working paper

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Monetary Policy in a World Without Perfect Capital Markets

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FEDERAL RESERVE BANK OF CLEVELAND

Working Paper 01-15 October 2001

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This paper examines a theoretical model in which an entrepreneur's net worth has an effect on his ability to finance current activity. Net worth, in turn, is determined by asset prices which can be affected by monetary policy. In this environment there is a welfare-improving role for the central bank to respond to asset price and technology shocks.

JEL Codes: General equilibrium, money and interest rates, monetary policy
Key Words: D51, E42, E52

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I. Introduction.

Ever since Alan Greenspan coined his now infamous phrase "irrational exhuberance" there has been an increased amount of interest in whether or not central banks should respond to asset prices. Although his remarks and many subsequent discussions have focused on whether or not central banks should "prick" asset price bubbles, more generally the question remains whether and under what conditions should central banks respond to asset prices. At the same time there is a long history in monetary research dating to Friedman (1969) that optimal monetary policy requires that the central bank simply set the nominal rate of interest to zero independent of asset prices or any other shocks that might buffet the system. This paper revisits these questions and argues that the optimal rate of interest should not be zero precisely because central bankers need the option of responding to external shocks – including asset prices. Although this is an often-cited argument this paper derives this result in the context of a well-specified general equilibrium model.

The starting point of the discussion is the Modigliani-Miller theorem. The theorem states that in a world with perfect capital markets a firm's financial position (debt vs. equity level) is irrelevant to its decisions on production and investment activities. This separation occurs because perfect capital markets allow information to flow easily. If entrepreneur Emily has a good idea for a new product, then the product will be produced irregardless of her personal financial position because outside investors will see through her to the profit opportunity in the good project, and provide any needed financing.

The Modiglani-Miller theorem is not necessarily meant to be a statement of reality. In fact, there is a voluminous empirical literature that provides evidence that financial position does affect a firm's ability to operate. But the theorem provides an important benchmark and forces one to think carefully about the workings of financial markets, and what imperfections are needed to create a world in which a firm's financial position does affect its ability to engage in production.

There are many possible imperfections that could generate such a world. In this paper we focus on an informational story. Suppose that only Emily, the entrepreneur, knows the intricate details of her proposed project. If outside investors provide financing to Emily they have no way of knowing for sure what she will do with their funds. Furthermore, suppose that they have limited ability to punish her after the fact if she runs off with their money, or squanders the funds on a misguided production activity. In such a scenario external investors will likely provide financing only if they are sure they can recoup their investment if things turn sour. One way of ensuring this is to limit the size of their financing to Emily's financial position. That is, external financing will be limited to the value of Emily's collateral that can be seized after the fact.

The previous outlines a story in which financial position, or what we will henceforth call "collateral" or "net worth", has a fundamental affect on a firm's ability to engage in production. This is not a Modigliani-Miller world. What is the role of monetary policy in such a world? Can monetary policy help the economy respond to fundamental shocks buffeting the system?

This paper addresses these questions in a theoretical model. To keep the analysis tractable the model builds upon Kiyotaki and Moore (1997). The model is highly stylized, but the essential point will survive more complicated modeling environments. We purposely structure the model so that in the absence of collateral constraints monetary policy is irrelevant. That is, in the absence of collateral constraints, employment, consumption, and output are entirely independent of the monetary regime. But in a world with collateral constraints, short run monetary policy suddenly becomes critical. A key conclusion is that there is a role for activist monetary policy: well-timed movements in the nominal rate of interest are welfare improving.

The next Section lays out the basic model. Section 3 then outlines the nature of optimal monetary policy. The final section links the paper to the existing literature.

II. The Model

The theoretical model consists of households and entrepreneurs. We will discuss the decision problems of each in turn.

