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*Inflation and the Real Price of Equities: Theory with Some Empirical Evidence**

This paper examines a channel of monetary transmission through the stock market. Theoretically, the model predicts an unambiguously negative relationship between money and real activity through the stock prices channel. Empirically, the evidence is in favor of a predominantly negative correlation between money and stock prices, mainly in the period prior to the 1980s. However, shocks to money have a *transitory* effect on stock prices.

1. Introduction

Monetary policy has been one of the most important macroeconomic tools in modern economic analysis. However, its relative effectiveness and ultimate power has been challenged over the last decades by several schools of thought. Particularly, in the 1980s with the emergence of the real business cycle school, attention has shifted from monetary aspects of business fluctuations to real aspects. In this class of models, money is essentially endogenous with output causing money, and the correlation between money and real activity is positive; see, for example, King and Plosser (1984). More recently, efforts have centered on accommodating models based on optimizing principles to reflect a sensitivity to monetary arrangements in general. For instance, Lucas (1987) has indicated that money should be an ingredient in the modern general equilibrium approach to macroeconomics.

In this spirit, some theoretical and empirical papers have emerged trying to account for a view where money is *exogenous* and the correlation between money and real activity is positive. Theoretical models along these lines include Christiano (1991), Fuerst (1992), Christiano and Eichenbaum (1992), and Schlagenhauf and Wrase (1992). These authors focus on liquidity effects of monetary policy; that is, an increase in some monetary aggregate spills over to a decrease in interest rates and a consequent spur in real activity. Authors such as Cochrane (1989), Sims (1992), Eichenbaum (1992), and Bernanke and Blinder (1992) have tackled this issue from an empirical perspective.

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This paper looks at the question of monetary policy transmission through a channel that has not yet been discussed by any of the authors mentioned above, namely the stock market. I present a simple theoretical general equilibrium model with finance constraints on consumption and assets along the lines of Lucas (1990), and distortionary taxes and the dynamic financial decision of the firm explicitly taken into account along the lines suggested by Brock and Turnovsky (1981). Then, I show theoretically that the effect of monetary policy on real activity is unambiguously negative. The channel of monetary transmission is through the price of stocks which ultimately determines the demand for capital by firms. The rate of growth of some measure of the money stock, which functions as a measure of inflation, determines the market price of equities, which in turn will determine the level of the capital stock in the economy.[1]

The channel of monetary policy studied in the theoretical part leads to a few empirically testable hypotheses. Here, I focus on three tests. One regards the assumption of the exogeneity of the monetary aggregate which in my model depends on the causal relationship between the monetary aggregate and the stock price. The other is the model's implication that the rate of growth of some monetary aggregate and the discount factor on capital gains are negatively correlated, which empirically depends on the correlation between the monetary aggregate and the stock price. And third, I test if monetary shocks have permanent or transitory effects on stock prices.

I present some empirical evidence using nonborrowed reserves as a measure of the monetary aggregate. The empirical evidence using nonborrowed reserves as a measure of the monetary aggregate weakly confirms the exogeneity of the monetary aggregate and is in favor of a predominantly negative correlation between money and real activity through the stock market channel as predicted by the theoretical model. However, contrary to a recent result in the literature, I find that the monetary effects are transitory, indicating that there is no long-run relationship between money and stock prices.

The paper is organized as follows: in Section 2, the basic model is presented; Section 3 presents the integrated equilibrium; Section 4 derives the main theoretical results; Section 5 considers the empirical evidence; and Section 6 presents some final remarks. Some relevant data descriptions and sources are left to an appendix.

[1]See for example Gertler and Grinols (1982) for an early contribution that discusses the relationship between monetary volatility and investment.

2. The Model

The framework consists of a decentralized closed economy with three sectors: government, households, and firms. Time is discrete and perfect foresight is assumed. The equilibrium infinite horizon representative agent model is along the lines of Brock and Turnovsky (1981) with money introduced via cash-in-advance constraints in consumption and assets as in the recent paper of Lucas (1990).

Government

The government faces an intertemporal budget constraint given by

$$[(1 + \mu_{pt+1})m_{t+1} - m_t] = T_t - \tau_y(w_t + d_t) - \tau_c(\mu_{qt} + \mu_{pt})q_t e_t \,, \qquad (1)$$

where

$\mu_{pt} = (P_t/P_{t-1}) - 1$ = rate of inflation at time t;
P_t = price level at time t;
$m_t = (M_t/P_t)$ = real stock of money at time t;
M_t = nominal stock of money at time t;
$w_t = (W_t/P_t)$ = real wage rate at time t;
W_t = nominal wage rate at time t;
d_t = real dividends at time t;
$q_t = (Q_t/P_t)$ = real price of equities at time t;
Q_t = nominal price of equities at time t;
$\mu_{qt} = (q_t/q_{t-1}) - 1$ = rate of change of real price of equities at time t;
e_t = number of equities (shares) outstanding at time t;
T_t = real lump-sum tax-rebate at time t;
y_t = real output at time t;
$0 \le \tau_y \le 1$ income tax rate;
$0 \le \tau_c \le 1$ capital gains tax rate.

