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Commentary

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Lee Ohanian and Alan Stockman's paper presents a careful, lucid survey of a series of technically difficult models of the liquidity effect. I would like first to clarify for the reader (exactly as I had to do for myself) what seem to me to be the key issues and conclusions of their survey and then to offer an assessment (not of their admirable paper, but) of the research program on which it reports.

In years, I am somewhat younger than Alan Stockman and slightly older than Lee Ohanian. In training, however, I am completely antediluvian. I will therefore attempt to clarify the issues using, for the most part, the venerable (and much maligned) IS-LM model. Ohanian and Stockman begin their analysis of the liquidity effect with an IS-LM model. But they treat it as if it were just another model on par with the sequence of micro-foundational models that they explore through the rest of the paper. Actually, the IS-LM model operates on a different plane from the other models. It displays the relationships among aggregates with only the most implicit commitment to particular micro-foundations. Therefore, each of Ohanian and Stockman's models can be seen as attempts to fill in the details that lie behind the IS-LM-AS (aggregate supply) analysis, rather than as substitutes for that analysis. Thus, consider, for example, their first model: the sticky-price model. Cast as a dynamic optimization model for a representative agent, it can be seen as particularizing the IS-LM model: It treats the consumption function as a life-cycle or permanent-income type; the investment function as the most rudimentary neoclassical type; money demand as governed by the quantity theory; and labor supply as derived from utility maximization; and, most important of all, it insists that these functions and the decisions that lie behind them are joint and not independent. But if we keep these restrictions in mind, we can still use the IS-LM model to understand what some of the issues are.

THE LIQUIDITY AND INFLATION EFFECTS

Consider the canonical (classical) IS-LM-AS in Figure 1. The aggregate supply curve is vertical, indicating market clearing in labor and product markets. If the money supply increases by ΔM, the LM curve shifts to the right, and equivalently the AD (aggregate demand) curve shifts upward. At the original price level, p, aggregate demand exceeds aggregate supply. If such a situation is technically infeasible, then prices must rise from p to p', which shifts the LM curve back to its original position, since the location of the LM curve depends on the real money supply, M/p. Interest rates remain unchanged. This is the flexible price case.

Now, if, in the short-run aggregate supply can exceed its long-run level at AS (which might be, as Ohanian and Stockman observe, a result of the assumption of monopolistic competition) and if prices are sticky, say at p, then output rises and interest rates fall from i to i'. This is the liquidity effect: An expansion of money results in a fall in interest rates. It is a fall in the nominal interest rate and, because prices are sticky, in the real interest rate as well.

If increases in the money supply are not simply lump-sum, but are this period's realization of higher growth rates of money associated with increasing rates of inflation, then there is another effect to consider. Investment is a function of ex ante (or anticipated) real rates, not of nominal rates of interest. As anticipated rates of inflation increase, a constant ex ante real interest rate must be represented by higher nominal rates of interest. Thus, as the rate of inflation increases in Figure 2 by $\Delta\dot{p}$, the IS curve must shift vertically by $\Delta\dot{p}$ in order for each level of GNP to correspond to the correct real interest rate.[1]

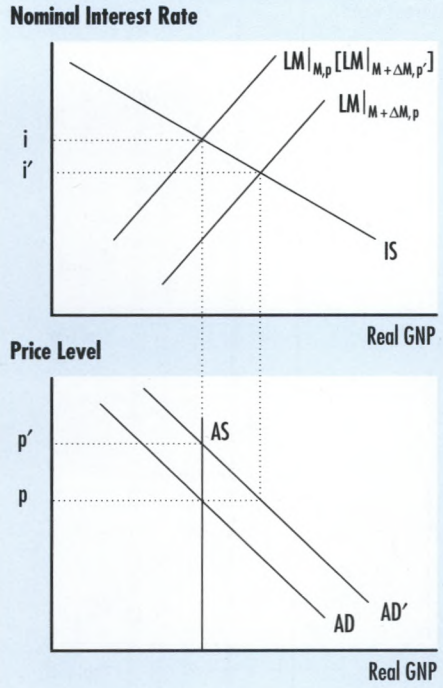
[1] That it is only the IS curve that is shifted by a change in anticipated inflation results from nominal interest rates being plotted on the vertical axis. Were the vertical axis to measure real interest rates instead, then the LM curve would shift and the IS curve would not be directly affected. See Mundell (1971, pp. 18-19).

