

Hannsgen, Greg

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## Working Paper No. 384

### **Minsky's Acceleration Channel and the Role of Money**

by

[Greg Hannsgen](#)

The Levy Economics Institute of Bard College

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Address for correspondence:

G. Hannsgen

The Levy Economics Institute of Bard College

Blithewood

Annandale-on-Hudson, N.Y. 12504-5000 U.S.A.

Phone: (845) 758-7721

email: [hannsgen@levy.org](mailto:hannsgen@levy.org)

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## **1. INTRODUCTION**

Fifteen to twenty years after the endogenous supply of money became a cornerstone of post-Keynesian economics (Moore 1979, 1988a, 1988b; Rousseas, 1986; Wray 1990; Kaldor 1970, 1985), the ways in which monetary policy affects the economy are not yet widely agreed upon by heterodox economists (see, for example, Rogers 1989; Davidson 2002, ch. 7). This issue has taken on a new urgency as efforts to stimulate the economy through monetary policy are failing in Japan and having little effect in the United States (Belson 2003).

In the simplest version of the post-Keynesian view, banks are price setters (or rather, interest rate setters) and quantity takers; that is, they are free to set the interest rate at which they

provide loans, but have no control over the volume of their lending. Hence, most post-Keynesian innovators of monetary endogeneity attribute the effects of monetary conditions almost entirely to the level of the central bank-determined interest rate, which is marked up by commercial banks to obtain an appropriate lending rate. Changes in the quantity of money are not an independent causal force driving economic activity. Instead, the stock of money spontaneously adjusts as needed to provide all loans desired by creditworthy agents (Moore 1988a; 1988b).<sup>1</sup> Interest rates, in this view, affect the economy through their impact on interest-sensitive expenditures. Horizontalists--those who argue that the supply curve of money is flat--are particularly adamant about this point.

However, the view that interest rate changes move the economy along a downward-sloping demand curve for capital goods and consumer durables does not comport with other Keynesian and heterodox beliefs. These beliefs were strongly expressed in one of the very documents that is most associated in the English-speaking world with endogenous money. The Radcliffe Committee's deliberations (Committee on the Working of the Monetary System 1960, 76-105, 108-116, 129, 146-152, 157-58, 159-168) cast doubt on the size of the impact of interest rates on aggregate spending. Careful empirical studies supported the view of these Radcliffe scholars (Tinbergen 1938; Meyer and Kuh 1957). These and many similar arguments have attracted many Keynesian and new Keynesian adherents in the present day (Chirinko, Fazzari, and Meyer 1999; Arestis and Sawyer 2002). Of course, few if any of the Radcliffe memoranda denied that extremely high interest rates could bring some bouts of inflation to an end by inducing recessions, nor would present-day monetary skeptics.<sup>2</sup>

More recently, it has been argued that the Cambridge capital critique has undermined the usual justification for the monotonic relationship between the amount of capital and its rate of return, which forms the basis for many accounts of monetary non-neutrality (Garegnani 1983; McKenna and Zannoni 1990; Rogers 1989). In this view, the collapse of the neoclassical supply-demand theory of distribution leaves the macroeconomic "investment function" without any logical foundations. Some economists argue that it is just as well that this function be rejected anyway, as it implies the existence of a full-employment rate of interest, a dangerous notion (Garegnani 1983), since many economists believe it will automatically be attained without policy intervention via some "long-run" adjustment mechanism, such as the so-called "Keynes effect."

These considerations have led some post-Keynesians, circuitists, and neo-Ricardians to turn to the distributional role of the interest rate as an explanation for its effect on real activity (Sraffa [1960] 1975; Pivetti 2001, 114-115). In this view, the interest rate set by the central bank determines the rate of profit. Then, owing to the inverse relationship between the rate of profit and the real wage in the neo-Ricardian model, tight monetary policy tilts the income distribution toward firms and wealthy individuals. Clearly, such distributional effects could alter both the composition and volume of output. However, the magnitude and direction of this effect are somewhat ambiguous, so it may not fully account for the fact that monetary tightenings have been regularly followed by recessions since World War II (Romer and Romer 1989; Christiano, Eichenbaum and Evans 1996, 19-23; Leeper, Sims and Zha 1996, 12).

Is there any other way money might "matter," then, even when its quantity is endogenous? (see Arestis and Sawyer 2002, 2003a, 2003b) Many post-Keynesians of all stripes now follow Keynes's 1937 approach by allowing for a shortage of money (or finance) to constrain firms and consumers, perhaps when the monetary authorities refuse to accommodate money demand, when creditworthiness is in question, or in some other situation or combination of situations (for example, Davidson 2002, Ch. 7; Wolfson 1996). This acknowledgment seems intuitively sensible and consistent with survey evidence that bankers sometimes willfully tighten their lending standards. However, it re-introduces the notion that the quantity of money is partly determined by the central bank or commercial banks. Horizontalists are somewhat reluctant to concede this point to their critics, probably because it attenuates distinctions between heterodox and orthodox monetary theories and complicates the task of building models.

This paper represents an effort to establish a role for money while satisfying those who hold that the supply of money is completely endogenous--that is, loosely speaking, that the banking system is fully accommodative--and that the usual account of the "monetary transmission mechanism" is subject to fatal objections. It uses Hyman Minsky's financial fragility hypothesis (1986) to account for the effects of monetary policy, especially the instability of the economy at full employment. In the interpretation of Minsky's theory presented here, abrupt *changes* in, rather than only high *levels* of, the interest rate can precipitate financial crises.

Section 2 describes Minsky's financial theory of the business cycle, recounting some alleged flaws in the theory, and outlining a possible response to Minsky's critics. The next section formalizes this response and analyzes the properties of the solution and show how they depend upon the relative strength of two different effects. Section 4 tests the model with using vector autoregression (VAR) techniques. Section 5 concludes and considers policy implications.

## **2. MINSKY AND HIS CRITICISM**

Hyman Minsky tried to combine a number of money supply and money demand considerations in his complex theory. In his famous two-price diagram (1986, 191), he demonstrated how investment could be determined by the interaction of profit expectations, interest rates, liquidity preference, the production costs of capital goods, the rate of cash flow, and borrowers' and lenders' risk. Higher interest rates were only one part of a very complex model, but they would affect the quantity of investment in two ways: (1) by raising the costs of financing the production of capital goods; and (2) by lowering the present discounted values of the income streams to be generated once those capital goods are put to use.

