers feel overworked – measured by when the marginal utility of leisure exceeds the real wage. The latter makes prices rise when firms feel that revenues are not covering costs—measured by when the marginal product of labor falls below the real wage.

A model like this does not have an elaborate story, based on forward-looking optimizing behavior, for its price and wage dynamics. New Keynesian style models do provide such stories. The stories are arguably in disagreement with microeconomic evidence, however. Actual industries have highly skewed distributions of firm sizes, and regular turnover of firms, with entry and exit decisions a key component of competition. None of these elements is present in the microeconomics underlying New Keynesian macroeconomics. Our objective here is to show that the somewhat old-fashioned and somewhat more transparent "disequilibrium" style of modeling can incorporate dynamically optimizing agents and in the end give results for macroeconomic behavior similar to those from New Keynesian models. Both types of model imply strong, quick responses of real variables to nominal disturbances—in particular to monetary policy. In fact, the empirical weakness of these models is that they imply stronger real effects of monetary policy than clearly emerge in the data.

The model of this section includes money illusion in the Phillips Curve. There is no a priori argument that this must be irrational, however, so long as fluctuations in prices are stationary, as is assumed here. The assumption of a real cost to nominal changes in prices, as in New Keynesian models, is a similarly arbitrary introduction of non-neutrality, with no greater a priori justification. Both kinds of assumption would need to be reconsidered if the models containing them were being used to project the effects of large and permanent changes in the inflation rate. It is useful to recognize where we are introducing non-neutrality into a model and to bear in mind the limitations of non-neutrality assumptions. But it was one of Keynes's central insights that in this respect a little ad hockery is not too high a price to pay for maintaining a model's grip on reality.

3.1. **Consumer.** *Optimization problem:*

$$\max_{C,L,V,M,B_C} \int_0^\infty e^{-\beta t} \frac{C_t^{\mu_0} (1 - L_t)^{\mu_1}}{\mu_0 + \mu_1} dt \tag{1}$$

subject to

$$\lambda: \qquad PC^* + \dot{B}_C + \dot{M} + \tau \leq WL + \pi + rB_C \tag{2}$$

$$\psi_C: \qquad C^* \geq C \cdot (1 + \gamma V) \tag{3}$$

$$\psi_V: \qquad V \geq \frac{PC^*}{M} \, . \tag{4}$$

Note that the demand for money arises out of the γV term in (2). This term implies that the budgetary cost of the consumption C that enters utility is blown up by a transactions cost factor $(1 + \gamma V)$ before it enters the budget constraint (as C^*). Larger real balances therefore make possible increased consumption.

FOC's:

$$\partial C: \qquad \frac{\mu_0 U}{C} = (1 + \gamma V)\, \psi_C \tag{5}$$

where U is instantaneous utility, the undiscounted integrand in (1).

$$\partial L: \qquad \frac{\mu_1 U}{1 - L} = W\lambda \tag{6}$$

(Equation above not used directly.)

$$\partial C^*: \quad P\lambda + \frac{P\psi_V}{M} = \psi_C \tag{7}$$

$$\partial B_C: \quad -\dot{\lambda} + \beta\lambda = r\lambda \tag{8}$$

$$\partial M: \quad -\dot{\lambda} + \beta\lambda = \psi_V \frac{PC^*}{M^2} \tag{9}$$

$$\partial V: \quad \gamma C \psi_C = \psi_V \, . \tag{10}$$

3.2. **Firm.** *Optimization problem:*

$$\max_{\pi, I, K, L, C^*, B_F} \int_0^\infty e^{-\beta t} \phi\left(\pi_t\right) dt \tag{11}$$

subject to

$$\zeta: \quad \pi \leq PC^* - WL + \dot{B}_F - rB_F \tag{12}$$

$$\omega: \quad C^* + \left(1 + \xi \frac{I}{K}\right) I \leq AK^\alpha L^{1-\alpha} \tag{13}$$

$$\sigma_K: \quad \dot{K} \leq I - \delta K \tag{14}$$

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FOC's:

$$\partial I: \quad \sigma_K = \left(1 + 2\xi \frac{I}{K}\right) \omega \tag{15}$$

$$\partial K: \quad -\dot{\sigma}_K + (\beta + \delta)\, \sigma_K = \omega \cdot \left(\alpha \cdot A \cdot \left(\frac{K}{L}\right)^{\alpha - 1} + \xi \frac{I^2}{K^2}\right) \tag{16}$$

$$\partial L: \quad \zeta W = \omega \cdot (1 - \alpha) \cdot A \cdot \left(\frac{K}{L}\right)^{\alpha} \tag{17}$$