If prices are sticky at p, then the nominal interest rate rises by less than the increase in inflation to i': Anticipated inflation stimulates output, investment and (short-run) growth.[2] Real rates therefore fall. This is the Mundell-Tobin effect.[3] If, however, prices are flexible, prices rise until aggregate demand equals aggregate supply (from p to p'), shifting the LM curve back and increasing interest rates from i to i''. Here, the nominal interest rate fully reflects the increased rate of inflation. This is the Fisher effect: An increase in inflation corresponds to a one-for-one increase in nominal interest rates.[4]

There can also be a Mundell-Tobin effect with flexible prices. If consumption depends not only on GNP but also on the real value of nominally denominated wealth (bonds or money), then, as in Figure 3, there are two effects: First, the upward shift of the IS curve by the full amount of the anticipated inflation and, second, a partly offsetting downward shift of the IS curve owing to rising prices that reduce real wealth in the consumption function.[5] The LM curve has to shift less far back to restore equality between aggregate demand and supply, so that interest rates rise from i to i', which is less than the increase in inflation. Real rates of interest therefore fall. Because of the full employment assumption, current output is unchanged, but investment rises (and consumption falls) as a result of lower real rates of interest, which increases the rate of GNP growth.

Therefore, we have three effects: a liquidity effect; a Fisher effect; and a Mundell-Tobin effect. These constitute a powerful taxonomy, and—I think—one that is clearer than that used by Ohanian and Stockman. Ohanian and Stockman define a liquidity effect to be the systemic change in an interest rate as the result of a monetary expansion. They distinguish between a real and a nominal liquidity effect. I think that it would better to reserve the term liquidity effect only for those changes in the real rate of interest induced directly by money expansion. The only interesting liquidity effects are real because, without a change in the real rate of interest, there can be no accompanying effect on any other real variables that interest us: GNP; investment; consumption; and employment. What we should recognize is that liquidity effects are often (and depending upon the model, often necessarily) accompanied by the other two effects. The systemic effect is the sum of several partial effects.

Figure 1



THE MODELS

Ohanian and Stockman consider a series of models. How do these effects play out in each of them?

One-Sector, Sticky-Price, Rational-Expectations Model

Some of the key features of this model were already described above. One additional feature is that money is modeled using the cash-in-advance constraint. In the IS-LM model, this means that the LM is vertical at a level of GNP determined by the real supply of money (Figure 4). The increase in money (the shift of LM to the right) has the usual liquidity effect, ceteris paribus, reducing the interest rate. In this model, we can understand that effect as arising from an increase in current consumption because of the relax-

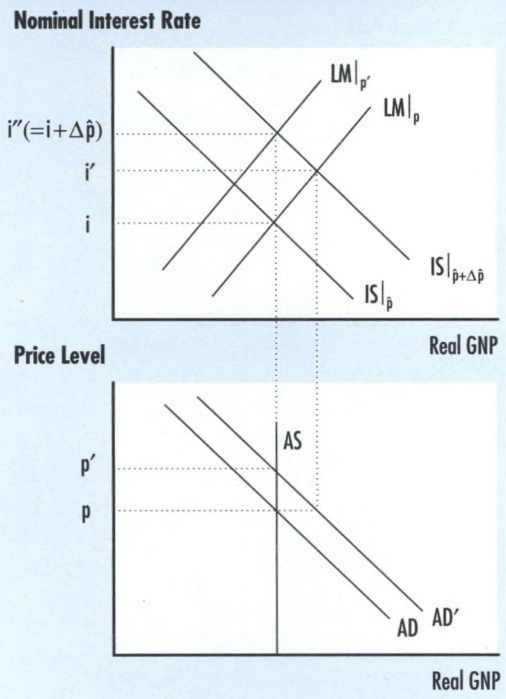
[2] The steady-state rate of growth is not affected.