The two-price diagram can be usefully distinguished from Minsky's *dynamic* theory of monetary non-neutrality (1986, Ch. 9, especially 214-218). The latter can be thought of as a theory of endogenous changes in the givens underlying the diagrammatic exposition, such as interest rates and the degree of liquidity preference. Changes in the interest rate are generated endogenously in this system by the interaction of the demand and supply of money. As the

economy approaches a cyclical peak, increasing amounts of money are demanded, and the money demand curve moves upward along the corresponding supply curve. Interest rates then rise. (Of course, the stability and upward slope of the supply curve are not accepted by all economists, a point discussed elsewhere in this paper.) The financial position of firms becomes more precarious, because the present discounted values of anticipated future quasi-rents from capital goods and other long-lived assets fall relative to interest costs. Firms at first ignore these signs of trouble, and, carried along on a wave of optimism, build ever more leveraged and illiquid positions. At some point, this unsustainable trend suddenly and dramatically comes to an end, possibly punctuated with a financial crisis and a recession. Thus, monetary factors could contribute to a cycle of boom and bust, which could be dampened only through government intervention.

This cyclical story has the property that Lerner called the "instability of stability." A "full-employment equilibrium" does not exist. By the time full employment is reached, borrowers are already overextended, setting the stage for a debacle, which in turn sows the seeds of a new expansion.

Minsky's theory has been subjected to many of the criticisms described above of theories that rely upon a less than perfectly elastic supply of money and a downward-sloping relationship between investment and the interest rate: First, because the money supply curve is horizontal, the critics say, changes in the interest rate cannot be determined endogenously and do not move in any systematic fashion over the cycle. For example, interest rates would not necessarily rise as the economy reached a peak. Thus Minsky's story could not account for cyclical phenomena (Rochon 2001). This view is inconsistent with the American post-War experience, which shows that rates are somewhat pro-cyclical (Wolfson 1994), but comports well with some evidence from other developed countries and other eras. This is, of course, the familiar argument raised by the horizontalists.

A second objection to Minsky's theory, raised by Lavoie (1997), Lavoie and Seccareccia (2001), and others who identify with the horizontalist cause, is that leverage ratios and other measures of balance sheet health need not and do not tend to worsen during an economic expansion. Whether leverage ratios rise matters for two reasons. Most obviously, in making his claim that a full employment economy always gives way to an unsustainable boom, Minsky relies directly upon the notion that fragility inevitably develops in the course of the business cycle. Second, Minsky's theory invokes the relationship between the level of risk in the economy and the markup on bank loan rates.

Lavoie and Seccareccia (*op. cit.*) question this key point, which will be taken up again later in this paper, by arguing that while an *individual* firm will no doubt become leveraged if that firm borrows more money, an increase in debt-financed spending *throughout the economy* may improve profitability sufficiently to keep debt-equity ratios from rising. And if leverage did not increase, there might not be any reason for banks to raise interest rates. Lavoie dubs this self-perpetuating cycle the "paradox of debt."

Third, the critics of Minsky's could cite problems uncovered during the course of the Cambridge capital debate as another indictment of Minsky's theory, since the latter relies on an inverse relationship between the quantity of investment and its rate of return, though they have not emphasized this point. Joan Robinson felt that the Cambridge critiques did not apply to Minsky's theory (1983); McKenna and Zannoni (1990) make the same point, citing Minsky's use of Kaleckian principle of increasing risk rather than marginal productivity theory.

Thus, Minsky's theory fails as an account of the business cycle, according to its critics, because: first, it is inconsistent with a horizontal supply curve of money; second, its claim that balance sheets deteriorate in economic upswings is logically flawed and inconsistent with historical experience; and possibly third, it suffers from the same defects as the neoclassical theory of capital. This paper will not argue in favor or against any of these arguments, but will instead sidestep such debates by presenting an interpretation of Minsky's theory that omits those elements that some find objectionable.

To counter the first of these arguments, an adherent of Minsky's views could partially abandon claims about the slope of money supply curve by presenting them as limited to, but valid for, a certain historical and institutional context (Hannsgen 2002; Essay One). Thus, conceding a point to Lavoie and Seccareccia, one can admit that there is no immutable "law of supply," dictating that interest rates increase during the course of an expansion but still argue that they did so during a certain historical period in the United States. Specifically, after the Fed-Treasury Accord of 1951, the Fed attempted to quell incipient inflationary pressures during booms by tightening monetary policy. Because of this policy regime, and not due to a universal law of upward-sloping money supply curves, interest rates have tended to rise late in expansions. In turn, rising rates have eroded the financial strength of firms.

There is a certain pragmatic payoff to viewing Minsky's theory in this way. Once it is recognized that the cycle of financial boom and bust is the product of a specific form of macroeconomic policy rather than a natural law, we are presented with the possibility of alleviating instability by making changes in the activities of the monetary authorities.

There are grounds for the claim that Minsky himself favored this line of argument

These three near financial crises [of 1966, 1970, and 1974-1975] were triggered when Federal Reserve operations, undertaken in an effort to curb inflation, led to a run-up of interest rates ... Since 1974-75 there have been two additional episodes of financial trauma: in 1979-80 and in 1982-83. Both followed an exercise by the Federal Reserve to curb inflation. Clearly, in the financial environment that has ruled since 1966, traditional monetary restraint efforts by the Federal Reserve lead to threatened financial breakdowns as well as unemployment and loss of output. (Minsky 1986, 18)

Here, Minsky sets aside his supply-demand theory of interest rates in favor of a

policy-determined rate. The economy falls victim to rising interest rates, but these are produced by Fed actions, and not the interaction of rising demand and an upward-sloping supply curve. Thus, at least in this passage, Minsky's theory of investment is clearly meant as a critique of the Fed's strategy for fighting inflation.

This interpretation would be consistent with the observation that interest rates are not procyclical in some economies (those that use monetary policy differently). As we shall see, it would offer an account of financial stresses on corporations that is independent of less tangible notions of investor and banker psychology. It would allow us to adopt Minsky's appealing account of the cycle without committing us to implausible law-like generalizations.