Equation above not used directly.

$$\partial B_F: \qquad -\frac{\dot{\zeta}}{\zeta} = r - \beta \tag{18}$$

$$\partial C^*: \qquad P\zeta = \omega\ . \tag{19}$$

3.3. **Price and Wage Adjustment.**

$$\text{Phillips Curve:} \qquad \frac{\dot{W}}{W} = \eta_L \frac{\mu_1 U}{(1-L)W\lambda} \tag{20}$$

$$\text{Markup Equation:} \qquad \frac{\dot{P}}{P} = -\eta_C \log\left(\frac{A\left(\frac{K}{L}\right)^{\alpha}\omega}{W\zeta}\right) \tag{21}$$

These equations can only be interpreted as temporary local approximations. Certainly the expected "normal" rate of inflation will change over time if the economy's actual inflation level drifts. This normal level of inflation will tend to become the reference point for price adjustment, shutting off, or at least greatly attenuating, long run effects of changes in the inflation rate on real equilibrium. However, as we have already noted, this caveat applies equally to other, "micro-founded" models of wage and price adjustment. Theories that postulate a cost of adjustment for prices, or that postulate an exogenously determined contract length or mean time between opportunities to adjust price, will not be quantitatively stable if the inflation rate drifts. It is a fact that contract lengths change when the inflation environment changes. Whatever the costs of price adjustment are, institutions will adapt to change those costs if the inflation rate drifts. The question of which type of potentially unstable description of price adjustment is best is empirical, and as yet has no clear answer.

3.4. **Government.** *Constraint:*

$$\frac{\dot{B}_C - \dot{B}_F + \dot{M}}{P} + \tau = r\frac{B_C - B_F}{P} \tag{22}$$

Behavior: Monetary and fiscal policy equations must be specified jointly in a model like this, as was explained in Leeper (1991). Monetary policy can be given the form

$$\dot{r} = -\theta_1 r + \theta_2 \log M + \varepsilon_M \tag{23}$$

and fiscal policy the form

$$\tau = -\phi_0 + \phi_1 \frac{B}{P} + \varepsilon_F \,. \tag{24}$$

This model behaves as Leeper (1991) would suggest: Existence and uniqueness of equilibrium requires a combination of active fiscal with passive monetary policy, or vice versa. Active monetary policy combined with active fiscal policy leads to non-existence, while passive monetary policy combined with passive fiscal policy leads to non-uniqueness. In Leeper's definition, "active" monetary policy increases interest rates with the price level, or else increases them more than one-for-one with the inflation rate. Active fiscal policy commits to a level or path of τ, the real primary surplus, that does not respond strongly to B/P—in particular with a coefficient less than the steady-state real rate (β in this model). Passive monetary policy pegs r or otherwise makes it respond to inflation by too little to make inflation increases raise the real rate of interest. Passive fiscal policy[3] commits to increasing τ with B/P by enough so that the increased interest expense in the budget is more than offset.

3.5. **Can this Model be ISLM'd?** Because it has firms that make an investment decision, consumers who make savings and money-holding decisions, and a government that controls interest rates and deficits, this model has at least the sectoral structure of an ISLM model. And indeed we can derive analogues of the elements of the ISLM model.

[3]Woodford calls such fiscal policies "Ricardian", though the Ricardian equivalence proposition does not rest on policy taking this form.

There is a standard liquidity preference, or money demand, relation in this model, which emerges if we equate the right-hand sides of (8) and (9), then use (7) and (10) to eliminate the Lagrange multipliers. The result is

$$r = \gamma V^2 \,. \tag{25}$$

From (5), (7) and (10) we can get an expression for λP as

$$\lambda P = \frac{D_C U}{(1+\gamma V)^2} \,. \tag{26}$$

In a model where for simplicity the dependence of transactions demand on C (or on any other measure of aggregate activity) were suppressed, the right-hand side of (26) would be just the marginal utility of consumption.

Substituting (26) into (8) gives us the usual forward-looking consumption Euler equation:

$$\frac{-\frac{d}{dt} D_C U}{D_C U} = r - \beta - \frac{\dot{P}}{P} - \frac{2\gamma \dot{V}}{1+\gamma V} \,. \tag{27}$$

The only non-standard (for rational expectations models) element of this equation is the term in V on the right-hand side. This term is important, though, as it implies (after substituting for V using the money demand equation) that there is strong dependence of the rate of growth of $D_C U$ on $\dot{r}$ as well as on r itself.