[3] Tobin (1965) concentrates on the increase in the steady-state capital stock that results from the depression of real interest rates due to anticipated inflation, and the Mundell-Tobin effect is often thought of as a proposition about capital deepening and the accompanying increase in steady-state consumption. The presentation here, however, closely follows Mundell (1971, chapter 2). Mundell focuses on the failure of the Fisher hypothesis through exactly the same mechanism. Mundell's treatment suits the issues raised in the current discussion of the liquidity effect. For an excellent historical discussion of the relationship of the Fisher hypothesis to the Mundell-Tobin effect, see Cottrell (1993).

[4] See Fisher (1930).

[5] The initial shift of the IS curve from $IS|\bar{p},p$ to $IS|\bar{p}+\Delta\bar{p},p$ would, ceteris paribus, result in a shift in aggregate demand from AD to AD′. Since aggregate demand falls with rising prices because of the wealth effect, the final aggregate demand curve is flatter than AD″.

Figure 2



ation of the cash-in-advance constraint. Optimally, agents want to consume more in future periods as well (an implication of the life-cycle/permanent-income hypothesis) and so increase capital accumulation today, lowering the rate of return on capital and the real rate of interest. (Notice that the liquidity effect here has nothing whatsoever to do with the interest elasticity of the demand for money; it works the same whether the LM curve is vertical or simply upward sloping.)[6]

Prices are pre-determined in the current period in this model. They can, however, adjust in the future. Thus, an unexpected increase in money this period is associated with perfectly anticipated inflation. Consequently, the IS curve shifts up at the same time that the LM curve shifts out. There are two cases. In Figure 4a, the liquidity effect outweighs the inflation effect, and both real and nominal interest rates fall. In Figure 4b, the inflation effect outweighs the liquidity effect, and nominal interests rates rise, although since i' is less than i'', real interest rates fall. As Ohanian and Stockman observe, which case one obtains depends on the degree of relative risk aversion (or equivalently on the degree of intertemporal substitution between consumption today and tomorrow). Yet, either way the real rate falls, which is the important point about the liquidity effect. Christiano (1991) usefully distinguishes between a *dominant* liquidity effect (Figure 4a) and a non-dominant liquidity effect (or dominant inflation effecting, as shown in Figure 4b).

Models with Some Sticky Prices

In the model with perfectly flexible prices, there is no anticipated inflation effect, because the price level jumps immediately to bring aggregate supply and demand back into equality. If some prices are flexible this period, fewer prices will have to adjust in future periods. Therefore, while there will be an anticipated inflation effect, it will be smaller than in the model with all prices sticky. It is therefore in this case less likely that the inflation effect will dominate as in Figure 4b, and more likely that both nominal and real interest rates will fall. Ohanian and Stockman's contribution with respect to this model is to show that for reasonable parameterizations only small degrees of price stickiness are enough to produce dominant liquidity effects.

Capital Accumulation and Technology Shocks

The possibility of Hicks-neutral technology shocks and capital accumulation introduces two new effects into the analysis. A technology shock can be represented as in Figure 5 as shifting the AS curve to the right. If prices were perfectly flexible, they would fall immediately (without anticipated inflation) from p to p', shifting the LM curve right and lowering the interest rate to i''. This is the pure *technology-shock effect*. If prices are not perfectly flexible, however, there will be anticipated deflation, and the IS curve will also shift down, so that the final equilibrium interest rate is i''. This fall in the nominal rate is greater than the pure Fisher effect ($i-i'''$) so that the real rate falls.