Households:

Households are infinitely lived, discounting the future at rate β. Their period-by-period utility function is given by

$$U(c_t, L_t) \equiv c_t - \frac{L_t^{1+\frac{1}{\tau}}}{1+\frac{1}{\tau}} \tag{1}$$

where $\tau > 0$, c_t denotes consumption and L_t denotes work effort. We choose this particular functional form for convenience. Each period the household chooses how much to work at a real wage of w_t, and how much to save. The only means of savings by households is in the form of acquiring shares to a real asset that pays out dividends of D_t consumption goods at the end of time-t. It is helpful to think of this as an apple tree that produces D_t apples in time-t. The exogenous dividend process is given by

$$D_{t+1} = (1-\rho_D)D_{ss} + \rho_D D_t + \varepsilon_{t+1}^D .$$

The tree trades at share price q_t at the beginning of the period (before the time-t dividend is paid). We assume that shares must be purchased with cash accumulated in advance:

$$P_t f_t \left(q_t - D_t\right) \leq M_t - B_t \tag{2}$$

where f_t is the consumer's tree purchases, q_t is the real tree price, P_t is the nominal price level, M_t is cash holdings at the beginning of the period, and B_t denotes bond purchases (these will be in zero net supply). We assume that shares must be purchased with cash because it is a simple mechanism by which monetary policy will have a direct effect on real asset prices. There are many other ways of generating this dependence, but this is the most transparent. Notice, however, that cash is not needed to purchase the consumption good. This point will be returned to later. Also for simplicity we assume that dividends are available within the period to purchase new shares. The household's intertemporal budget constraint is given by

$$M_{t+1} \leq M_t - P_t c_t + P_t w_t L_t + B_t (R_t - 1) + P_t q_t f_{t-1} - P_t f_t (q_t - D_t) \qquad (3)$$

where R_t is the gross nominal interest rate on bond holdings.

The household's first order conditions include:

$$L_t = w_t^{\tau} \qquad (4)$$

$$E_t \frac{\beta P_t R_{t+1}}{P_{t+1}} = 1 \qquad (5)$$

$$q_t R_t = D_t R_t + E_t \beta q_{t+1} \qquad (6)$$

A few comments are in order. First, labor supply (4) responds positively to the real wage with elasticity τ. Second, the Fisher equation (5) is "off" a period (R_{t+1} is the gross nominal rate between t+1 and t+2) because cash is required for financial market transactions but not for goods market transactions. Third, this cash constraint on financial transactions implies that movements in the nominal rate of interest have a direct effect on real asset prices (6). That is, to purchase a tree requires holding cash-in-advance, and this has an opportunity cost of R_t.

Entrepreneurs:

Entrepreneurs are also infinitely-lived, discounting the future at rate β, and have linear preferences over consumption. They are distinct from households in that they operate a constant returns to scale production technology that uses labor to produce consumption goods:

$$y_t = A_t H_t \tag{7}$$

where A_t is the current level of productivity, and H_t denotes the number of workers employed at real wage w_t. The productivity level A_t is an exogenous random process given by

$$A_{t+1} = (1-\rho_A)A_{ss} + \rho_A A_t + \varepsilon_{t+1}^A .$$

The entrepreneur is constrained by a borrowing limit. In particular, the entrepreneur must be able to cover his entire wage bill with collateral accumulated in advance. We will denote this collateral as n_t for "net worth". The loan constraint is thus

$$w_t H_t \leq n_t . \tag{8}$$

Why is the firm so constrained? There are many possible informational stories that would motivate such a constraint. For example, suppose that the hired workers first supply their labor input, but that output is subsequently produced if and only if the entrepreneur provides his unique human capital to the process. We now have a classic hold-up problem in which the entrepreneur could force workers to accept lower wages ex post, for otherwise nothing will be produced. These problems can be entirely avoided if there is an existing stock of collateral that the workers could simply seize in such a case. Hence, to avoid these hold-up problems, workers are willing to work if and only if the wage bill is entirely covered by existing collateral.

