INFLATION AND INTERMEDIATION IN A MODEL WITH ENDOGENOUS GROWTH

Joseph H. Haslag

March 1995

RESEARCH DEPARTMENT

WORKING PAPER

95-02

Federal Reserve Bank of Dallas

Inflation and Intermediation
in a Model with Endogenous Growth

Joseph H. Haslag

Research Department
Federal Reserve Bank of Dallas
and
Department of Economics
Southern Methodist University

March 1995

Abstract: In this paper, I examine the effects that changes in money growth/inflation have on inside money and capital accumulation in a general equilibrium model. Money is held to meet a cash-in-advance constraint and a reserve requirement. A change in the inflation rate will, in general, affect the ratio of inside money to outside money (the money multiplier). The data indicate a small, negative relationship between changes in the inflation rate and the money multiplier. The model can replicate this stylized observation provided the computational experiments impose enough complementarity between the cash good and credit good. In addition, the model predicts that an anticipated increase in the inflation rate causes agents to substitute unintermediated capital fiat money for unintermediated capital (disintermediation). Disintermediation occurs over time in the sense that intermediated capital grows at a slower rate in the higher inflation environment. In this setup, the model is also capable of replicating Goldsmith's observation; the ratio of intermediaries' assets to output rises over time.

I benefitted from helpful discussions with Scott Freeman, Greg Huffman, Mark Wynne, and Carlos Zarazaga. Any errors in this paper are solely mine. The views expressed in this paper do not necessarily represent the views of the Federal Reserve Bank of Dallas nor the Board of Governors of the Federal Reserve System.

1. Introduction

Beginning with the work of James Tobin (1965) and Miguel Sidrauski (1967), researchers have been interested in the relationship between changes in money growth/inflation and the rate of output growth. There is ample empirical evidence suggesting that higher inflation, for example, results in slower growth.[1] Recent versions of the monetary growth models offer alternative explanations of this stylized relationship. The most frequently used model has agents holding money to satisfy a cash-in-advance constraint. In models developed by Alan Stockman (1981) and Jeremy Greenwood and Gregory Huffman (1987), leisure is the credit good. Thus, an increase in the growth rate of money induces agents to substitute for more leisure and growth slows.[2]

Another line of research has asked how intermediation affects the growth rate. One approach focuses on the "depth" of financial structures and is identified closely with the work of Rondo Cameron (1967), Raymond Goldmith (1969), Ronald MacKinnon (1973), and Edward Shaw (1973). In these studies, the link between the size of the "financial superstructure" and capital purchases is offered as an explanation for differences in growth rates across countries. More recently, Jeremy Greenwood and Boyan Jovanavic (1990) specify a general equilibrium model in which there are economies of scale in information. Greenwood and Jovanavic demonstrate how intermediaries can exploit these economies of scale, leading to faster growth compared with the autarky equilibrium. In another approach, the existence of a financial intermediary is sufficient to induce faster growth. Valerie R. Bencivenga and Bruce D. Smith

---

[1] See, for example, the evidence presented in Milton Friedman (1977), Roger Kormendi and Philip Meguire (1985), and Mark Wynne (1993).

[2] In addition, this mechanism is found in papers by Thomas Cooley and Gary Hansen (1989) and Paul Gomme (1993). Larry Jones and Rodolfo Manuelli (1995) introduce a nominal depreciation allowance into the tax code. the implication is that the return to capital, and thus, growth, are inversely related to the inflation rate.

(1991) specify a general equilibrium model in which an intermediary provides liquidity services to agents facing idniosynchratic liquidity shocks. They demonstrate that in a version of the Diamond-Dybvig (1983) model, growth will be faster in an equilibrium in which the intermediary knows aggregate liquidity needs. Bencivenga and Smith show that risk-averse agents will purchase too little of the illiquid capital good compared with an intermediary. Because the intermediary does not face any aggregate uncertainty, it can allocate more saving into the high-return capital good and still meet the population's liquidity needs.

In this paper, I specify a general equilibrium model in which both output growth and the quantity of intermediation are endogenous responses to changes in anticipated money growth. Throughout this paper, I use the term changes in anticipated inflation as shorthand for permanent, anticipated changes in the growth rate of fiat money. Here, as in several of the papers cited above, the inflation rate and output growth are inversely related. The contribution of this paper is show that this model is also capable of replicating two additional stylized observations: the relationship between changes in anticipated inflation and changes in the ratio of inside money to outside money (the money multiplier) and Goldsmith's result that the ratio of intermediaries' assets to output increases over time. In addition, the model specified here matches with a commonly held view; namely, that higher inflation results greater disintermediation.