Unlike a neutral technology shock, capital accumulation, ceteris paribus, not only shifts the AS curve to the right, it also reduces the marginal product of capital,

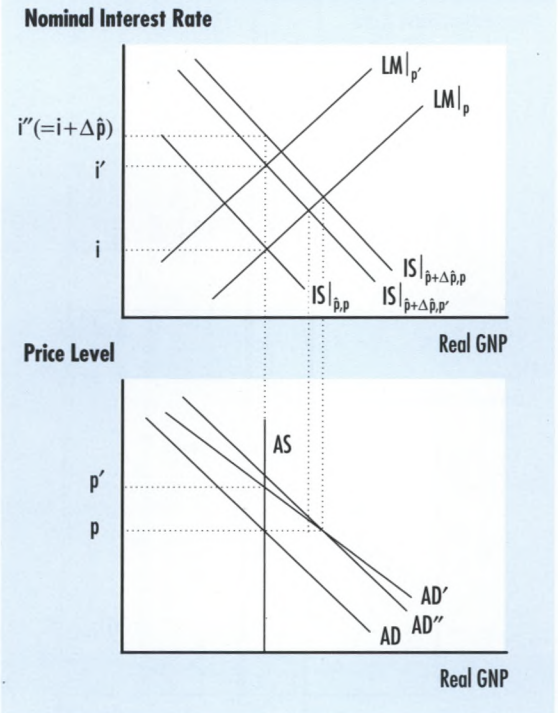
[6] This point deserves emphasis since Ohanian and Stockman note it in a way that suggests mild surprise or novelty and because many economists talk as if an interest-elastic money demand implied a liquidity effect. Although the interest elasticity of money demand affects the *size* of the liquidity effect, it is neither necessary nor sufficient for its existence. It is not necessary because there is a liquidity effect in Figure 4, where the LM curve is vertical. It is not sufficient because there is no liquidity effect in Figure 1, where the LM curve is not vertical, unless we make the additional assumption that prices are sticky.

which can be represented by a downward shift of the IS curve. This would simply magnify the drop in interest rates (real and nominal) in Figure 5. The interesting question, which can be answered in Ohanian and Stockman's parameterized model, but not in this qualitative model, is what the typical time-series behavior of interest rates would be given repetitive shocks to both money and technology in the face of capital accumulation.

The Increasing-Returns Model

The increasing-returns model is much more difficult to cast in an IS-LM-AS framework, although it could no doubt be done with some ingenuity. The model, which I know only from Ohanian and Stockman's sketch, does not appear to have very attractive properties with respect to the empirical observations that motivate Ohanian and Stockman's survey. I therefore omit further consideration of it.

Figure 3



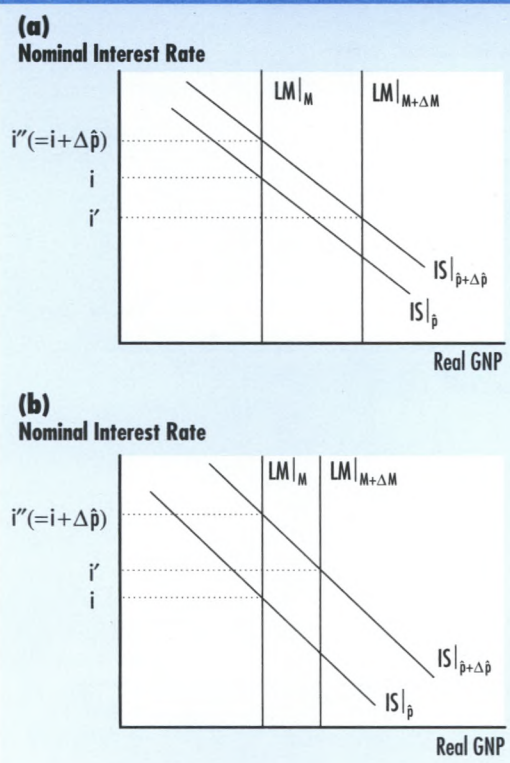
Limited-Participation Models

Ohanian and Stockman consider two models in which asset markets and goods markets are separated so that household decisions with respect to holdings of money and consumption must be made sequentially. The simpler of the two for our purposes is the one associated with Grossman and Weiss, and Rotemberg. This model is less easily rendered in an IS-LM version. Nevertheless, it is not difficult to understand its essence.