The standard government budget constraint (1) is expressed in real flow terms with the budget being financed by additions to the stock of money. The tax structure, which follows Brock and Turnovsky (1981), is assumed linear with symmetrical ordinary personal income taxes accruing on labor income and dividends, and capital gains taxes accruing on nominal unrealized capital gains. The government financial policy considered here is the constant rate of growth of money rule; that is, the nominal stock of money is assumed to follow

$$M_{t+1} = (1 + \mu)M_t \,, \qquad (2)$$

where μ is the exogenous constant rate of growth of money.

Households

I assume that households can be consolidated in a single representative unit. However, I follow Lucas (1990) and assume that this consolidated unit consists of a multiple-member party. The typical unit consists of the head of the household who supplies labor inelastically in exchange for money wages; the shopper, who uses part of the unit's monetary resources to buy consumption goods; and another member, the securities trader, who uses the remaining part of the unit's monetary resources to engage in the purchase of shares. The three-member party regroups at the end of each period pooling its resources. The feature of this framework is that the household unit is subject to cash-in-advance constraints in both the goods and assets markets. In turn, the total stock of money must be used for transactions in the goods and assets markets.[2]

The representative household unit faces an intertemporal problem, taking (d_t/q_te_t) as parametrically given:

$$\underset{\{c_t, m_{t+1}, q_{t+1}e_{t+1}\}_{t=0}^{\infty}}{\text{Max}} \sum_{t=0}^{\infty} \beta^t\, U(c_t) \tag{3}$$

subject to the constraints

$$m_t - (q_{t+1}e_{t+1} - q_te_t) \geq c_t \tag{3a}$$

$$\begin{aligned} w_t + [(d_t/q_te_t) + \mu_{qt}]q_te_t - \tau_y[w_t + (d_t/q_te_t)q_te_t] \\ - \tau_c(\mu_{qt} + \mu_{pt})q_te_t + T_t \\ - c_t + [m_t - (q_{t+1}e_{t+1} - q_te_t) - c_t] = [(1 + \mu_{pt+1})m_{t+1} - m_t] \\ + [q_{t+1}e_{t+1} - q_te_t] \end{aligned} \tag{3b}$$

$$M(o) = M_o > 0 \text{ given.} \tag{3c}$$

In equilibrium, the transversality conditions

$$\lim_{t\to\infty} \beta^{t-1}(\lambda_{1t} + \lambda_{2t})\, m_t = \lim_{t\to\infty} \beta^{t-1}(\lambda_{1t} + \lambda_{2t})\, q_te_t = 0 \tag{3d}$$

and the government budget constraint (1) hold, with $0<\beta<1$ being the consumer subjective discount factor, and c_t = real consumption at time t, λ_{it} $(i = 1,2)$ = nonnegative Lagrange multiplier on budget constraints (3a,b) respectively at time t, $U(.)$ = utility function with $U_c(.)>0$ and $U_{cc}(.)<0$.

Equation (3a) is the cash-in-advance constraint on the net purchase of shares and consumption. (3b) is the households budget constraint in real flow terms with labor income, dividends and capital gains as the main sources to be used as tax payments, consumption, and/or additions to money and equities stocks. Equation (3c) is the given initial condition, and (3d) are the

[2]In Lucas (1990), government financial policy follows an exogenous stochastic process, and the timings of the transactions, the division of cash resources, and the observability of the government financial policy are of crucial importance. In my case of perfect foresight, these problems are not crucial.

appropriate transversality conditions which are satisfied in equilibrium. The government budget constraint, (1), is also a constraint for the household unit.

Defining $\rho_t \equiv \beta\,(\lambda_{2t+1}/\lambda_{2t})$ to be the consumer discount factor on wealth, the first-order optimality conditions with respect to c_t, m_{t+1} and $q_{t+1}e_{t+1}$ may be compactly written as

$$U_c(c_t) = \lambda_{1t} + \lambda_{2t} \tag{4a}$$

$$\rho_t[1 + (\lambda_{1t+1}/\lambda_{2t+1})] = 1 + \mu_{pt+1} \tag{4b}$$

$$\rho_t\{1 + (\lambda_{1t+1}/\lambda_{2t+1}) + (d_{t+1}/q_{t+1}e_{t+1})(1 - \tau_y) + (1 - \tau_c)\mu_{qt+1} - \tau_c\mu_{pt+1}\} = [1 + (\lambda_{1t}/\lambda_{2t})]\ . \tag{4c}$$

Equations (4a)–(4c) describe the conditions for an interior equilibrium. Equation (4a) states that the marginal utility of consumption equals the marginal utility of wealth plus the liquidity value of cash. This is the usual relationship derived in cash-in-advance models where a wedge between the marginal utilities of consumption and wealth is driven by the cash-in-advance constraint on consumption and assets. Equation (4b) equates the discounted benefits, in terms of liquidity, of holding cash with its costs determined by the gross rate of inflation. Finally, (4c) is the arbitrage condition that insures that equities yield a rate of return comparable to the forgone consumption and liquidity value.