We can easily enrich this story by assuming that there exist financial institutions that intermediate between workers and entrepreneurs. For example, suppose that these intermediaries provide within-period financing to entrepreneurs, and that this financing is used by firms to pay workers. The intermediary, however, is concerned about the hold-up problem, and thus limits its lending to the firm's net worth. Hence we once again have the collateral constraint (8).[1]

Below we will assume that the loan constraint binds so that labor demand is given by

$$H_t = \left(\frac{n_t}{w_t} \right). \tag{9}$$

Notice that labor demand varies inversely (with a unit elasticity) to the real wage, but is positively affected by the level of net worth. Firms that have more collateral are able to employ more workers because hold-up problems are less severe. The binding collateral constraint implies that $A_t > w_t$, ie., the firm would like to hire more workers but is collateral-constrained.

Entrepreneurs' sole source of net worth is previously acquired ownership of apple trees. If we let e_{t-1} denote the number of tree shares acquired at the beginning of time t-1, then time-t net worth is given by

$$n_t = e_{t-1} q_t \tag{10}$$

so that the loan constraint is given by

$$w_t H_t \le e_{t-1} q_t \tag{11}$$

As noted above, the assumption that the loan constraint is binding implies that the firm's marginal profits per worker employed is $(A_t - w_t)$. These profits motivate the entrepreneur to acquire more net worth. We will need to limit this accumulation tendency so that collateral remains relevant. The entrepreneur's budget constraint is given by

$$c_t^e + e_t q_t = e_{t-1} q_t + e_t D_t + H_t (A_t - w_t) \tag{12}$$

Using the binding loan constraint, we can rewrite this as

$$c_t^e + e_t (q_t - D_t) = e_{t-1} q_t \frac{A_t}{w_t} \tag{13}$$

[1] Kiyotaki and Moore (1997) use a similar constraint. See Hart and Moore (1994) for a discussion of the

Using the asset price equation (6), the budget constraint of the entrepreneur can be rewritten as

$$E_t n_{t+1} = n_t\left(\frac{A_t R_t}{w_t \beta}\right) - \left(\frac{R_t}{\beta}\right) c_t^e$$

Notice that the coefficient on n_t exceeds $1/\beta$. Hence, because of the profit opportunities from net worth ($A_t > w_t$) and because the entrepreneur need not accumulate cash to purchase trees ($R_t > 1$), the entrepreneur would like to accumulate trees until the constraint no longer binds.[2] To prevent this from happening we will assume that entrepreneurs consume their dividends and a fraction of their profits each period:

$$c_t^e = q_t D_t + (1-\gamma) e_{t-1} q_t \frac{A_t}{w_t} \tag{14}$$

so that entrepreneurial tree holdings evolve as

$$e_t = \gamma e_{t-1} \frac{A_t}{w_t} \tag{15}$$

We assume $\gamma < 1$ to offset the high return to internal funds and thus keep the entrepreneur collateral constrained in equilibrium. This assumption of imposing entrepreneurial consumption is common to this literature: the two-period lives of Bernanke and Gertler (1989), the "bruised fruit" of Kiyotaki and Moore (1997), the constant consumption share of Bernanke, Gertler and Gilchrist (2000), or the higher discount rate of Carlstrom and Fuerst (1997).

Equilibrium:

There are two markets in this theoretical model, the market for apple trees and the labor market. The respective market-clearing conditions are $e_t + f_t = 1$, and $L_t = H_t$. The equilibrium

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hold-up problem.

[2] The assumption that entrepreneurs do not need cash to purchase trees is unimportant. Even without this cash-in-advance constraint the fact that $A_t > w_t$ implies that entrepreneurs will have an incentive to accumulate net worth until their collateral constraint is no longer binding.

tree price is given above by (6). As for the labor market, equating labor supply to labor demand and solving for the real wage and employment level yields

$$w_t = n_t^{\frac{1}{1+\tau}} \tag{16}$$

$$L_t = n_t^{\frac{\tau}{1+\tau}}. \tag{17}$$

The equilibrium real wage and employment level is increasing in net worth because higher net worth increases labor demand. The labor supply curve is fixed and given by (4).