I think that it is helpful to consider an even simpler model than Ohanian and Stockman's simplification of Grossman and Weiss' model. I like to think of the Grossman and Weiss model as a kind of Hindu overlapping-generations model. The young in the overlapping-generations model corresponds to Grossman and Weiss' odd agents, and the old to their even agents. Instead of the old dying as they do in a standard overlapping-generations model, they are reincarnated again as young, while the young become old. Unlike Ohanian and Stockman, or Grossman and Weiss, let us first consider the model without a cash-in-advance constraint. That an increase in the money supply that is disproportionately received by one of the generations in an overlapping-generations model results in a less-than-proportional increase in prices is a standard result.[7] The intuition is simple. If the young receive an increase, they appear to have higher wealth at current prices and wish to consume more, now and in the future. If total resources are fixed, then prices rise. This has two effects: It reduces the real value of the increased money available to the young, and it reduces the real value of the money held by the old, reducing their consumption and freeing up resources available to the young. Because extra resources are available to the young, the price level need not rise as far to reduce the real value of the young's holdings of money to a sustainable level. The trick only works because the resources available to the young can be extracted from the old through an inflation tax. As the money becomes more dispersed—as it must when the young spend some of it—both young and old come to hold the new money balances. But since inflation can transfer resources but not create them, even-

[7] See Hoover (1988, chapter 6, section 3).

Figure 4



tually prices must rise in direct proportion to the increased money supply. Thus, even though prices rise less than proportionally this period, further inflation can be anticipated.

Since money is the only asset in my simplified version of this model, the real rate of interest is just the inverse of the rate of inflation, and the nominal rate of interest is zero. The liquidity effect in this model is the fall in the real rate due to increased inflation. Ohanian and Stockman's version of Grossman and Weiss' model is able to retain a non-zero nominal interest rate by imposing a cash-in-advance constraint that applies to two periods instead of just one for those in the asset market, and to one period for those out of the asset market. This means that even if nominal interest rates rise above zero, money will of necessity still be held.

The Lucas model goes one step further in collapsing the two types of agents into a single household with common budgets and consumption, but with sequencing of financial and consumption decisions or differentiated roles for household members. The fundamental idea remains similar.

THE PROSPECTS FOR LIQUIDITY MODELS

The critical question to ask about all of these models is whether they really capture the liquidity effect that we think we see in the world or, for that matter, whether they capture our intuitive understanding of the liquidity effect. I think there is reason to doubt that they do. I see two related problems.

First, in all of these models—including even the basic IS-LM model with a vertical LM curve—the liquidity effect seems to operate through the wrong mechanism. The modus operandi of the liquidity effect in the models surveyed by Ohanian and Stockman is to affect the marginal rates of substitution between consumption in different periods or between consumption and leisure. In most of the models, although an interest rate is determined, interest rates do not matter in the sense that they are not causally important, but rather are priced as redundant assets. Thus, for example, the sticky-price model sets the interest rate according to the following logic: If there were a bond, it would have to yield a real rate of interest equal to the marginal rate of substitution between consumption today and consumption tomorrow, or it would be dominated in rate of return by real capital. In the model, that logic is perfectly correct; it picks out the correct shadow price. My concern, however, is precisely that this is a *shadow* price of a *shadow* asset. Bonds do not do anything important in the model; they are dispensable—a fifth wheel for the economic car. Yet, normally, we think the liquidity effect is important because monetary policy affects interest rates and interest rates are *causally* effective in altering consumption and, more particularly, investment decisions.

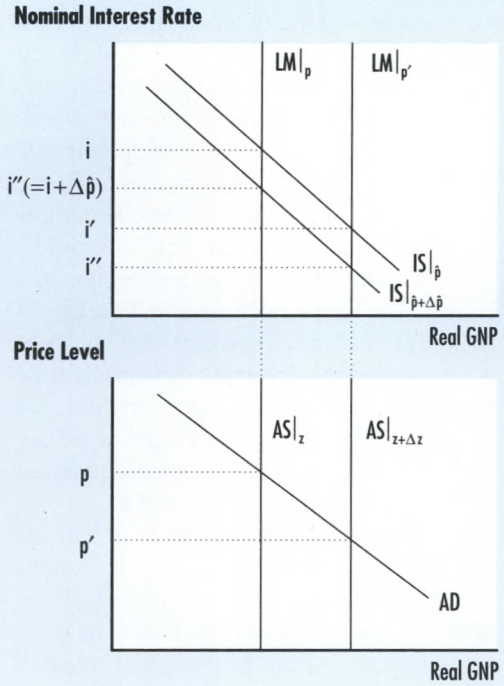
These models miss this feature for two reasons. First, because they are general-equilibrium models in which all the endogenous variables are determined simultaneously, they cannot adequately model the causal efficacy of interest rates. Causes operate in particular directions, and directionality requires recursive rather than simultaneous structure. The second reason that these models miss the causal efficacy of interest