Firms

The corporate sector, consisting of a representative firm, maximizes a specific objective in order to choose capital, labor demand, and the dividend rate to be distributed to shareholders. Towards a derivation of the firm objective function, which follows Brock and Turnovsky (1981) closely, consider the following constraints:

$$y_t = f(k_t) \tag{5a}$$

$$\pi_t = y_t - w_t = d_t + RE_t \tag{5b}$$

$$I_t = \Delta k_t = q_{t+1}(\Delta e_t) + RE_t \tag{5c}$$

$$k(o) = k_o > 0\ , \quad e(o) = e_o > 0\ , \quad \text{given}, \tag{5d}$$

where

Δ = the difference operator, $\Delta k_t = (k_{t+1} - k_t)$,
k_t = stock of physical capital,
π_t = real gross profits,
RE_t = retained earnings,
I_t = real investment,
$f(.)$ = neoclassical production function with positive but diminishing marginal physical products, that is, $f_k > 0$ and $f_{kk} < 0$; assumed to be linear homogeneous.

The firm produces according to the technology constraint described in (5a). Real gross profit, defined in (5b), is production minus the wage bill, which is distributed as dividends to stockholders and maintained as retained earnings. Firms are assumed to finance investment through the issue of equities and through retained earnings according to (5c). Finally, (5d) denotes the given initial conditions.[3]

The current market value of securities outstanding, V_t, is defined as

$$V_t = q_t e_t \,, \tag{6}$$

and the firm objective is to maximize its initial market value, $V_o = q_o e_o$. Towards that, first eliminate RE_t from (5b,c) to obtain

$$d_t = \pi_t - \Delta k_t + q_{t+1}(\Delta e_t) \,. \tag{7a}$$

Then, differencing (6), one obtains

$$\Delta V_t = q_{t+1}e_{t+1} - q_t e_t \,. \tag{7b}$$

Noting that $\Delta q_t = (q_{t+1} - q_t)$, one may use (5), (6), and (7) to obtain an equation for the evolution of the value of the firm as

$$V_{t+1} = (1 + \mu_{qt+1})\, V_t + d_t - \pi_t + \Delta k_t \,. \tag{8}$$

The dividend policy used here is the one suggested by Lintner (1956) where the firm pays a fraction of profits,[4] or

$$d_t = \phi\, \pi_t \,; \qquad 0 \le \phi \le 1 \,. \tag{9}$$

Substituting (9) into the evolution of V_t, (8), one obtains

$$V_{t+1} = (1 + \mu_{qt+1})\, V_t - \gamma_t \,, \tag{10}$$

where $\gamma_t \equiv \{(1 - \phi)\pi_t - \Delta k_t\} = \{(1 - \phi)[f(k_t) - w_t] - \Delta k_t\}$ is the firm net cash flow. Equation (10) is a difference equation with variable term and coefficient.[5] The solution of (11), for an arbitrary t, is

[3]I abstract from bond financed debt by firms focusing on the equity financed case, see, for example, Brock and Turnovsky (1981), and Atkinson and Stiglitz (1980), Lecture 5, for a general account of the firm financial structure.

[4]See, for example, Jorgenson and Yun (1991), pages 86–89, for an empirical description of this dividend policy.

[5]Brock and Turnovsky (1981) used a different dividend policy, that is, $d_t = iq_t e_t$, where i is set exogenously by the firm. Turnovsky (1990) examined two alternative dividend policies also found in the literature. One is where all after-tax profit is paid out as dividends and the other is where the financing of all investment is through retained earnings such that dividends become after-tax profits minus the installation cost of capital. In all the alternative cases, the difference Equation (10) is slightly changed.

$$V_t = [\Pi_{j=0}^{t-1}(1 + \mu_{qj})] \sum_{n=t}^{\infty} [\Pi_{\tau=0}^{n}(1 + \mu_{q\tau+1})]^{-1} \gamma_1 . \tag{11}$$

Note that it is optimal for the firm to set $\phi = 0$, that is, pay zero dividends. The argument for positive dividends hinges on a firm signaling its performance to the market.[6] The firm objective, in order to choose real quantities, is to maximize its value at $t = 0$, and from (11) the problem may be stated as

$$\underset{\{k_{t+1}\}_{t=0}^{\infty}}{\text{Max}}\ V_o = \sum_{t=0}^{\infty} [\Pi_{\tau=0}^{t}(1 + \mu_{q\tau+1})]^{-1} \gamma_t , \tag{12}$$

subject to the constraints

$$\gamma_t = (1 - \phi)[f(k_t) - w_t] - \Delta k_t \tag{12a}$$

$$k(o) = k_o > 0 \text{ , given.} \tag{12b}$$

In equilibrium, the transversality condition

$$\lim_{T\to\infty} [\Pi_{\tau=0T}(1 + \mu_{q\tau+1})]^{-1} k_{T+1} = 0 \tag{13}$$

holds, and the first-order condition for the representative firm is given by

$$(1 - \phi)f_k(k_{t+1}) + 1 = 1 + \mu_{qt+2} , \tag{14}$$

which says that the marginal physical product of capital net of dividend payments is equal to the net cost of capital. It is then straightforward to show that by substituting the optimality condition (14) into the transversality condition (13) one obtains

$$V_t = q_t e_t = k_t , \tag{15}$$

which shows that, in equilibrium, the underlying market value of the firm is equal to its capital stock, or alternatively, there is no divergence between the equity value and the capitalized value of earnings in equilibrium.[7]

3. General Equilibrium

The full equilibrium of this economy consists of the government budget constraint, (1), the household cash constraint (3a), the household first-order conditions (4a)–(4c), the firm first-order condition (14) together with (15), and the goods, money, and equity markets equilibrium. Here, I am going to

[6]See Hines (1991) for a detailed description of this argument and further references.