In addition to the qualification of claims about the slope of the money supply curve, Minsky's supporters should point out that Minsky did not argue that leverage always increased during an economic upswing, nor did his theory of the cycle depend upon the existence of such a relationship. Minsky (1986) acknowledged the existence of feedback from higher profits to lower leverage (the "paradox of debt"). In a boom,

Endogenous increases in money and liquid assets raise the price of capital assets relative to money and current output prices. This increases the difference between capital-asset and investment-good prices. In a robust financial structure, the supply of short-term financing responds to demand, so that investment will rise, increasing the yield of the existing stock of capital assets. Thus, not only does the price of a capital asset for a given set of quasi-rents increase, but on the average the quasi-rents increase as well. This means that the internal financing through retained earnings is greater than anticipated, and the push toward a greater use of short-term debt in liability structures is frustrated. The rise in profits and in internal funds available for the financing of investment is another reason why it takes time for a robust financial structure to be transformed into a fragile structure (212-213).<sup>3</sup>

It is thus clear that Minsky did not mean to argue that leverage and interest rates increase throughout an expansion (a point sometimes conceded by his critics). Rather, leverage might initially fall, as rising demand generated greater cash flow, leading to further expansion and yet more cash flow, and so on. It is only later that "the successful functioning of an economy within an initially robust financial structure will lead to a structure that becomes more fragile as time elapses" (213). This account is in no way inconsistent with any other aspects of Minsky's theory.

This paper pursues these two strategies--making the interest rate a function of policy only and avoiding dubious assumptions about the dynamics of leverage ratios--as a way of addressing the main criticisms to which Minsky's model (and other theories of monetary nonneutrality) have been subjected, while retaining its essential features. Moreover, the model will not involve the marginal productivity of capital, another sticking point for some scholars. What follows draws upon certain ideas in Minsky's work to construct a *dynamic* theory of the effects of monetary policy, resting on the role of debt contracts written in nominal terms. This paper

attempts to show that one can be a Minskyan and simultaneously believe that (a) the money supply is completely endogenous; (b) the interest rate is policy-determined; (c) the Cambridge critiques are valid; and (d) a boom can to some extent "provide its own financing" and avoid the perils of rising indebtedness by generating strong cash flows.

### 3. THE MODEL

Minsky argued that rising interest rates discourage investment because of their effect on the balance sheets of financial and nonfinancial firms. The author will explain this effect below and call it the "delta-R" or "acceleration" effect to distinguish it from the influence of high interest rate levels.<sup>4</sup> This theory is introduced by formulating a model in which investment depends upon the first difference of the interest rate. If Minsky's theory is correct, one would expect that such a model would be unstable (have a tendency to crash), at least in the presence of counter-inflationary monetary policy. The solution of the model shows that unstable paths are indeed possible for some values of the parameters. Specifically, if the parameter representing the sensitivity of monetary policy to the inflation rate is relatively high, the model becomes unstable. Also, the model can always be made unstable if the delta-R effect is assumed to be sufficiently strong. Moreover, these two destabilizing factors work more strongly in combination than singly.

Why does Minsky believe that *changes* in interest rates are important? He notes that:

One cause of the observed instability, not only of the past decade and a half but of the past century and a half, lies in the financing needs of industrial and industrializing economies. External or bankers' finance is no longer needed solely or even mainly to finance commerce and inventories; investment in an ownership of capital assets with long lives also requires external finance. This means that a lack of synchronization between contractual payments on debts and receipts from operations can be built into the banker-business relation as positions in long-lived assets are financed by short-term liabilities (1986, p. 199).

This "lack of synchronization" was important in situations in which a large number of firms had cash inflows (returns from long-lived, illiquid assets) that were fixed in nominal terms and could not simply raise prices to pay for rising short-term debt service costs. Two examples cited by Minsky were the REIT bankruptcies of 1970 and the savings and loan crisis of the early 1980s. In the latter case, which may be the more familiar to readers, savings and loans were under competitive pressure from money-market mutual funds and other intermediaries to pay higher interest rates to their depositors, while their income from mortgages was fixed over the long term.

The use of "mismatched" maturities, as described in Minsky's statement, is an instance of what Minsky calls "speculative finance," in which corporations take out short-term loans or banks accept deposits, intending to pay them off with freshly borrowed funds, because the assets being financed are longer-lived and may not even begin to generate revenues until some future

date. (Firms need not do this if the payoff from an investment is received at the same time that the loan must be repaid, that is, that there is no maturity mismatch between assets and liabilities.)

Minsky believed that speculative finance could endogenously emerge after a period of more conservative, or "hedge" finance and would often evolve into "Ponzi" finance, the use of borrowed money to make interest payments in addition to payments on the principal. Agents who engaged in speculative or Ponzi finance, Minsky pointed out, were vulnerable to changes in the short-term rates if they borrowed at a variable interest rate or later needed to refinance (Minsky 1986, 208). In an environment of rising short-term interest rates, ongoing finance costs for investment projects rise relative to revenue streams that are either fixed in nominal terms or that will not be realized until some future date. Firms might experience "present value reversals," in which once-promising investments began to lose money (220). As a result, investment projects would be deferred or abandoned, and the entire economy could be destabilized.

The instability of a financial regime heavily weighted by speculative and Ponzi finance is due to the impact of *changing* interest rates that develop as an investment boom matures (214, emphasis added).

Bear in mind that it is *rising* interest rates, rather than *high* rates per se, that do the mischief in Minsky's view. A high and stable *level* of interest rates might have an effect on the economy, but it would not cause the problem highlighted here, because high rates would presumably be taken into account if they were already present when an investment was initiated. A firm would be much less likely to take on a project if interest rate costs were prohibitive from the outset. Thus, cash-flow problems and the widespread embarrassment of debtors would be less likely to ensue. For example, if interest rates on deposits were already 20 percent in the early and mid-1970s, savings and loans would have simply charged even more than 20 percent for their mortgage loans, and might not have gone bankrupt in the 1980s as long as Paul Volcker did not raise their interest costs any further. A *reversal* (from positive to negative) of the present value of a project cannot occur if future revenue and cost streams and the interest rates used to discount those streams do not change. It may be worthwhile to note in passing that *decreases* in interest rates can provide cash windfalls to homeowners, a phenomenon much in evidence during the boom of the late 90s.

There is a great deal of psychological evidence that people are at least as concerned with changes in variables as levels:

An essential feature of the present theory is that the carriers of value are changes in wealth or welfare, rather than final states. This assumption is compatible with basic principles of perception and judgment. Our perceptual apparatus is attuned to the evaluation of changes or differences rather than to evaluations of absolute magnitudes. When we respond to attributes such as brightness, loudness, or temperature, the past and present context of experience defines an adaptation level,

or reference point, and stimuli are perceived in relation to this reference point. Thus, an object at a given temperature may be experienced as hot or cold to the touch depending on the temperature to which one has adapted. The same principle applies to non-sensory attributes such as health, prestige, and wealth. The same level of wealth, for example, may imply abject poverty for one person and great riches for another—depending on their current assets (Kahneman and Tversky 1979, 277).