rates is that there is no mechanism for interest rates to be determined other than through the shadow prices associated with consumption, leisure and saving choices. The financial sectors in these models are simply not rich enough. Partly this is a result of the models assuming representative agents. Robinson Crusoe does not need a financial system. The point is not that there is something wrong in principle with general-equilibrium models. Rather, it is that a model of the liquidity effect should have important financial markets. Models in which the same equilibria are supported whether or not bonds are present appear to miss the crucial point.[8]

Actually, Grossman and Weiss' model is not technically a representative-agent model if that is taken to mean a single-agent model, but it is close enough to make no difference for my point. Similarly, it is true of all the limited-participation models that bonds have a non-redundant function. Their function, however, is an artifact of the cash-in-advance constraint, about which I shall have more to say presently.

It might be useful to compare the understanding of interest rate determination in this model with that of John Maynard Keynes in *The General Theory*.[9] Keynes assumed that the economy was populated by heterogeneous people with a diversity of opinions about what normal interest rates were. At current rates, those who feared capital losses would hold money (which for Keynes included Treasury bills and other short-term, interest-bearing assets) and those who hoped for capital gains would hold bonds. The market interest rate was determined as the point at which those hopes and fears were balanced. An injection of money lowered interest rates because a lower rate increased the proportion of the population who feared capital loss and therefore increased their willingness to hold the new money. Investors in real capital then looked to the market rate as part of their process of evaluating the desirability of a new investment. I am not arguing that Keynes' analysis is necessarily correct, but it does seem better than the representative-agent models at capturing the spirit of the liquidity effect: The financial market matters fundamentally and interest rates are causally efficacious. Two further points: Keynes highlights the importance of the term structure, because he distinguishes between short (or money) rates of interest and long-term rates of interest and, at the same time, he raises the question of what to count as money.

Figure 5



What to count as money raises the second major problem with all of the models in Ohanian and Stockman's survey: They rely on the cash-in-advance constraint. Money, therefore, is whatever asset is a direct constraint on current expenditure. The cash-in-advance constraint is, however, a lousy way to model money, mainly because it is not clear that any asset serves uniquely to limit current expenditure. For very few purchases is cash literally necessary in advance of purchase: Coins in vending machines are one of the few obvious examples. For any number of other purchases, cash may be preferred, for example, because of lower transactions costs or anonymity. Reflection on the trends in transactions technology, however, suggests that cash is becoming less and less essential; credit cards do for almost everything. And,

[8] McCallum (1983) makes a related point about money. In an acceptable monetary model, the existence of money should alter the set of possible real outcomes for the economy.

[9] See Keynes (1936, chapter 13).

although credit card accounts must be settled, ultimately through the transfer of central bank reserves between banks, the settlement is not *in advance* but *in arrears*. And this is not just the trend of the future; it is for large parts of the economy the established practice from ancient times. Businesses operate on trade credit. My grandparents, who ran a rural grocery in Georgia, extended credit to the inhabitants of Chattanooga Valley and were paid when their customers became more liquid. The amusing chapter in Thackery's *Vanity Fair* on "How to Live on Nothing a Year" is premised on the practice of 19th-century English merchants of extending credit payable on "quarter days." A good model of money is elusive, but the cash-in-advance constraint is a weak reed on which to build it.

So where does that leave us? Ohanian and Stockman's efforts mean that we know a good deal more about a particular research program, but I am afraid what they have convinced me is that the particular research program—representative-agent, cash-in-advance models—is a dead end and that we still are a long way from understanding the liquidity effect.

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