Several papers have examined the effect that a change in monetary policy would have on the money multiplier. John G. Gurley and Edward S. Shaw (1960), for instance, argue that a one-time, unanticipated change in money supply results in price level shocks that are negatively correlated with the money multiplier. In Gurley and Shaw, the unanticipated decline in the money stock, for example, results in an increase in the value of nominally denominated assets.[3] Because of these wealth effects, the demand for deposits rises and the money multiplier increases. In another experiment, Scott Freeman and Greg Huffman (1991) ask how a permanent change in money growth would affect the money multiplier. In their setup, money is a substitute for capital. Freeman and Huffman, therefore, have a Tobin effect operating in their model: an increase in the anticipated money growth permanently lowers the rate of return on money, increasing deposits and resulting in a higher money multiplier.

In a related paper, Peter Ireland (1994) offers an alternative view of the effect on changes in anticipated inflation on inside money. Ireland cites empirical evidence suggesting that the ratio of M2 to M1 has been increasing over time, asking whether a model in which output grows endogenously over time could explain this observation. Ireland uses a modified version of Robert Townsend's (1983) model in which agents are spatially separated and transactions costs of non-cash purchases. There are two types of exchange media--privately issued money (M2) and government issued money (M1). M2 dominates M1 in rate of return, but M1 is less costly to use in trade with distant agents. Hence, there is a well defined demand for M1. With an increase in the anticipated inflation rate, a Fisher effect results in an increase in the nominal spread between M2 and M1, which results in agents using more of M2 money. Ireland's model predicts that the ratio of M2 to M1, the intensity of intermediation services in his model, is positively related to changes in anticipated inflation.

In this paper, the experiments are similar to those examined in Freeman and Huffman and Ireland. Specifically, I am interested in analyzing the effects of changes in the anticipated rate of inflation, not one-time changes in the money stock. What is different in this paper is

[3] See Allan Meltzer (1969) for an excellent survey of the early theoretical literature seeking to explain the relationship between changes in outside money and the money multiplier.

that there is both an intermediation- and consumption-based demand for money. Intermediaries hold fiat money to satisfy a reserve requirement, while the consumption-based demand is a standard cash-in-advance constraint. The implication is that when agents economize on money balances in response to an increase in anticipated inflation rate, the effect is to reduce consumption of the cash good and to accumulate deposits at a slower rate.[4] With both currency and required reserves in this model, it is natural to interpret the outside money in this model as high-powered money. With both real deposits and the real demand for outside money falling, the effect of the monetary policy action on the money multiplier is ambiguous. Anticipated changes in the inflation rate are negatively correlated with the accumulation of deposits and output growth as the data indicate. The estimated correlation between the inflation rate and the money multiplier is a useful guide for the selection of certain parameter values so that the model economies can replicate the same relationship as observed in the data.

I run computational experiments to quantify several relationships between the inflation rate and intermediation services. In addition to the experiments examining the relationship between the money multiplier and inflation, I introduce unintermediated capital into the model. In doing so, it is possible to make statements about the relationship between changes in the anticipated inflation rate and disintermediation. Intermediated capital is still useful in this setup because there is an intrinsic advantage to intermediation services. This advantage is reflected as a difference between the technologies transforming intermediated or unintermediated capital into output. Some of the computational experiments, therefore, examine the role that the changes in anticipated inflation have on disintermediation.

The main findings in this paper are easily summarized. First, I calculate the impact that

---

[4] Growth is endogenous in this setup. Following Sergio Rebelo (1991), I specify a linear production technology. The upshot is that the model is capable of replicating the negative correlation between inflation and output growth identified in the literature.

a change in anticipated inflation has on the money multiplier. In this model, the effect of a change in the inflation rate depends on the relative magnitudes of two elasticities; specifically, the elasticity of real deposits and the consumption of the cash good with respect to the inflation rate. The elasticity of the cash good depends on the substitutability of the cash good for the credit good. Postwar data indicate a small, negative correlation between the inflation rate and the M1 money multiplier, but no statistically significant relationship between inflation and the M2 money multiplier. The model predicts a small, negative relationship between anticipated inflation and the money multiplier for parameter settings in which cash and credit consumption goods are "moderately close" gross complements. If the two consumption goods are gross substitutes, the model predicts that the inflation rate is positively associated with the money multiplier.