To the extent that investment depends upon the *perceptions* of executives and stockholders, Kahneman and Tversky's theory would suggest that their reaction to an upward trend in interest rates might go beyond what was dictated by balance sheets and other fundamentals.

In what follows, Latin letters indicate variables and their subscripts indicate time. Capital letters with overbars represent particular constant values of various variables. Greek letters are positive parameters.

The aggregate demand function is

$$Y_t = -\delta(R_t - R_{t-1}) + \varepsilon Y_{t-1} + \phi \quad (1)$$

where  $R$  is the interest rate and  $Y$  is GDP. The first term is used to capture the delta- $R$  effect. The second term can be thought of an adjustment term. Epsilon is assumed to be between zero and unity. The larger epsilon is, the more slowly the adjustment process moves the economy toward equilibrium. The impact of this term can be thought of as a kind of inertia that tends to hold  $Y$  in place once it departs from its equilibrium value. One can see this easily by considering what the dynamics would be if the first term were omitted. The term is meant to capture three effects: (1) the expectations and animal spirits of entrepreneurs are influenced by sales and capital utilization in the previous period; and (2) lagged output affects the cash flow of the firm; and (3) for well-known reasons, consumption is partly driven by past income. All of these factors tend to cause a persistence of boom or bust conditions.

The first reason begins with the observation that capitalist firms generally operate with excess capacity. They may do so in order to be prepared for unexpected increases in the demand for their products. Companies may also want to maintain a credible threat to attack potential new industry entrants by flooding the market with cheap goods (Steindl [1952] 1976; Courvisanos 1996). Thus, there may be some optimal level of excess capacity above zero. Firms may seek to adjust their capacity when they are above or below this target by disinvesting or investing in capital goods.

The second reason for the inclusion of a lagged output variable is that it may be a good proxy for cash flow or profits, which themselves would be expected to influence investment decisions (Tinbergen 1938; Kalecki 1969; Fazzari, Hubbard and Peterson 1988). Firms may be constrained by a lack of funds or prohibitive marginal financing costs, given informational imperfections in the credit market. In that case, increased sales (and the resulting cash flows) may permit companies to undertake investments that could otherwise not be financed. The

favorable effect of increased output in the recent past on the profit expectations of executives and investors and hence on purchases of capital goods seems reasonable also.

It is these types of arguments that Lavoie and Seccareccia (2001) may have in mind when they argue that a boom may be self-sustaining, avoiding the problem of increasing debt loads, due to the reciprocal effects of rising profits and increasing aggregate demand. They cite both Kalecki and Steindl in their critique of Minsky (2001, 84). Incorporating these effects into the model enable one to determine if they can offset the delta-R effect, as the critics claim.

The model uses the following central bank reaction function

$$R_t = \theta(P_{t-1} - \bar{P}) + \eta \quad (2)$$

where P is the inflation rate. This function indicates that the central bank increases interest rates proportionately as inflation rises. The equation is meant to be suggestive of inflation targeting or a "Taylor rule."<sup>5</sup> It is consistent with horizontalist notions (those of Lavoie, Moore, and others) that interest rates are an exogenous variable determined by the central bank. It also allows the central bank to change interest rates in response to developments in the economy, rather than pegging the rate over the long term. These central bank responses are emphasized by the critics of horizontalism. The key point about (2) is that it does not involve an upward-sloping supply curve justified by increasing liquidity preference of commercial banks, deteriorating balance sheets, or any of the other rationales for the imperfect elasticity of the money supply curve. To the extent that interest rates rise in a boom, they do so as a result of a policy response by the central bank.

The inflation equation is a mixture of conventional and unorthodox elements.

$$P_t = \lambda R_{t-1} + \beta(Y_{t-1} - \bar{Y}) + P_t^* + \gamma \quad (3)$$

The first term, a multiple of the interest rate, suggests that firms are able to pass along some of their borrowing costs to consumers. This is what is known in the United States as the "Wright Patman effect," after a congressman who argued that using tight money to reduce inflation was tantamount to "throwing gasoline on fire"(quoted in Barth and Ramey 2001, 199). Some empirical evidence has lately been adduced to support this old theory (Barth and Ramey 2001)

Alternatively, positing a conflicting claims theory of inflation (Rowthorn 1977), interest rates could determine the share of output garnered by rentiers. Increases in that share could lead to an effort by workers to regain their own share by bargaining for higher wages (Lima and Meirelles 2001). Having granted wage demands, firms would try to maintain their target rates of profit by raising prices. In yet a third, Sraffian, model, excessive interest rates can lead to an explosive solution, converging on a steady rate of inflation of all prices (Podkaminer 1998).<sup>6</sup>

The second term is a traditional Phillips curve term, which indicates that unexpected inflation

is directly related to the output gap. The equation is completed with the now-standard inflationary expectations term and a constant representing the economy's inflationary bias. The last three elements of the equation are also consistent with conflicting claims theories, as those theories posit that various groups adopt a bolder bargaining posture when output is high and unemployment low and take expected inflation into account (Rowthorn 1977, 218-219). Expectations are formed adaptively.

$$P_t^* - P_{t-1}^* = \alpha (P_{t-1} - P_{t-1}^*) \quad (4)$$

After substituting (2) in (1) and (3), we have a system of two first-order and one second-order difference equations, which, omitting the constant term, can be written as the following purely first-order system in four equations

$$\begin{bmatrix} P_t^* \\ P_t \\ Y_t \\ Z_t \end{bmatrix} = \begin{bmatrix} 1-\alpha & \alpha & 0 & 0 \\ 1-\alpha & \alpha & \beta & \lambda\theta \\ 0 & -\delta\theta & \varepsilon & \delta\theta \\ 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} P_{t-1}^* \\ P_{t-1} \\ Y_{t-1} \\ Z_{t-1} \end{bmatrix} \quad (5)$$

We make the reasonable assumption that  $\varepsilon < 1$ . As written, this system is always unstable. (See the appendix for detailed information on the mathematics.) If we assume  $\lambda=0$ , that is, that inflation is not driven by interest-rate increases, the system will then be stable if and only if

$$1 + [\varepsilon(1 - \alpha) - 1]\beta\delta\theta - [(1 - \alpha)\beta\delta\theta]^2 > 0$$

It is clear that there is some number  $K$ , such that the system is stable if and only if  $\beta\delta\theta < K$ .

Assuming  $\lambda=0$ , the roots are all positive or complex.