To derive an investment function, we introduce

$$P_K = 1 + 2\xi \frac{I}{K} \,, \tag{28}$$

the price of capital goods in terms of consumption goods (if they were traded). Then from (15), (16), (18), and (19) we can derive

$$\frac{\alpha A \left(\frac{K}{L}\right)^{\alpha-1} + \xi \frac{I^2}{K^2}}{P_K} = r - \beta - \frac{\dot{P}}{P} - \frac{\dot{P}_K}{P_K} \,. \tag{29}$$

This equation matches the real interest rate in terms of capital goods prices to the marginal product of savings (i.e., of capital measured in consumption goods units).

We have arrived at a pair of equations that characterizes household savings behavior ((27) and (2)), an investment equation, and a money demand equation. Is it useful to think of this as a version of ISLM? There is no harm in observing that there are parallels between this system and ISLM, but the difference between this system and the usual aggregate supply vs. aggregate demand (ASAD) reasoning that emerges from traditional ISLM are great — so great, I would argue, that to label this system "modern ISLM", or the like, is a barrier to understanding. Perhaps equally important, calling a system like this ISLM legitimizes the version of ISLM taught in undergraduate textbooks, as if it was a simplified distillation of this kind of model, which it is not.

There are two crucial characteristics of this system that make an ASAD interpretation of it untenable. The inflation rate as well as the interest rate (or equivalently, real and nominal rates separately) enter the "aggregate demand" portion of the model; and investment depends on the expected rate of growth of real capital goods prices. The wage and price dynamics equations do provide growth rates for W and P as functions of real variables and the price and wage levels, but even holding P and W levels fixed, there is no possibility of solving the "ISLM" sectors of the model for C and L, treating these as determined by "demand", and then reading off $\dot{W}$ and $\dot{P}$ recursively from "aggregate supply" in the form of the Phillips curve and markup equations, (20) and (21). The system is fundamentally simultaneous, and fundamentally forward looking. The price level is predetermined, but the inflation rate is not and appears in both "aggregate demand" and "aggregate supply" portions of the model. As current levels of C and L change, expectations about their future paths necessarily change also, which will affect $\dot{P}_K/P_K$. Thus we cannot even derive aggregate demand as a schedule connecting C and L to the inflation rate. The effects of given changes in the current values of the interest rate or the government's primary surplus can be drastically different according to how persistent they are expected to be.

3.6. **Responses to Policy.** With a "standard" active-money, passive-fiscal policy combination, the response of the economy to a monetary policy expansion takes the form shown in Figures 1 and 2.[4] The policy parameters underlying these responses are $\theta_1 = .2$, $\theta_2 = .01$, $\phi_0 = .4$, $\phi_1 = .06$. An interest rate reduction, initially of about 1 percentage point, produces an instant 18% rise in M, humpshaped responses of wages and prices peaking at about 6% and 2%, respectively, and immediate expansions in employment, consumption and investment. The initial expansion in L is 16%, roughly the same as that in M. With this policy configuration, the model is Ricardian, so that disturbances to the fiscal policy equation affect nothing except the time paths of τ and B/P.

The model also has a well-behaved equilibrium when monetary policy is passive and fiscal policy is active. For this case we set $\theta_2 = 0$, $\phi_0 = -.4$, and $\phi_1 = 0$, with all other parameters in the model the same as for the previous case. The responses are shown in Figures 3 and 4. Here monetary "expansion", while lowering r and raising M as would be expected, produces contractionary effects on prices, wages, and employment. This reflects the fact that, unlike the preceding case, here the fiscal authorities do not "back up" the monetary expansion with a tax decrease. The monetary expansion, by lowering interest rates, lowers the conventional deficit, or increases the surplus, and thereby starts to contract the volume of outstanding government liabilities. This is deflationary. With passive fiscal policy, this effect would be offset by tax cuts as the

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[4]All the responses shown are based on linearization of the model about its steady-state. The calculations were carried out with the matlab program `gensysct.m`, available through the author's web page at `www.princeton.edu/∼csims`. The complete set of parameter values used to generate the responses are shown in the appendix.