We will assume that monetary policy is given by directives for the gross nominal interest rate R_t. The implied path for the inflation rate comes from (5), while the supporting money supply behavior can be backed out of the binding cash constraint.

Steady-state:

We can use the above to solve for the steady-state of the model. Let π denote the steady-state inflation rate. Then we have:

$$R = \frac{1+\pi}{\beta}$$

$$q = \frac{DR}{R-\beta}$$

$$e = \frac{(\gamma A)^{1+\tau}}{q}$$

$$w = \gamma A$$

$$L = (\gamma A)^{\tau}$$

In what follows, it is important to note that monetary policy is superneutral with respect to steady-state employment and output. This is because we have assumed that cash is not needed to facilitate consumption nor employment transactions. Monetary policy does affect the steady-state share price, but has no effect on steady-state net worth (n = eq) because the entrepreneur's steady-state share holdings move inversely with the steady-state asset price. This immediately implies that there is no unique optimal long run nominal rate of interest. In particular, there is no presumption in favor of the Friedman rule of a zero nominal rate.

However, the informational frictions make the steady-state level of employment "too low". If there were no collateral constraint, then real wages would be given by w = A, and employment by $L = A^{\tau}$. But these levels are not achievable because of the presence of the informational friction that manifests itself in the collateral constraint. It is in this sense that the size of γ proxies for the degree of agency costs within the model.

Log-Linearizing the Model.

Because monetary policy has no effect on steady-states, it is convenient to express the equilibrium in terms of log-deviations. Below the ~'s represent percent deviations from steady-state:

$$\tilde{L}_t = \frac{\tau}{1+\tau}\tilde{n}_t \tag{18}$$

$$\tilde{n}_t = \tilde{q}_t + \tilde{e}_{t-1} \tag{19}$$

$$\tilde{e}_t = \tilde{e}_{t-1} + \tilde{A}_t - \frac{1}{1+\tau}\tilde{n}_t \tag{20}$$

Using (19) to eliminate n_t we can write (18) and (20) in terms of e_t:

$$\tilde{L}_t = \frac{\tau}{1+\tau}\left(\tilde{q}_t + \tilde{e}_{t-1}\right) \tag{21}$$

$$\tilde{e}_t = \frac{\tau}{1+\tau}\tilde{e}_{t-1} + \tilde{A}_t - \frac{1}{1+\tau}\tilde{q}_t . \tag{22}$$

The tree price (6) can be expressed as

$$\tilde{q}_t + \tilde{R}_t = \left(\frac{R-\beta}{R}\right)\tilde{D}_t + E_t \frac{\beta}{R}\tilde{q}_{t+1} \tag{23}$$

In summary, the model consists of equations (21)-(23). There is one predetermined variable, e_{t-1}, and three exogenous shocks: A_t, D_t, and R_t.

Experiment 1: A Shock to Productivity (A_t).

Before turning to the question of monetary policy, it is useful to sharpen one's economic intuition about the model by considering several experiments. For example, suppose monetary policy is given by an interest rate peg ($\widetilde{R}_t$) and that we hold all other variables constant, and only consider shocks to productivity. Then we have

$$\widetilde{L}_{t+1} = \frac{\tau}{1+\tau}\left(\widetilde{L}_t + \widetilde{A}_t\right).$$

Notice that contemporaneous employment does not respond to shocks to productivity, A_t. This is a manifestation of the collateral constraint. When productivity is high, the firm would like to expand employment but is unable to do so because of the need to finance current activity with current collateral. Thus, the collateral constraint limits the ability of the firm to respond to shocks.

There is, however, a delayed response. A positive shock to A_t has no effect on current employment, but raises e_t and thus tomorrow's net worth. Hence, employment responds with a lag to shocks to productivity.