This crude model shows that the delta-R effect, combined with strong anti-inflationary monetary policy, can destabilize the economy. The effect is destabilizing in that it can eliminate the tendency of the economy to move toward a stationary position of any type. If the monetary authorities refrain from anti-inflationary policy ( $\theta=0$ ) or if the delta-R effect does not exist ( $\delta=0$ ), the economy will always be stable. It is interesting to note that high values of  $\varepsilon$ , the effect of past income on aggregate demand, have a tendency to *stabilize* the economy.

The type of instability generated by this model is not exactly the same as that described in Minsky's theory. That notion was that when the economy reached full employment, it would not stop there. It would careen ahead into an unsustainable financial boom, which would set the stage for a financial crisis and a recession. Then, the process would repeat itself. Such a pattern does emerge under certain strong assumptions about the parameters.<sup>7</sup> The economy has no tendency to reach a point of rest under certain conditions, a point consistent with Minsky's

theory of "the instability of stability." Moreover, this attribute of the model is due to the delta-R effect and the use of monetary policy, exactly as Minsky described them.

Another point relates to the Lavoie and Seccareccia (2001) critique of Minsky, especially their claim that a boom might be sustained for a protracted period without a financial breakdown. Lavoie and Seccareccia (*op. cit.*) argue that booms do not necessarily lead to excessive corporate indebtedness because they usually bring strong earnings, which strengthen balance sheets. This model shows that the economy can be stabilized (possibly at a high level of output) by a high degree of persistence in investment (here represented by the parameter  $\epsilon$ ). Such inertia could be generated by a virtuous cycle of strong earnings and robust investment, as suggested by the two critics. Nevertheless, with some parameter values, the inertia will not be strong enough.

#### 4. EMPIRICAL EVIDENCE

It is well known that most post-War recessions in the U.S. have been preceded by runups in interest rates. Since so many other variables (such as oil prices) are involved and since policy is at least somewhat endogenous, it is not appropriate to immediately draw the conclusion that there is a strong relationship of cause and effect running from monetary policy to output.

Moreover, many careful micro-level empirical studies of the determinants of investment find that interest rates have a relatively small impact, at least compared with other factors such as cash flow (Elliot 1973). Also, macro studies report that random shocks to interest rates are responsible for only a small, though significant, fraction of the total variation in output (Leeper, Sims and Zha, 1996; Christiano, Eichenbaum and Evans, 1996). Previous attempts at measuring the impact of monetary policy have found that it accounts for a fairly large share of the variability of output. One study using widely accepted techniques found that the FFR was responsible for 21%, 44%, and 38% of the movement of output at the 4, 8, and 12 quarter horizons, respectively (Christiano, Eichenbaum, and Evans 1996). That study and others consistently find that a shock to interest rates causes a deep and long-lasting drop in output.

Few studies have considered the impact of the rate of change of interest rates. Gertler and Gilchrist (1994), using data on manufacturers, estimate a structural model with a differenced short-term interest rate on the right hand side. They find that, consistent with their financial theory of investment, the coverage ratio is an important variable. On the other hand, the change in the interest rate enters with the "wrong" sign in their large-firm equations and in one of their two small-firm specifications (Gertler and Gilchrist 1994, 336). Chirinko, Fazzari, and Meyer (1999) test a change-in-user-cost variable using panel data and find that its coefficient is significantly less than unity but greater than zero. Because the user-cost coefficient is reduced when a cash flow variable is added to their equation, they suggest that the effect of interest rate changes may work partly through their impact on funds available for investment (63; see footnote 4).

Micro data are helpful that they allow for more powerful tests of particular investment theories

than studies using broad aggregates (Fazzari, Hubbard, and Petersen 1988; Gertler and Gilchrist 1994; Carpenter, Fazzari, and Petersen 1994). It could be argued, however, that in light of Lavoie's critique some of these micro studies do not help us find the effects of financial variables as a *macroeconomic* phenomenon. Some use fixed year effects, and all exploit interfirm variation to measure the impact of cash flow, user costs of capital, and other variables. In de-emphasizing the business cycle component of cash flow variation, these studies fail to capture what might be thought of as what Scitovsky called pecuniary externalities: when firm X's cash flow improves, it not only produces more output, but also purchases more output from firms Y and Z. Such effects are neglected in studies that use a kind of representative agent approach that counts only the effect on X. In other words, the micro studies suffer from the fallacy of composition.

How might one test the model presented above (5), using macro data? If one were to add a random disturbance to each equation of (5), the system would become a standard, first-order VAR with a only five free parameters. In general, VARs can be consistently estimated using the method of least squares; a model such as ours with linear restrictions on the parameters requires the use of a maximum likelihood procedure (Hamilton 1994, 315-318)

The set of linear restrictions implied by the model could be tested, at least in principle. However, such an approach would not be the best test of the delta-R theory. The test would involve not just our hypothesis regarding the determinants of investment, but a number of auxiliary hypotheses implied by the model, such as our supposition that the central bank only considers the inflation rate in making its policy decision. If a hypothesis test led us to reject the null, it would not be clear whether it was our theory of investment that was being rejected, or instead the model's assumptions regarding the determinants of other variables.

Fortunately, it happens that one of the most important and distinctive virtues of the VAR technique is that it permits the researcher to assess the effects of a particular variable without committing him or herself to a particular model of the economy, or in econometric terms, identifying restrictions (Sims 1980). A VAR model allows one to conservatively assume that all variables are endogenous.

An estimate of a VAR enables one to construct two types of evidence that may be of use to us: impulse response functions and variance decompositions. Impulse response functions represent the reaction of a particular variable over time to a random shock in one of the other variables. The notion is that part of some variable, the change in the interest rate in this case, is random, because Fed actions depend on the politics of the open market committee, the mood of its members, and so on, which are of course omitted from the model. The effects of shocks generated in this way offer clues as to the driving forces behind some variable, in this case industrial production, and this effect over time is graphed in an impulse response function.

The second tool of VAR analysis, the variance decomposition, reveals the percentage of the variability in one variable that is due to random variation in each of the other variables. This exercise gives us some sense of the relative importance of our explanatory variable of interest.

If the delta-R effect is important, random changes in that variable must have a substantial impact on output, and such effects should be revealed by these two tools of VAR analysis.

This study uses variables corresponding to the unknown quantities in equations (1)-(4), replacing the expectations term with a money stock measure.<sup>8, 9</sup> The equations include the following variables for the sample period from April, 1960 to June, 2002: the federal funds rate (FFR), the rate of growth of the FFR, industrial production, the CPI, and M1. The sample period was the entire period for which data were available when the regressions were run. Since the scale of the variables has increased greatly over time, the variables were transformed to logs, allowing us essentially to weight all percentage changes equally. All the variables other than the interest rate were used in natural log form. The VAR contains the rate of growth rather than the first difference of the FFR because of the problem of collinearity. Likelihood ratio tests rejected any order less than 15, so that number of lags was used. Some summary statistics for the VAR appear in Table 1.