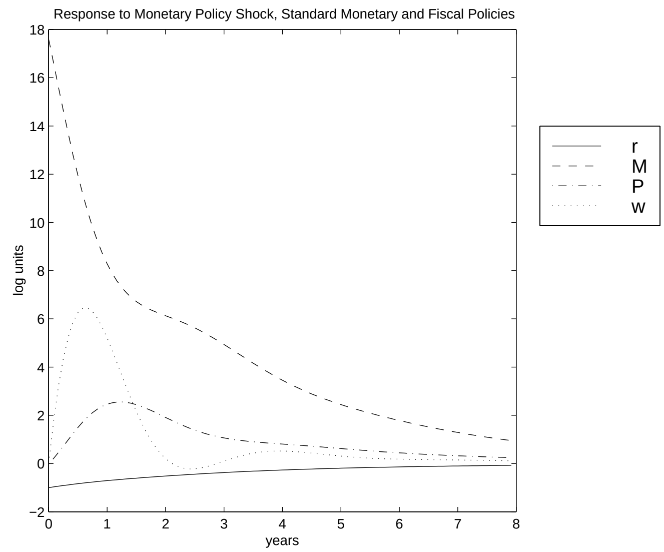

FIGURE 1. Nominal Variables

Note: All variables in log units except r, which is in natural units (not per cent).

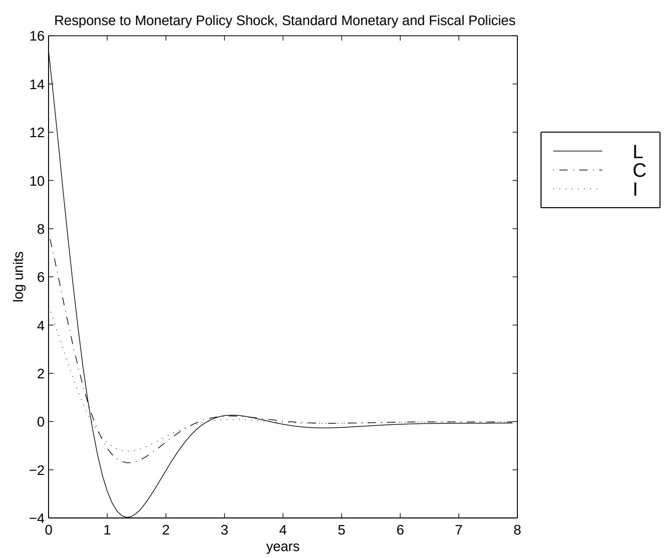

FIGURE 2. Real Variables

Note: All variables in log units except I, which is scaled so that the units are % of steady-state C.

debt declined. Since that does not happen here, the effect of the interest rate decline is contractionary.

That this seems bizarre or counterintuitive to many macro-economists probably reflects in part economists' widespread training in ISLM. That an interest rate increase engineered by the central bank could exacerbate rather than reduce inflation, is commonly recognized in current policy discussions, even though it is not mentioned in most (any?) intermediate macro textbooks. It is particularly likely to occur in economies where the political ability to adjust taxes to public obligations is weak, as in many poorer countries.

With this combination of policy reaction functions, a positive disturbance to the fiscal policy equation has a contractionary effect. The responses are displayed in Figures 5 and 6. Money does decline in reaction to the fiscal contraction, and it is a necessary aspect of the equilibrium that monetary policy "accommodates" fiscal policy in this respect, allowing M to drop to maintain its commitment to a fixed r.

4. Conclusion

- Keynesian reasoning ought to be essentially forward looking and to emphasize expectational factors in savings and investment decisions. Traditional ISLM hides and inhibits development of this aspect of Keynesian modeling.
- ISLM ignores connections between monetary and fiscal policy that are enforced by the government budget constraint. In many policy contexts, this is a major gap.
- It remains to be seen whether there is a way to capture these aspects of Keynesian modeling in a package as neat and non-technical as ISLM, but that should not be an excuse for continuing to make ISLM the core of our teaching and informal policy discussion.

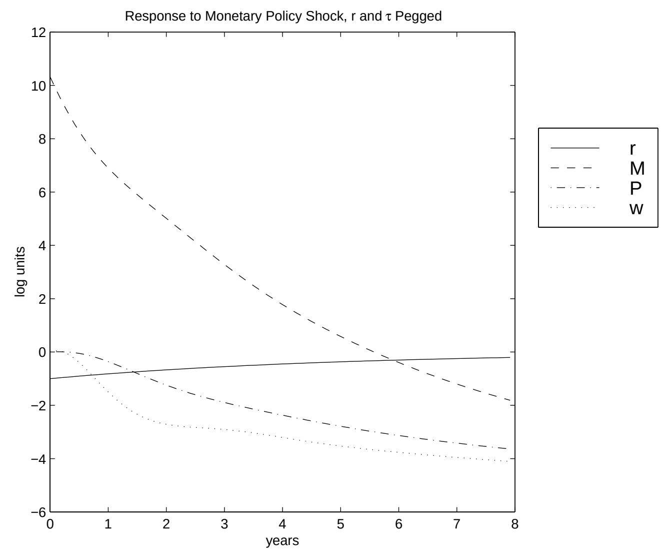

Figure 3. Nominal Variables

Note: All variables in log units except r, which is in natural units (not per cent).