Second, a widely held belief is that increases in the inflation rate result in financial disintermediation. Often, the existence of interest-rate (Regulation Q) ceilings is the proposed explanation for this relationship. Another finding presented in this paper is that disintermediation occurs in a general equilibrium model, even though no interest-rate ceilings are present. On the bank's liability side, agents deposit fewer goods when the inflation rate increases which is one commonly characterization of disintermediation. On the household's asset side, the bank becomes smaller in the sense that intermediated capital shrinks relative to total capital: disintermediation agents substitute unintermediated capital for intermediated capital.[5] In addition to "immediate" disintermediation, a sustained increase in the inflation rate results in intermediated capital accumulating at a slower rate, so that disintermeidation also

[5] In a related paper, John H. Boyd and Mark Gertler (1994) investigate the claim that the U.S. banking industry is declining. One measure that Boyd and Gertler use is the ratio of bank loans to nominal GDP. These authors are trying to correctly measure whether there is a trend toward less intermediation. Here, the emphasis is whether intermediated capital responds negatively to changes in the inflation rate.

occurs over time as measured by the gap between what intermediated capital would have been s periods ahead under a lower inflation rate and what intermediated capital is s periods from now for this inflation rate. Computational experiments also show that the model can replicate Goldsmith's finding that the intermediaries' asset rise relative to output over time in growing economies.

The paper is organized as follows. Section 2 lays out the basic model. I calibrate the model in Section 3. In addition, I run computational experiments to examine the inflation-rate effects on consumption of the cash good versus the credit good and on the money multiplier. Unintermediated capital is introduced in Section 4. I run computational experiments to look at the effects of higher inflation on the ratio of intermediated-to-unintermediated capital. I also calculate the total capital stock over a 100-period horizon and different inflation rates for the economies.

2. The Model

The model economy consists of four types of agents: firms, households, banks, and a monetary authority. In each period, firms operate in a perfectly competitive market, producing three different goods--a 'credit' consumption good (c), a 'cash-in-advance' consumption good (cg), and a capital good (k). Purchases of the capital good this period, or investment, are denoted x_t. Firms seek to maximize period-t profits, represented by the following expression:

(1)

$$pr_t^f = p_{1t}c_t + p_{2t}cg_t + p_{3t}x_t - p_{2t}r_t k_t$$

where pr^f denotes the firm's profit. Profits are maximized subject to $c_t + cg_t + x_t \leq f(k_t)$. I use p_1 to denote the price of the credit consumption good, p_2 is the price of the cash good, and p_3 is the price of the investment good with each measured in units of fiat money. Here, r is the rental price of capital. Here, $f(k_t)$ represents a common-knowledge technology that is homogeneous of degree one in the capital stock.[6] The law of motion for the capital stock is $k_{t+1} = (1-\delta)k_t + x_t$, where δ is the depreciation rate. The period-0 stock of capital is assumed to be given.

Note that the credit, cash, and investment goods are perfect substitutes in production. Throughout this analysis I assume that strictly positive quantities of the credit, cash, and investment goods are produced. By the first-order conditions, all goods will sell at the same period-t price; that is, $p_1 = p_2 = p_3 = p$. In addition, profit-maximizing behavior implies that the marginal product of capital, $f'()$, equals the real rental paid to capital.

Banks in this model also operate in a perfectly competitive environment. Formally, the period-t profit maximization condition is:

(2)
$$pr_t^b = p_t[r_t + 1 - \delta]k_t + res_t - p_t q_t d_t ,$$

where pr^b is bank profits, res is the amount of reserve balances carried by the banks, d_t denotes the quantity of goods deposited last period and carried over to period t, and q is the real return offered on deposits. The initial stock of reserves, res_0, is given. The bank's period-t profit is maximized subject to $k_t + res_t/p_t \leq d_t$ (the balance-sheet equation) and $res_t \geq \gamma_{t-1}p_{t-1}d_t$ (the reserve requirement). The zero-profit condition implies that the real return offered on deposits, q_t, equals $(1-\gamma_{t-1})[r_t + 1-\delta] + \gamma_{t-1}\, p_{t-1}/p_t$. In addition, I assume that $p_{t-1}/p_t < r_t + 1-\delta$ so that reserves are rate of return dominated. Rate-of-return dominance implies that banks hold reserves up to the amount required; that is, $res_t = \gamma_{t-1}p_{t-1}d_t$.

---

[6] Following Rebelo (1991), the capital good is interpreted as a combination of both physical and human capital.

The representative household maximizes the present discounted value of utility subject to a sequence of budget constraints and to a cash-in-advance constraint on the purchases of the cash good. The household's problem is

[P1]

$$\max \sum_{t=0}^{\infty} \beta^t U(cg_t, c_t) \quad s.t.$$

subject to

(a) $p_t (c_t + d_{t+1} + curr_{t+1})$

$\leq p_t q_t d_t + T_t$

(b) $p_t\, cg_t \leq curr_t$,

where T is a lump-sum cash injection from the monetary authority. The initial stock of currency, $curr_0$, is given.