This lagged response generates persistence to a temporary productivity shock. That is, even if there is only a temporary one period shock to A_t, the effect on employment L_t and thus output is much longer and only dies out at the rate given by $\tau/(1+\tau)$. If the shock to productivity is serially correlated, this effect remains so that the collateral constraint causes a productivity shock to have a more persistent effect

Experiment 2: A Shock to Dividends (D_t).

Now consider a shock to dividends. Holding monetary policy fixed, we can solve (23) for

$$\widetilde{q}_t = \left(\frac{R-\beta}{R-\beta\,\rho_D}\right)\widetilde{D}_t\,.$$

Proceeding as before we have:

$$\tilde{L}_t = \frac{\tau}{1+\tau}\tilde{e}_{t-1} + \left(\frac{\tau}{1+\tau}\right)\left(\frac{R-\beta}{R-\beta\rho_D}\right)\tilde{D}_t$$

$$\tilde{e}_t = \frac{\tau}{1+\tau}\tilde{e}_{t-1} + \left(\frac{\tau}{1+\tau} - \rho\right)\left(\frac{R-\beta}{R-\beta\rho_D}\right)\tilde{D}_t$$

Combining we have:

$$\tilde{L}_t = \frac{\tau}{1+\tau}\left(\tilde{L}_{t-1} + \tilde{\varepsilon}_t^D\right)$$

where recall that ε_t^D is the innovation in the dividend process. The most remarkable observation is that employment responds positively to dividend shocks even though these shocks have no effect on worker productivity nor on labor supply. Instead, the effect of dividends on employment comes entirely through the collateral constraint. Because trees are used as collateral, and a dividend shock drives up the price of trees, the collateral constraint is relaxed and the firm is able to expand employment. Once again these effects are highly persistent.

III. Optimal Monetary Policy Under Commitment.

What is the optimal response of the nominal interest rate to productivity and dividend shocks? This section will answer this question in the case of commitment. That is, we assume that the central bank can credibly commit to an interest rate policy where by an interest rate policy we mean a reaction function linking movements in the nominal interest rate to movements in fundamental shocks buffeting the economy.

The most natural choice for a welfare criterion is the sum of household and entrepreneurial utility. This is given by

$$V_t \equiv c_t + c_t^e - \frac{L_t^{1+\frac{1}{\tau}}}{1+\frac{1}{\tau}} = A_t L_t + D_t - \frac{L_t^{1+\frac{1}{\tau}}}{1+\frac{1}{\tau}}, \qquad (24)$$

where the equality follows from the fact that total time-t consumption must equal the total supply of time-t consumption goods. This supply comes from those goods produced using the entrepreneur's production technology, and the dividends that are produced by the apple tree. The only choice variable in V_t is employment. Maximizing V_t with respect to L_t yields the following optimality condition

$$L_t = A_t^{\tau}.$$

We will call this solution the "first best" outcome because the welfare criterion cannot be made any higher. Notice two natural features of the first best. First, employment responds positively to productivity shocks. When productivity is high, it is efficient for employment to respond positively. Second, the first best employment does not respond to dividend or share prices. The welfare criterion V_t is increasing in D_t, but these shocks have no effect on labor productivity, and thus it is efficient for employment to not respond to these shocks.

Is the first-best achievable? If there was no collateral constraint, then we would have $w_t = A_t$ and the first-best could be achieved with any monetary policy.

But in a world with agency costs, this first-best is not possible because employment is given by (17), which, as noted above, is too low ($A_t > w_t$) because of the collateral constraint, Furthermore, according to (17), employment fluctuates with net worth and not with the level of productivity. Compared to the first-best outcome, these employment responses are dreadful: contemporaneous employment does not respond to productivity even though it is efficient to do so, but employment does respond to share prices which, in an efficient world, should have no effect on employment. In short, the collateral constraint causes the economy to under respond to productivity shocks, and to over respond to dividend shocks.