The sums of the 15 coefficients for all lags of each variable in the IP equation were: growth of FFR, .000352; FFR, -.00045; M1, -.00171; CPI, .83061; IP, 1.00259. The sign of the first figure seems to conflict with Minsky's theory, but since causal influences in multi-equation models encompass feedback from one equation to another, the coefficients of one equation do not provide a full picture of the (direct and indirect) effects of policy. An impulse response function discussed below will capture these feedback effects. Another feature of the FFR growth coefficients is that, at short lags, they are positive, while most of the coefficients at 7 or more lags are negative. Assuming that money is endogenous and exerts no causal influences of its own, one has no expectations one way or another regarding the sign of the M1 coefficient. All the other coefficients seem consistent with economic theory.

Providing some sense of the importance of interest rates, table 2 reports significance tests for the two main variables of interest in the industrial production equation. The FFR growth variable reaches the 10 percent level of significance, according to two of the three tests, while the coefficients for levels are not significantly different from zero. This finding favors the delta-R view, as opposed to more conventional theories of the effects of monetary policy. The M1 and CPI variables, in tests not reported on the tables, failed to reach significant levels, a result that is consistent with most macroeconomic theories that assume money is endogenous. IP was significant in its own equation.

The impulse response functions for a shock to the FFR growth variable proved to be implausible and highly dependent upon the assumptions made about the contemporaneous interactions of the variables (the "ordering" of the variables, which is discussed in any textbook in the field, e.g. Hamilton (1994, 319)). This paper deploys the "generalized" version of this output, which does not depend upon the ordering (Pesaran and Pesaran 1997). Essentially, instead of orthogonalizing the disturbances, this technique gauges the new information about output carried by the untransformed (or reduced form) VAR errors, which are correlated.<sup>10</sup>

The impulse response function for a shock to the variable of interest is shown in figure 1. In

response to a shock, output rises for nearly a year, then falls deeply and does not turn back upward until 29 months have passed. This finding is largely consistent with the aggregate demand function (1) above, which includes an interest rate-change term. However, in light of the fact, pointed out above, that the interest-rate-growth coefficients add up to a positive number, one suspects that the delta-R effect operates through a complicated chain of events involving one or more other economic variables. The pattern of signs in the estimated regression coefficients--mostly positive for the first 6 months, and mostly negative thereafter--is consistent with the two-humped shape of the impulse response function.

A (generalized) variance decomposition is shown in table 3 and figure 2. The effect here is also delayed, but by the 50-month horizon, the FFR growth variable accounts for over 15 percent of the variance in output. It is important to note that during the first 10 months, when output is moving in the "wrong" direction, the FFR growth variable does not account for much of the movement of industrial output--5 percent or so at the most. Thus, not only does the delta-R effect work in the expected direction over the long term, but such long term movements also accounts for a major portion of the variance of output.

Since the Schwarz-Bayesian and Akaike criteria indicated that a lower order model was appropriate, a 5-lag VAR was estimated. The results were slightly weakened. A 20-lag VAR, on the other hand, attributed around 25 percent of the variance in output to our policy variable for the near the end of the 50-month period. The drop in industrial production was slightly deeper. Thus, the results are somewhat robust to specification changes. A model omitting interest rate levels also indicates a strong role for interest rate changes. Non-nested tests of interest rate-levels VARs against interest rate-growth VARs give a slight edge to the more traditional levels variable.

The variance decompositions also suggest that *levels* of the interest rate are at least as important as changes. This finding is consistent with the two-price static version of Minsky's model, but may be troubling to those who believe that the Cambridge critiques are applicable in this setting.

Nevertheless, the evidence in this paper suggests that the rate of change of the interest rate influences the level of output--a relationship resembling the aggregate demand function (1).

## 5. CONCLUSION

The model and empirical evidence above confirm Minsky's verbal argument that the economy can be destabilized when agents with speculative and Ponzi positions face an environment of changing short-term interest rates caused by an activist anti-inflationary monetary policy. The model entirely omits any effects due to a less than perfectly elastic supply of finance or money, depending instead on a government policy reaction function. This will perhaps address some of the points made by the horizontalists about Minsky's theory. Not only have we avoided assumptions about the money supply curve, but we have also omitted the usual downward-sloping investment demand curve, which, as we pointed out above, may also be

dubious. Finally, we have provided a justification for the claim that balance sheets under some circumstances deteriorate over the course of a boom, even as cash flow rises. Thus, it is possible to adhere to Minsky's theory of investment, even if one assumes that many of the critiques of his post-Keynesian antagonists are correct.

Since the model shows that variable interest rates only destabilize the economy, it raises the question of whether there is any useful role for monetary policy. This issue has received renewed attention recently (Arestis and Sawyer 2003b). Certainly, these findings suggest that a regime of interest-rate targeting ( $\theta=0$ ) provides the greatest stability. They also imply that stimulative policy may lose its effectiveness even before rates reach their nominal floor of zero. In order to raise output, the downward motion of interest rates must accelerate. Expansionary monetary policies are essentially unsustainable over the long term in a way that fiscal policies might not always be.<sup>11</sup>

As for the *level* of interest rates, the Cambridge critique suggests, perhaps implausibly, that policy makers should be indifferent. But surely low rates can allow the government to "manage the debt," by keeping the Treasury's costs under control. Moreover, other types of the distributional effects emphasized by the neo-Ricardian economists are an important consideration.

One way of dealing with the problem discussed here, at least as it affects the banking system, would be to consider institutional reforms to the banking system aimed at lessening the mismatch between the maturities of assets and liabilities, which can create a vulnerability to increases in short-term rates, as described in this paper. This mismatch is related to the speculative and Ponzi financing implicated by Minsky's theory. If an agent finances long-term investments with short-term borrowing, that agent must find a way to make interest payments along the way, and this is usually accomplished with further borrowing.

As a way of aligning the maturities of assets and liabilities, a number of proposals for "narrow banking" or "core banking" have been put forward (e.g., Phillips 1992; Pierce 1991). If such proposals were adopted, banks would be permitted to hold only short-term safe assets, including government securities and possibly high quality commercial paper. Then, banks themselves would not speculate on future interest rates. Firms that had relied on bank loans would have to turn to other forms of finance, possibly including long-term instruments, such as bonds. To increase the access of small and medium-sized firms to the capital markets, regulators could encourage small banks to underwrite securities. Currently, many loans are securitized, but they remain on the books of many banks, where they may pose significant default, prepayment, or interest rate risk.