[7]See Ekeland and Scheinkman (1986) for applications of the transversality condition in a discrete time framework.

focus on the (average) stationary equilibrium of the economy. The stationary equilibrium is attained when all real variables are constant, that is,

$$k_{t+1} = k_t = k \; ; \qquad c_{t+1} = c_t = c \; ; \tag{16a}$$

$$\lambda_{it+1} = \lambda_{it} = \lambda_i \; , \qquad i = 1, 2 \; ; \rightarrow \rho_t = \rho = \beta \; ; \tag{16b}$$

$$\Delta(m_{t+1}) = 0 \rightarrow (1 + \mu_p)(m' - m) = 0 \rightarrow \mu_p = \mu \; , \tag{16c}$$

where a prime over a variable indicates next period and (16c) follows directly from (2). Also the rate of change of the real price of equities is constant, or $\mu_{qt+1} = \mu_{qt} = \mu_q$. Thus, the general equilibrium is characterized by the following set of equations

$$m = f(k) = c \; ; \tag{17a}$$

$$\lambda_1 = U_c(c)[(1 + \mu - \beta)/(1 + \mu)] \; ; \tag{17b}$$

$$\lambda_2 = \beta \; U_c(c)/(1 + \mu) \; ; \tag{17c}$$

$$\mu_q = \{(1 + \mu)(1 - \beta) + \tau_c \beta^2 \mu\} \; / \; \beta^2 \{[\phi/(1 - \phi)] (1 - \tau_y) + (1 - \tau_c)\} \; ; \tag{17d}$$

$$f_k(k) = \mu_q/(1 - \phi) \; ; \tag{17e}$$

$$T = \{k[\phi \tau_y f_k(k) + \tau_c(\mu_q + \mu)] + \mu c + \tau_y w\} \; ; \tag{17f}$$

and the transversality conditions (13) and (3d), where (17a) represents the goods market equilibrium condition together with the cash-in-advance constraint. The system (17) consists of 7 equations which solve for 7 endogenous variables, k, c, m, μ_q, λ_1, λ_2, and T, given μ, β, τ_y, τ_c, and ϕ.[8] Then, the real price of equities, q, is determined on a period by period basis by a recursion on (17d), with (15) determining on a period by period basis the equilibrium quantity of equities issued by firms.

A sketch of the recursive solution is as follows: Equation (17d), which describes the arbitrage condition for equities, solves for the rate of change of the real price of equities, μ_q; the solution for μ_q may be substituted into the solution for the marginal physical product of capital, (17e), which solves implicitly for the capital stock, k; the basic goods market equilibrium and quantity theory of money equations in (17a) solve for real consumption, c, and real money balances, m; equation (17c) solves for the marginal utility of real wealth, λ_2; (17b) solves for the marginal value of the liquidity constraints,

[8]Note that $1 + \mu \geq \beta$ is assumed throughout the analysis. If $1 + \mu > \beta$, all cash constraints are binding, velocity of circulation is unitary, and money is dominated in rate of return by capital. If $1 + \mu = \beta$, the cash constraints are slack, velocity is variable, and money is not dominated in rate of return by any other asset.

λ_1; and T adjusts endogenously to balance the government budget constraint in (17f).[9]

4. Inflation, the Real Price of Equities, and the Capital stock

The main point of this part of the paper is to examine the effect of inflation on the capital stock through the stock market channel. Since the solution for the system (17) is recursive, it is straightforward to calculate this effect. First, from (17d), one obtains

$$d\mu_q/d\mu = [(1-\beta)+\beta^2\tau_c] \,/\, \beta^2\{[\phi/(1-\phi)](1-\tau_y)+(1-\tau_c)\} > 0 \quad (18a)$$

and then from (17e)

$$dk/d\mu = (d\mu_q/d\mu)/(1-\phi)f_{kk} < 0\,. \quad (18b)$$

It is clear that the qualitative sign of $dk/d\mu$ is unambiguously negative. An increase in the rate of growth of money increases the rate of change of the real price of equities (that is, lowers the discount factor on capital gains, $q/q' \equiv [1/(1+\mu_q)]$) leading to an increase in the cost of capital and a consequent decrease in the capital stock. Since both consumption and equities require cash, money functions as a tax on investment. The higher the tax, the lower the capital stock. This result has been previously obtained in the perfect foresight theoretical models of Stockman (1981), Brock and Turnovsky (1981), Abel (1985), Turnovsky (1987), and more recently in the models studied by Schlagenhauf and Wrase (1992).[10]

In the polar case where there are no taxes, $\tau_y = \tau_c = 0$, and the finance constraint is relaxed according to Friedman's optimum quantity of money rule, $1+\mu = \beta$, Equation (17d) reduces to $\mu_q = (1-\phi)(1-\beta)/\beta$. In turn, from Equation (17e), the capital stock is determined by $f_k(k) = (1-\beta)/\beta$ which is the modified golden rule, see, for example, Burmeister and Dobell (1970). In this case, the capital stock is independent of the rate of inflation, a result originating in Sidrausky (1967) for the case of money in the utility function.

[9]In the stationary equilibrium the capital gains are paid out of retained earnings since by (5c) and (15) one obtains $RE = \mu_q k$.