Can monetary policy improve on this economy's ability to respond to shocks? Yes. To illustrate this ability, let us consider a second best exercise. Let $\lambda_t < 1$, denote how far employment is from the first-best outcome in time-t:

$$L_t = \lambda_t A_t^{\tau}. \tag{25}$$

For example, consider an interest rate peg $R_t = R > 1$. From above, we know that employment does not respond to A_t but does respond to D_t. This implies that λ_t is varying in such a way to force employment to respond in this inefficient manner suggesting that welfare would be higher with a stable λ.

To see this substitute (25) into V_t:

$$V_t = A_t \lambda_t A_t^{\tau} + D_t - \frac{\left(\lambda_t A_t^{\tau}\right)^{1+\frac{1}{\tau}}}{1+\frac{1}{\tau}} = A_t^{1+\tau}\left[\lambda_t - \frac{\lambda_t^{1+\frac{1}{\tau}}}{1+\frac{1}{\tau}}\right] + D_t.$$

Notice that the productivity shock separates out, and that V_t is concave in λ_t. This concavity implies a preference for certainty: Recall that monetary policy has no effect on the steady-state level of employment. Now consider two monetary policies, one of which stabilizes λ_t at some constant λ, while the other policy has λ_t variable but with a mean of λ.[3] Because V_t is concave, welfare is higher under the constant-λ policy.

What interest rate policy will stabilize λ at some constant as opposed to allowing it to fluctuate around this constant? This occurs when

$$\widetilde{L}_t = \tau \widetilde{A}_t.$$

[3] The steady-state relationships imply that $\lambda = \gamma$.

Imposing this on the system (21)-(23), we can then back out the implied interest rate policy. This optimal policy implies the following behavior:

$$\widetilde{A}_t = \frac{1}{1+\tau}(\widetilde{q}_t + \widetilde{e}_{t-1})$$

$$\widetilde{e}_t = \widetilde{e}_{t-1}.$$

The latter implies that optimal policy keeps e_t at its initial level, which we will normalize to the steady-state for simplicity. With $\widetilde{e}_t = \widetilde{e}_{t-1} = 0$, we have $(1+\tau)\widetilde{A}_t = \widetilde{q}_t$, so that (23) can be written as

$$(1+\tau)\widetilde{A}_t + \widetilde{R}_t = \left(\frac{R-\beta}{R}\right)\widetilde{D}_t + \frac{\beta}{R}(1+\tau)\rho_A \widetilde{A}_t,$$

or solving for the *optimal interest rate policy*:

$$\widetilde{R}_t = \left(\frac{R-\beta}{R}\right)\widetilde{D}_t - (1+\tau)\left(\frac{R-\beta\rho_A}{R}\right)\widetilde{A}_t. \qquad (26)$$

There are several observations of interest.

First, when there is a positive shock to productivity A_t, the central bank should lower the nominal interest rate so that employment can expand in an efficient manner. A constant interest rate policy does not allow this because of the collateral constraint. This procyclical interest rate policy overcomes the collateral constraint by making tree prices procyclical, and thus allows the economy to respond appropriately.

Second, and in contrast, if there is a positive shock to dividends, the central bank should increase the interest rate by enough to keep employment constant. It is inefficient for employment to respond to these dividend shocks, and the central bank can ensure no response by raising the nominal rate in response. In this case, the central bank increases the nominal rate by enough to keep share prices at their initial level.

Third, suppose that there is a common shock, $\widetilde{A}_t = \widetilde{D}_t$. Since $\tau > 0$ and $\rho_A < 1$, optimal interest rate policy remains procyclical with the nominal rate declining in response to a positive productivity innovation.

Fourth, there is an obvious danger to a policy with very low average nominal interest rates. The optimal policy requires an ability to move the nominal rate adequately in response to shocks. As the average nominal rate approaches the zero bound, this flexibility is lost. In the model without the collateral constraint, there is no preference for the average inflation rate. For example, the Friedman rule of $R_t = 1$ is as good as any other. In this model with collateral constraints, the Friedman rule would be disastrous as the central bank loses all ability to respond in the way implied by (26).