In taking a skeptical view of monetary policy, this model takes up certain Keynesian themes that have been neglected in recent years. Keynes believed that monetary policy might be ineffective as a means of ending the Great Depression. Later, at the time of the Radcliffe Committee's deliberations (Committee on the Working of the Monetary System 1960), the effectiveness of monetary policy as an anti-inflationary tool was being seriously debated. In

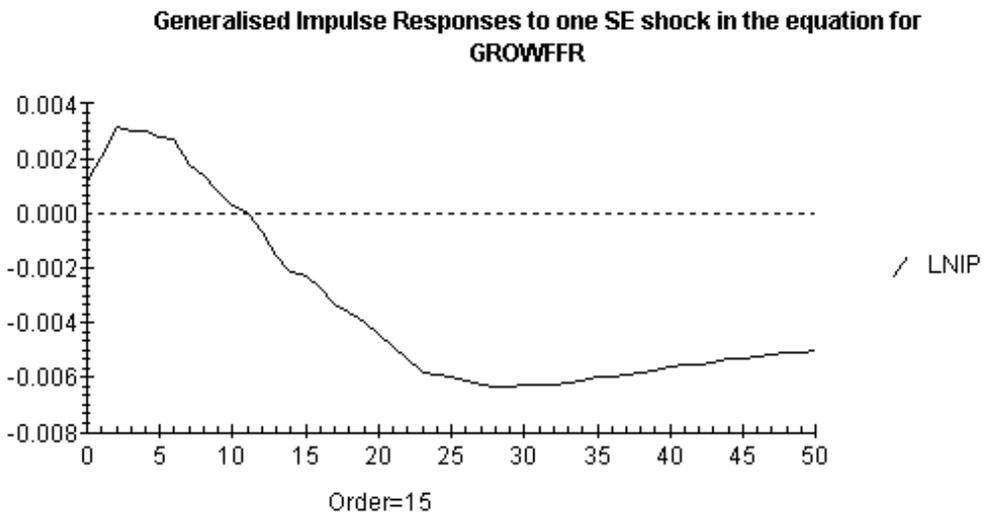
many countries, interest rates had been pegged during and immediately after the war, and it was by no means taken for granted that monetary policy would be the primary weapon in the fight for price stability.

Economists such as Kaldor and Kahn were in the anti-monetary policy camp. They believed the use of monetary policy would create an atmosphere of speculation and uncertainty in the financial markets and would act as a drag on productivity-enhancing investment. To a great extent, the argument of these Keynesians hinged on the undesirable effects of the *variability*, rather than the excessive level, of interest rates. Minsky's work can also be read as part of this tradition.

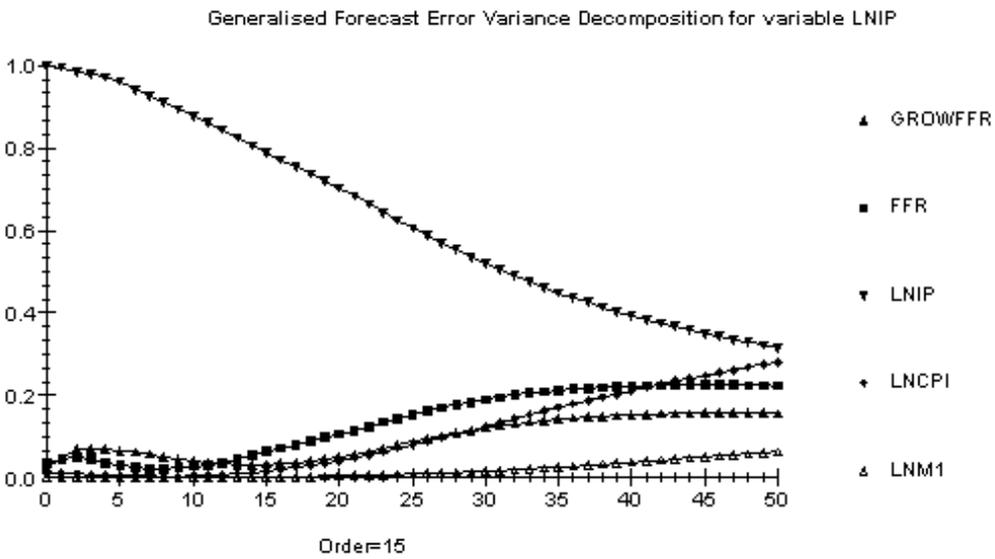
As of late, many macroeconomists--perhaps most--have embraced the use of monetary policy. Standard macroeconomics texts give equal billing to fiscal and monetary policy, as if they were perfect substitutes, or claim that "inflation is always and everywhere a monetary phenomenon." Some have attributed the recent stability of the economy to the Fed's newfound ability to engineer "smooth landings" (Romer 1999). Many new Keynesians believe that monetary forces have dominated the vicissitudes of the economy in the post-War period (Bernanke, Gertler and Watson 1997; Romer and Romer 1989). Some Keynesians believe monetary policy operates at least partially through its effect on reserves, and thereby on credit extended by banks. Others emphasize the effects of past Fed efforts to directly control the supply of credit. Others seem to envisage a movement along a smooth demand curve for investment. The closest counterpart in the mainstream literature to the model developed here would be the balance-sheet channel posited by some new Keynesians. This paper illustrates the possible dangers associated with relying upon dubious connections between monetary policy and economic outcomes--namely, courting instability of real variables such as output.

There are several avenues that future research in this area might follow. Clearly, it would be useful to explicitly model the level of debt and factor it into the investment decision, as it clearly interacts with the effects of changing interest rates. This interaction will introduce non-linearities into the investment function, and it may destabilize the model. Finally, there is another important non-linearity that needs to be considered: the effects of interest rate changes may not be symmetric. While it is clear that the type of financial distress brought about by rising interest rates can have an adverse impact, it is not clear that reductions in interest rates would have an equal, but opposite, effect.

**FIGURE 1**



**FIGURE 2**



<b>TABLE 1: Statistics for Vector Autoregression</b>	
<b>Statistic</b>	
$R^2$	.999
$\bar{R}^2$	.999
F Statistic	18669.6 (.000)
SBC	1600.4
Akaike	1758.9
Durbin-Watson	2.003

Regression contained 15 lags of the following variables: m1, ffr (federal funds rate), grffr (growth rate of the federal funds rate), IP (industrial production), CPI (consumer price index). All variables were transformed into logs. Data were monthly and spanned the period April 1960 to June 2002. Source: [www.economagic.com](http://www.economagic.com).  
SBC=Schwarz Bayesian Criterion. Akaike=Akaike Information Criterion.