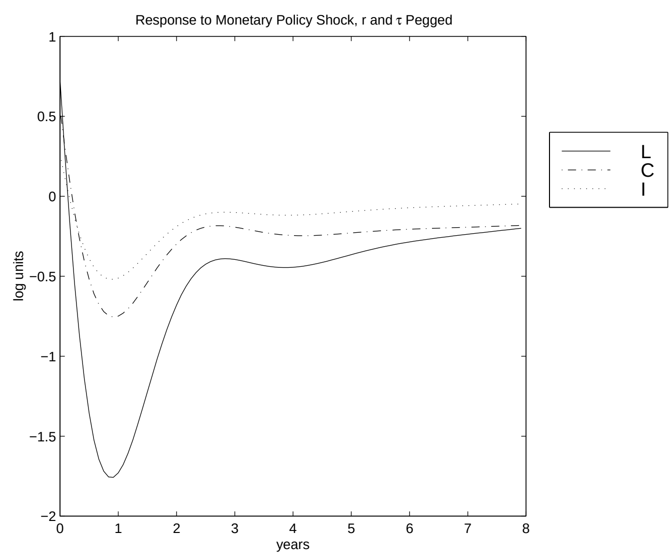

Figure 4. Real Variables

Note: All variables in log units except I, which is scaled so that the units are % of steady-state C

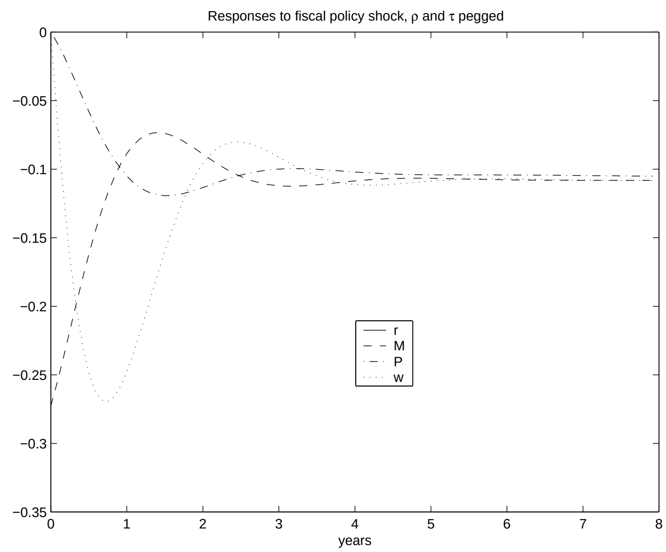

Figure 5. Nominal Variables

Note: All variables in log units except r, which is in natural units (not per cent).

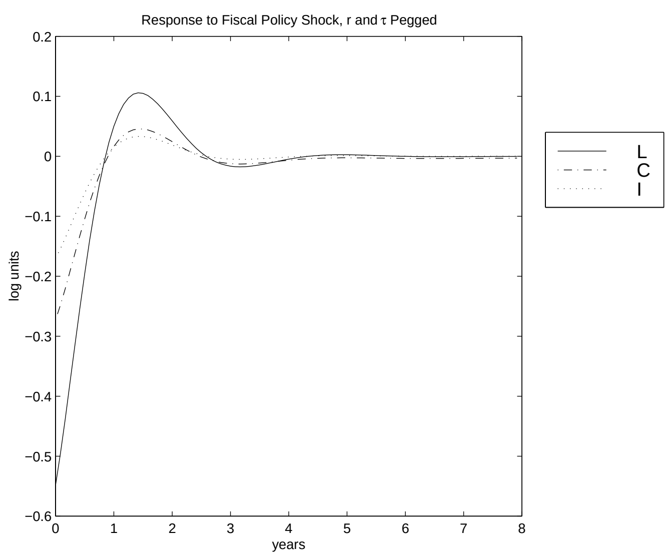

Figure 6. Real Variables

Note: All variables in log units except I, which is scaled so that the units are % of steady-state C

Appendix A. Parameter settings

α: 0.3

β: 0.05

γ: 0.01

δ: 0.07

A: 12.211

ξ: 1.0

μ_0: -0.9

μ_1: -0.3

θ_1: 0.2

θ_2: 0.01/0.0

η_C: 0.5

η_L: 0.5

ϕ_0: 0.4/-0.4

ϕ_1: 0.06/0.0

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