Fifth, this optimal policy is not time consistent. Within each period there is always an incentive to drive the nominal rate down to zero, thus inflating asset prices, and allowing employment to temporarily move closer to the first best. This desire to deviate is eliminated only at the Friedman rule of R = 1. Thus, although the optimal policy under commitment calls for the average nominal interest rate to be sufficiently positive, the time consistent policy is R = 1. Hence, we have a novel form of the commitment problem. The central bank would like to commit to higher nominal interest rates than would arise in the model without commitment.

IV. Conclusions.

This paper addresses the question of whether monetary policy should respond to asset prices. We address this question in a stylized model in which asset prices have a direct effect on real activity because of binding collateral constraints. In this environment there is a welfare-improving role for a monetary policy that will actively respond to asset price and productivity shocks. This activist interest rate policy allows the economy to respond to shocks in a Pareto efficient manner. By assumption, monetary policy cannot eliminate the long run impact of the informational constraint, but it can smooth the fluctuations in this constraint. This smoothing is welfare-improving.

In a related piece, Bernanke and Gertler (1999) argue that monetary policy should not respond directly to asset prices.[4] There are two key differences in the analyses. First, Bernanke and Gertler do not conduct an optimal policy exercise, but instead assume that the central bank is following a Taylor-type policy rule in which the interest rate responds positively to inflation shocks. Within the confines of this rule, they ask whether or not there is a separate role for a response to asset prices. In contrast, the current paper deduces the nature of the optimal policy rule. A second key difference is that Bernanke and Gertler consider a model with sticky goods prices, while the current paper considers a flexible price environment. In their sticky price model, asset price movements increase "aggregate demand" and directly increase current inflation.[5] Hence, a Taylor rule that responds to inflation is also indirectly responding to share prices, so that there may be no need for a direct response to share prices. In this paper's flexible price environment asset price movements have no direct effect on inflation, so that this indirect response to asset prices is precluded.

[4] Their theoretical environment builds on Bernanke and Gertler (1989), Carlstrom and Fuerst (1997) and Bernanke, Gertler, and Gilchrist (2000). See Carlstrom and Fuerst (2001) for a related discussion.
[5] In contrast, in the model of this paper, asset price movements increase "aggregate supply" by easing the loan constraint upon firms.

References

Bernanke, B., and M. Gertler, 1989, "Agency Costs, Net Worth and Business Fluctuations," *American Economic Review* (73), 257-276.

Bernanke, B., M. Gertler, and S. Gilchrist, 2000, "The Financial Accelerator in a Quantitative Business Cycle Framework," in *Handbook of Macroeconomics Volume 1C,* edited by John Taylor and Michael Woodford (Elsevier), 1341-1393.

Bernanke, B., M. Gertler, 1999, "Monetary Policy and Asset Price Volatility," *Federal Reserve Bank of Kansas City Economic Review* 84(4), 17-52.

Carlstrom, C. T., and T. S. Fuerst, 1997, "Agency Costs, Net Worth and Business Fluctuations: A Computable General Equilibrium Analysis," *American Economic Review,* 87(5), 893-910.

Carlstrom, C. T., and T. S. Fuerst, 2001, "Monetary Shocks, Agency Costs and Business Cycles," *forthcoming, Carnegie-Rochester Series on Public Policy.*

Friedman, Milton (1969), "The Optimum Quantity of Money," in his *The Optimum Quantity of Money and Other Essays*, Chicago: Aldine.

Hart, O. and J. Moore (1994), "A Theory of Debt Based on the Inalienability of Human Capital," *Quarterly Journal of Economics*, November, 841-79.

Kiyotaki, N. and J. Moore (1997), "Credit Cycles," *Journal of Political Economy*, 105(2), 211-248.

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