[10]Tobin (1965) studied a qualitative effect on the capital stock in an alternative portfolio model which is contrary to the one obtained in my model. The crucial distinction between Tobin's model and the one in this paper is the endogenous savings decision of the representative household. In the recent stochastic (mean-variance) models of Grinols and Turnovsky (1993) and Turnovsky (1993), an increase in the mean rate of inflation leads to Tobin's wealth effect, but an increase in the variance of inflation has the opposite effect. In my model, the increase in the deterministic part of inflation has the opposite of Tobin's wealth effect because of the finance constraint in consumption and net purchases of equities. See also Gertler and Grinols (1982), Christiano and Eichenbaum (1992) and Bernanke and Blinder (1992).

In summary, in my model the effect of money growth on the capital stock is intimately related to the effect of money growth on the endogenous rate of change of the real price of equities (or the discount factor on capital gains), the stock market channel. This is achieved with the presence of finance constraints and distortionary taxes. Intuitively, there are two assets, money and shares, and one consumption good in the model. The household's optimal allocation of wealth implies that the marginal benefits and costs of holding each asset and of consuming the good are equated. Since the rate of growth of money is taken to be exogenous, alternative values give alternative allocations between assets and consumption. Given the endogenous saving decision, the ultimate effect on real activity is through the demand for capital, as may be seen from Equations (17e) and (18b). An increase in the rate of growth of money leads to a decrease in the demand for capital, the substitution or anticipated inflation effect. The rest of this paper sheds some light on these issues empirically.

5. Some Empirical Evidence

Several authors have studied the relationship between inflation and stock returns, for example, Nelson (1976), Fama (1981), Pindyck (1984), Kaul (1987), Boudoukh and Richardson(1993). Others have studied the relationship between stock prices and the velocity of circulation, for example, Friedman (1988). My interest here is to test empirically some of the aspects of the theory presented in the previous section. First, the theory is built under the assumption that some measure of the rate of growth of money is exogenous to the economic system. In particular, the rate of growth of money is exogenous to the discount factor on capital gains as may be seen in Equation (18a). This leads to one empirical test of an assumption of the model, namely the causal relationship between money growth and the discount factor on capital gains. Second, an implication of the theory is the sign of the relationship between the rate of money growth and the discount factor on capital gains as may be seen in Equation (18b). An empirical investigation of this relationship would help to confirm the substitution or anticipated inflation effect discussed above.[11]

Third, I examine the persistence of monetary shocks on stock prices by using a simple bivariate vector autoregression (VAR), a methodology generally recommended by Sims (1980). The interest here is theoretical and

[11]There is no conflict here between the nonstochastic theoretical model and the empirical analysis because the statistical analysis below is based on a linearized version of the deterministic theoretical model with additive stochastic disturbances; see, for example, King, Plosser and Rebelo (1988).

empirical. For example, in the theoretical paper by Fuerst (1992), the short- and long-run effects of monetary policy are very different. In the short run a monetary shock drives interest rates down, but the long-run effect is to drive it up. Empirically, Boudoukh and Richardson (1993) have found the result that even though inflation and stock prices are negatively related in the short run, they are *positively* related in the *long run*. Using the VAR methodology here allows me to examine these issues in a natural way.

The data are for the United States from the Citibase data set. I am going to use one basic narrow measure of the money stock, namely nonborrowed reserves. The reason is that, in the recent contributions of Christiano and Eichenbaum (1992), and Eichenbaum (1992), it is claimed that nonborrowed reserves is a more appealing measure of exogenous monetary policy since it is in direct control by the monetary authority through open market operations. The stock price data is the Standard & Poors 500 corporations composite stock price index deflated by the consumer price index.[12] The basic sample is from 1959:2 to 1990:12 and the variables are the rate of growth of nonborrowed reserves and the Standard & Poors 500 corporations composite stock price index deflated by the consumer price index, that is, the ratio q/q'. I have divided the sample into two subsamples as in Bernanke and Blinder (1992) based on the fact that in late 1979 the then chairman of the Federal Reserve System, Paul Volcker, implemented a new anti-inflationary policy that lead to an abnormal increase in interest rates. The two series in question are stationary. However, I ran the empirical analysis in levels and first differences.[13]

The first test of the assumption of monetary exogeneity is the causal relationship between μ and q/q' relating to Equation (18a) in the theory. Table 1 presents Granger (1969) causality tests at 12 lags for the levels and first differences of the discount factor on capital gains and the levels and first differences of the rate of growth of nonborrowed reserves. In each case, two equations are estimated, equations A and B, with alternative null hypotheses described in the tables. The usual "*F*-test" is carried out, and results are described in the tables. The first columns present results for the whole sample, from 1959:*ii* to 1990:*xii*. I find no evidence of causality between the

[12]See the appendix for sources and transformations. Also, I have used the monetary base as a measure of narrow money in a previous version of this paper and discuss some of those results below. These are available from the author upon request.

[13]As may be seen below, the qualitative results in levels are almost the same as with first differences, but the latter are slightly more powerful. Note also that the dynamic patterns captured by the causality tests are sensitive to the difference operator; see Marshall (1992, 1339), and Christiano and Ljungqvist (1988) for similar results. Basically, the first differences filter reduces power at low frequencies and is likely to underestimate long-run relationships among time series. In turn, the first differences results emphasize the short-run relation.