<b>TABLE 2: Tests for Hypothesis that Variables Can Be Deleted from VAR Equation for IP</b>			
<b>Variable</b>	<b>Lagrange Multiplier</b>	<b>Likelihood Ratio</b>	<b>F Statistic</b>
GRFFR	CHSQ=24.24 (.061)	24.84 (.052)	1.44 (.122)
ffr	CHSQ=19.55 (.190)	19.94 (.174)	1.16 (.305)

Each statistic is for the null that the coefficients on all lags of the variable in the first column are zero. Figures in parentheses are significance levels for rejection of the null. Variables defined above.

**TABLE 3: Variance Decomposition for IP**

Horizon month	GRFFR	FFR	IP	CPI	M1
0	.028	.037	1.000	.010	.000
5	.066	.030	.962	.005	.000
10	.040	.028	.876	.004	.000
15	.033	.065	.788	.018	.002
20	.051	.107	.703	.042	.005
25	.087	.154	.606	.081	.010
30	.121	.190	.520	.125	.016
35	.142	.212	.449	.171	.026
40	.153	.223	.394	.212	.038
45	.157	.225	.351	.249	.051
50	.156	.223	.316	.281	.063

Cells indicate percentage of variance of IP accounted for by random shocks to the variables shown at the top.

## Appendix

The characteristic equation for (5) is

$$\mu^4 - (1 + \varepsilon)\mu^3 + (\varepsilon + \delta\theta\beta - \lambda\theta)\mu^2$$

$$+[(\alpha - 2)\delta\theta\beta + \lambda\theta(1 + \varepsilon - \alpha)]\mu$$

$$+(1 - \alpha)\delta\theta\beta + (\alpha - 1)\lambda\theta\varepsilon = 0$$

A necessary condition for stability is that

$$-\sum_{i=1}^4 a_i < 1$$

where  $a_1$  is the coefficient on  $R^3$ , etc. (Gandolfo 1997, 91) Assuming that  $\varepsilon < 1$ , that previous assumptions hold, and that all parameters are positive, this condition is not met. Therefore the system is always unstable. To try to obtain more interesting results, one can eliminate the unconventional  $\lambda$  term, which involves the "Wright Patman Effect" mentioned in the body of the paper. We correctly guess that there is a unit root. Factoring out  $\mu - 1$ , the characteristic equation becomes

$$\mu^3 - \varepsilon\mu^2 + \beta\delta\theta\mu - (1 - \alpha)\beta\delta\theta$$

Since the coefficients alternate in sign, the roots are all positive or complex. The necessary conditions for stability are (Gandolfo 1997, 91):

$$1 + a_1 + a_2 + a_3 > 0$$

$$1 - a_1 + a_2 - a_3 > 0$$

$$1 - a_2 + a_1a_3 - a_3^2 > 0$$

The two conditions are satisfied, since  $\alpha < 1$ . The third condition in our case is

$$1 - \beta\delta\theta + \varepsilon(1 - \alpha)\beta\delta\theta - (1 - \alpha)^2(\beta\delta\theta)^2 > 0$$

Keeping in mind that the parameters are positive, it is clear that there exists some function of the parameters  $K$ , such that the system is stable if and only if  $\beta\delta\theta < K$ . In terms of our model, this means that, given values of the other parameters, the system will always be unstable if  $\delta$  or  $\theta$  is sufficiently large. Since there is a unit root, the stability is around a *moving* equilibrium. The former parameter represents the effect of changes in the interest rate on aggregate demand--what we have called the delta-R effect. Theta is the parameter in the central bank's reaction function. This is the basis for the claim that a central bank can destabilize the economy by reacting too strongly to changes in the inflation rate.

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## NOTES

1. Most neoclassical writers now share this view, having abandoned the notion of an exogenously fixed money supply in the aftermath of recent attempts at monetary targeting.

2. Around the same time, in the United States, the Commission on Money and Credit (1961), while arguing that firms' lack of concern about interest rates was "overstated" (52), emphasized that expansionary policy would be ineffective if firms perceived inadequate demand (53).
3. And also, "Since we live in a world of uncertainty and current views about the future affect capital-asset prices, the governor mechanism by way of financing terms is often dominated by positive, disequilibrating feedbacks. An increase in the demand prices for capital assets relative to the supply prices of investment output increases investment, which increases not only profits but also the ratio of profits to payment commitments on outstanding debts, the amount of financing available from banks and financial markets at any set of terms, and businessmen's willingness to invest (1986, 228).
4. It has been argued by Chirinko, Fazzari, and Meyer (1999) that even within a strictly neoclassical framework, it is the rate of change in, rather than the level of, the cost of capital that determines investment. In standard micro theory, the interest rate determines the amount of capital employed, not investment. These authors also cite the financial effect of rising interest rates, though they do not emphasize bankruptcies and crises as Minsky did. They do not explicitly model the policy decisions of the central bank, but attempt to deal with endogeneity problems by using instrumental variables. Their empirical evidence is discussed below.
5. It is similar to an inflation targeting rule, rather than a Taylor rule, in the sense that the output gap is not an argument in the function. On the other hand, equation (2) shares the Taylor rule's lack of forward-looking terms (see Gramlich 2003).
6. Note that in Rowthorn's and Lima and Meirelles's models, it is the level, rather than the rate of change, of factor shares that determines inflation (1977, 222 ), as posited here. Also, Podkaminer's model involves interest rate levels (1998, 585).
7. I thank Kenneth Hannsgen for ascertaining this point. Mathematica calculations available from the author.
8. The neoclassical monetary VAR literature is discussed at length in Christiano, Eichenbaum, and Evans (1996).
9. It is common in the VAR literature to include a price expectations proxy, such as an index of commodities prices. This variable is used because it "fixes" to some extent the "anomalous" finding that interest rate hikes cause increases in inflation. But this finding is readily

explained. See my discussion of equation (3) above. For a short discussion of the standard view of this problem, see Christiano, Eichenbaum, and Evans (1996, 30-31).

10. Full estimated equations for the VAR are available from the author upon request at the address on page 1.
11. Short of fixing interest rates, policymakers could consider adding an "interest rate smoothing" term (lagged interest rates) to their policy functions, so as not to generate excessive volatility.