TABLE 1. *Granger Causality Tests—Nonborrowed Reserves*

	Whole Sample 59:2–90:12	Subsample 1 59:2–79:12	Subsample 2 80:1–90:12
I. Levels			
A. $(q/q')(t) = \Sigma_{j=1}^{12} \psi_{1j} [(q/q')(t-j)] + \Sigma_{j=1}^{12} \psi_{2j} [\mu(t-j)] + \epsilon_{1t}$			
Null Hypothesis: "μ does not cause (q/q')"			
	$F(12{,}347) = 1.209$	$F(12{,}215) = 2.005$	$F(12{,}108) = 1.895$
	$p\text{-}val = 0.274$	$p\text{-}val = 0.025$	$p\text{-}val = 0.042$
	Accept Null	Reject Null	Reject Null
B. $\mu(t) = \Sigma_{j=1}^{12} \psi_{3j} [\mu(t-j)] + \Sigma_{j=1}^{12} \psi_{4j} [(q/q')(t-j)] + \epsilon_{2t}$			
Null Hypothesis: "(q/q') does not cause μ"			
	$F(12{,}347) = 2.073$	$F(12{,}215) = 1.673$	$F(12{,}108) = 1.404$
	$p\text{-}val = 0.018$	$p\text{-}val = 0.074$	$p\text{-}val = 0.174$
	Reject Null	Reject Null	Accept Null
II. First Differences			
A. $\Delta(q/q')(t) = \Sigma_{j=1}^{12} \psi_{1j} [\Delta(q/q')(t-j)] + \Sigma_{j=1}^{12} \psi_{2j} [\Delta\mu(t-j)] + \epsilon_{1t}$			
Null Hypothesis: "$\Delta\mu$ does not cause $\Delta(q/q')$"			
	$F(12{,}346) = 1.535$	$F(12{,}214) = 2.667$	$F(12{,}95) = 2.029$
	$p\text{-}val = 0.109$	$p\text{-}val = 0.002$	$p\text{-}val = 0.029$
	Accept Null	Reject Null	Reject Null
B. $\Delta\mu(t) = \Sigma_{j=1}^{12} \psi_{3j} [\Delta\mu(t-j)] + \Sigma_{j=1}^{12} \psi_{4j} [\Delta(q/q')(t-j)] + \epsilon_{2t}$			
Null Hypothesis: "$\Delta(q/q')$ does not cause $\Delta\mu$"			
	$F(12{,}346) = 0.972$	$F(12{,}214) = 0.708$	$F(12{,}95) = 1.063$
	$p\text{-}val = 0.474$	$p\text{-}val = 0.742$	$p\text{-}val = 0.399$
	Accept Null	Accept Null	Accept Null

NOTE: Estimation by ordinary least squares (OLS).

two variables in any direction, except in the direction q/q' to μ. The second column is the first subsample studied by Bernanke and Blinder (1992). I find evidence that the rate of growth of nonborrowed reserves causes the discount factor on capital gains in levels and first differences, but with feedback in the case of levels. In the second subsample, basically the 1980s, for levels and first differences, the two tests suggest that the rate of growth of nonborrowed reserves causes the discount factor on capital gains, and not vice-versa.

There is some evidence suggesting that the rate of growth of nonborrowed reserves helps to predict the discount factor on capital gains. The data

TABLE 2. *Regressions*

	Whole Sample 59:3–90:12	Subsample 1 59:4–79:12	Subsample 2 80:1–90:12
Estimated Equation (Levels): $(q/q')(t) = \alpha + \beta\,[\mu(t)] + \xi_t$			
	α = 1.001*	α = 1.004*	α = 0.997*
	(0.002)	(0.002)	(0.005)
	β = −0.457*	β = −0.719*	β = −0.197
	(0.139)	(0.194)	(0.210)
	ρ = −0.300*	ρ = 0.279*	ρ = −0.348*
	(0.049)	(0.061)	(0.083)
	Nobs = 382	*Nobs* = 249	*Nobs* = 131
	R^2-*adj* = 0.111	R^2-*adj* = 0.109	R^2-*adj* = 0.120
	SSE = 0.034	*SSE* = 0.033	*SSE* = 0.036
	SSR = 0.450	*SSR* = 0.270	*SSR* = 0.173
	D-W = 1.931	*D-W* = 1.961	*D-W* = 1.886
Estimated Equation (First Differences): $\Delta(q/q')(t) = \alpha + \beta\,[\Delta\mu(t)] + \xi_t$			
	α = −0.000	α = 0.000	α = −0.000
	(0.001)	(0.001)	(0.003)
	β = −0.459*	β = −0.769*	β = −0.137
	(0.143)	(0.196)	(0.216)
	ρ = −0.283*	ρ = −0.313*	ρ = −0.219**
	(0.049)	(0.060)	(0.086)
	Nobs = 381	*Nobs* = 249	*Nobs* = 131
	R^2-adj = 0.101	R^2-adj = 0.151	R^2-*adj* = 0.034
	SSE = 0.040	*SSE* = 0.039	*SSE* = 0.043
	SSR = 0.634	*SSR* = 0.380	*SSR* = 0.243
	D-W = 2.180	*D-W* = 2.239	*D-W* = 2.089

NOTES: Standard error of estimates in parenthesis. (*) significant at the 1% level; (**) significant at the 5% level. ρ is the coefficient for first-order autocorrelation in the error. Method: OLS with Cochrane-Orcutt correction for autocorrelation in the errors. SEE = standard error of estimate; SSR = sum of squared residuals; D-W = Durbin-Watson statistic.

(weakly) suggest that the rate of growth of nonborrowed reserves is an exogenous variable which is consistent with the theoretical model presented in this paper.

The regression in Table 2 describe the relationship between the levels and first differences of the rate of growth of nonborrowed reserves as the independent variable with the contemporaneous value of the levels and first differences of the discount factor on capital gains relating to Equation (18b). The first column of Table 2 indicates the results for the whole sample. There is a significant negative relationship between the two variables. A one-unit increase in $\mu(t)$ or $\Delta\mu(t)$ leads to a decrease in $(q/q')(t)$ or $\Delta(q/q')(t)$ of about one half. The evidence suggests that these two variables are negatively correlated, which favors the substitution or anticipated inflation effect as the theoretical model predicts.

This negative correlation is confirmed in the first subsample. Prior to 1980, there is evidence of a negative correlation between these two variables, and the magnitude of the coefficient is 60% larger, in absolute value, than in the whole sample. In the final subsample, the 1980s, there is no evidence of any correlation between the two variables. In summary, the evidence in favor of the substitution effect is much more clear prior to 1980 than in the later period.

The conclusion from the evidence concerning the relationship between nonborrowed reserves and the discount factor on capital gains is that the data seem to accept a model in which the rate of growth of money is taken to be an exogenous process. The correlation between nonborrowed reserves and the discount factor on capital gains is negative, mainly in the period prior to 1980. This evidence confirms previous results in the literature which have found a predominant negative correlation between money and stock prices, see for example, Nelson (1976), Kaul (1987).

As noted above, Boudoukh and Richardson (1993), have found the result that inflation and stock prices are positively related in the long run. Up to this point, my empirical framework has only captured the short-run relationship. One natural way to measure the long-run relationship between money and stock prices is to estimate a bivariate VAR imposing the underlying restriction that money is exogenous.

I have estimated a bivariate VAR with the rate of growth of nonborrowed reserves entering first and as a function of its own 12 lags. The discount factor on capital gains enters second as a function of its own 12 lags and 12 lagged values of the rate of growth of nonborrowed reserves. I perform a one-standard deviation shock in nonborrowed reserves and calculate the implied impulse response functions.[14] Figure 1 presents the results for the whole sample and the two subsamples and Table 3 presents the decomposition of the forecast error variance (FEV) at different steps. The obvious result is that the effects of nonborrowed reserves on stock prices are very

[14] I have estimated several bivariate VARs with and without nonborrowed reserves exogeneity restrictions, in levels and first differences, with permanent shocks, and in all cases, I obtained almost exactly the same results as in Figure 1 and Table 3.

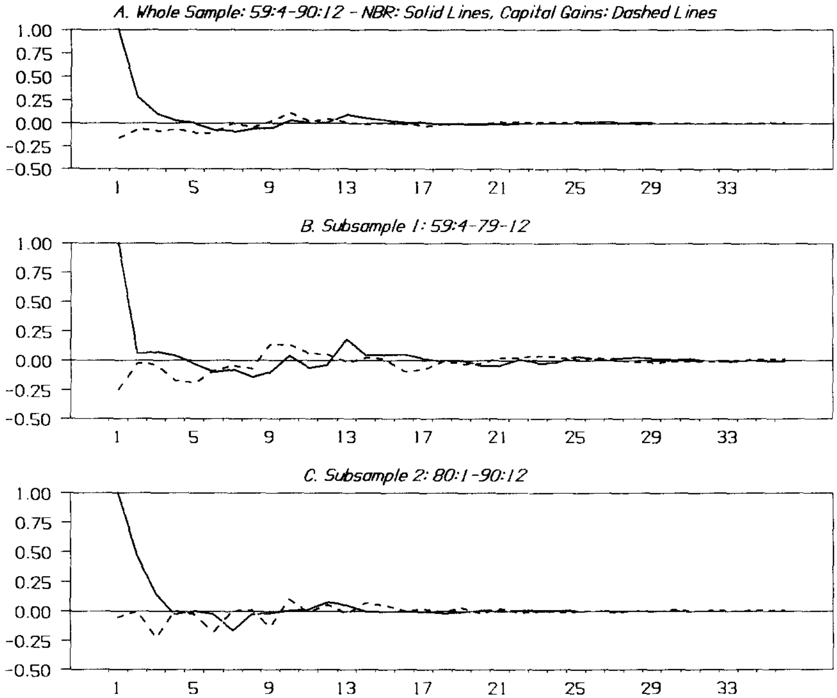

Figure 1.
Nonborrowed Reserve Shocks

much transitory. The contemporaneous effect is seen to be negative, but after 5 to 6 months the effect disappears almost completely. In effect, there is no long-run effect of nonborrowed reserves on stock prices indicating that there is no long-run correlation between the two.

This result is at odds with the result obtained by Boudoukh and Richardson (1993). The key differences are in their sample, which is much longer than mine (they have annual data), and in the instrumental variable methodology they adopt. It seems to me the approach used in this paper gives us more insights on the inflation/stock prices relationship from the point of view of linking the theory to the empirical evidence. The theory presented is based on the exogeneity of the monetary aggregate and the Granger causality test is a natural step towards the estimated dynamic VAR, see, for example, Christiano and Ljungqvist (1988).

The FEV decomposition in Table 3 shows that nonborrowed reserves explain a small fraction of the FEV of the stock price. The most relevant impact is in the period prior to the 1980s, where it explains about 16.5% of the FEV of the stock price at 24 and 36 steps.

TABLE 3. *Decomposition of Forecast Error Variance (FEV) for Discount Factor on Capital Gains (q/q')*

	Percent		
Months Ahead	Standard Errors	Nonborrowed Reserves	Capital Gains
	Whole Sample 59:3–90:12		
6	0.036	5.764	94.235
12	0.036	7.143	92.856
24	0.036	7.301	92.698
36	0.036	7.306	92.694
	Subsample 1 59:4–79:12		
6	0.033	12.283	87.716
12	0.035	15.153	84.849
24	0.035	16.515	83.484
36	0.035	16.620	83.379
	Subsample 2 80:1–90:12		
6	0.037	6.413	93.586
12	0.038	8.257	91.742
24	0.039	8.733	91.266
36	0.039	8.748	91.251

The general conclusion is that the evidence of the effect of monetary policy through the stock market studied in this paper indicates that, in the short run, money has a negative impact of stock prices and in the long run it has no impact at all. In the light of the theoretical model presented, the data show that the stock market channel is not sufficient to generate a positive correlation between money and the capital stock, that is, money and economic activity. Note however that the empirical evidence presented is on the relationship between money and stock prices. The link between stock prices and the capital stock, that is, stock prices and investment, is not examined here since it is beyond the scope of this paper. My empirical evidence suggests that *if that link exists,* then money and real activity are negatively related in the short run, but uncorrelated in the long run. If a positive short-run correlation between money and real activity is common wisdom in practice, it must operate through other channels of monetary transmission.

6. Final Remarks

This paper has presented a simple theoretical general equilibrium model with money where the financial decision of the firm is explicitly taken into account. The model delivers a channel of monetary transmission through the stock market. Monetary policy ultimately affects the demand for capital leading to fluctuations in real activity. The theory indicates that the effect of monetary policy on real activity is negative. This effect may be rationalized as a substitution or anticipated inflation effect. In particular, it implies that money and real activity are negatively correlated.

I have tested the theoretical model empirically on some basic grounds using nonborrowed reserves as a measure of the money stock. I find some evidence that nonborrowed reserves cause the discount factor on capital gains, predominantly in the 1980s, confirming the exogeneity assumption of the monetary aggregate in the model. However, the contemporaneous correlation between nonborrowed reserves and the discount factor on capital gains in the 1980s is not statistically significant. Before 1980, the contemporaneous correlation between nonborrowed reserves and the discount factor on capital gains is negative and statistically significant. Using the vector autoregression methodology, I found that the effects of nonborrowed reserves on stock prices are transitory. This indicates that the two variables are not correlated in the long run, contrary to the results of Boudoukh and Richardson (1993).

Finally, I have performed the causality tests and regressions for the monetary base as the monetary aggregate. However, for the monetary base the causality tests go in the opposite direction; that is, the discount factor on capital gains causes the monetary base and not vice-versa. The difference in causality of these two measures of narrow money is certainly a subject for future research. Also, empirical tests of other implications of the model are worth pursuing.

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Appendix

Data and Transformations

The data used in the empirical analysis come from the CITIBASE, Citicorp Economic Database and are available upon request.

The nonborrowed reserves data are: Nonborrowed Reserves of Depository Institutions, adjusted for changes in reserve requirements, seasonally adjusted, FMRNBA.

In the monetary series, the raw data were transformed as $\mu(t) = Ln(M_t/M_{t-1})$, and $\Delta\mu(t) = \mu(t) - \mu(t-1)$.

The stock price data are the common stock composite price index of the Standard & Poors 500 corporations, FSPCOM, 1967 = 100. I deflated this index by the seasonally adjusted consumer price index, PUNEW, 1967 = 100.

The discount factor on capital gains is computed as $q/q'(t) = \{[\text{FSPCOM}(t-1)/\text{PUNEW}(t-1)]/\text{FSPCOM}(t)/\text{PUNEW}(t)]\}$, and $\Delta[q/q'(t)] = [q/q'(t)] - [q/q'(t-1)]$.

The average value over the whole sample for the rate of growth of nonborrowed reserves is 0.37% and the standard deviation is also 1.31%. The standard deviation of the first differences of the rate of growth of nonborrowed reserves is 1.57%. From 1959:2 to 1979:12, which I describe as subsample 1, the average value of nonborrowed reserves is 0.30%, its standard deviation 1.07%, and the standard deviation of the first differences 1.43%. In the second subsample(2), the average value is 0.53%, the standard deviation increases to 1.68%, and the standard deviation of the first differences also increases to 1.81%. The stock price data are the Standard & Poors 500 corporations composite stock price index deflated by the consumer price index. The series for the discount factor on capital gains, q/q', is centered around unity. This is because it is closely related to excess returns on stocks which are essentially serially uncorrelated. Its standard deviation over the whole sample is 3.52%, and the standard deviation of its first differences is 4.24%. This series is approximately 5 times more volatile when compared to nonborrowed reserves.

Computational work, the Cochrane-Orcutt correction, and the VARs were performed using RATS 4.0 as in Doan (1992).