Constraint (a) is the law of motion for bank deposits. Goods deposited and carried over to next period (t+1) equal the gross return on period-t deposits plus the cash transfer from government, less purchases of the credit good and currency. Constraint (b) is the cash-in-advance constraint. As is typical in models in which a cash-in-advance is present, I assume that deposit returns cannot be used immediately to purchase the cash good. One interpretation is that deposit returns are paid after the market for the cash good meets. This restriction generates a well-defined demand for currency. Together, the reserve requirement and the cash-in-advance constraint generate a well-defined demand for money, making the existence of a monetary equilibrium possible, but not guaranteeing it.

The monetary authority prints money and distributes it in a lump-sum fashion to households. Formally, $T_t = N_t(m_t - m_{t-1})$. For simplicity, I assume that the population is constant and normalize N = 1. Thus, per capita transfers are identical to aggregate transfers. In addition, the monetary authority chooses the reserve requirement ratio. The monetary authority can commit to a sequence of money stocks and reserve requirements. Specifically, let money evolve according to the following rule:

(3)
$$M_t = \theta_t M_{t-1}$$

An equilibrium in this model economy is a sequence of prices $\{p_t, r_t, q_t\}$, a real allocation $\{c_t, cg_t, x_t, k_t\}$, stocks of financial assets $\{curr_t, res_t, d_t\}$, and monetary policy variables, $\{\gamma_t, \theta_t\}$ such that

(i) Given prices, money growth, and reserve requirement ratios, the real allocation and stocks of financial assets solve the household's maximization problem [P1];

(ii) Given prices, money growth, and reserve requirement ratios, the allocations solve the firm's period-t maximization problem;

(iii) Given prices, money growth, and reserve requirement ratios, the allocations solve the bank's period-t maximization problem;

(iv) $m_t = curr_t + res_t \ \forall\ t \geq 0$.

The necessary conditions for an equilibrium are:

(4)
$$\frac{U_{cg}(t)}{U_c(t)} = \pi_{t+1}\, q_{t+1}$$

(5)

$$\frac{U_{cg}(t)}{U_{cg}(t+1)} = \beta\, \pi_{t+1}\, q_{t+1}$$

(6)

$$p_t cg_t = curr_t$$

(7)

$$\lim_{T\to\infty} \left[\frac{d_t}{\prod_{s=0}^{T-1} R_s}\right] = 0$$

I assume throughout this analysis that $\pi_{t+1}\, q_{t+1} > 0$; that is, the nominal rate of interest is strictly positive. Accordingly, the cash-in-advance constraint is binding.

Consider a special case for the household's momentary utility function. Specifically, suppose that

$$U(.) = (1-\sigma)^{-1}[(cg_t^{-\lambda}+\omega\, c_t^{-\lambda})^{-1/\lambda}]^{1-\sigma}.$$

Further, let

$$f(k_t) = A\, k_t.$$

From these special functional forms, the first-order condition relating the marginal rate of substitution for the consumption goods takes on the following forms:

(8)

$$\frac{c_t}{cg_t} = (\omega R_{t+1})^{\frac{1}{1+\lambda}}$$

Equation (8) follows from equation (4), where $R_{t+1} = \pi_{t+1} [(1-\gamma_t)(A+1-\delta) + \gamma_t/\pi_{t+1}]$, and from the firm's and the bank's first-order conditions for profit maximization. In addition, the growth rate of the model economy is given by

(9) $\rho = \beta[(1-\gamma_t)(A+1-\delta) + \gamma_t/\pi_{t+1}]^{1/\sigma}$ [from equation (5)]

and, with $m_t = res_t + curr_t$

(10) $\theta = \pi\rho$ [from equations (3) and (6) and the reserve requirement constraint].

I assume that the monetary authority chooses a fixed growth rate of the money supply and a fixed reserve requirement ratio so that $\theta_t = \theta$ and $\gamma_t = \gamma$.

Equation (9) characterizes the balanced-growth* path for the agent's decision variables. By the household's first-order conditions, consumption of both the credit good and the cash good, as well as deposits, grow at the rate ρ_t. Similarly, the growth rate for deposits, capital, and output also grow at the same rate.

An interesting feature of this model economy is that the growth rate, ρ, is a function of the two policy variables, θ and γ. Together, equations (9) and (10) indicate that faster money growth results in higher inflation and a lower growth rate. This finding holds because the inflation rate lowers the value of reserve holdings, thus, lowering the return that be offered on deposits. Households elect, therefore, to accumulate fewer deposits because of the low return offered when inflation is high.[7] Similarly, an increase in reserve requirements also lowers the return offered by banks, forcing banks to hold a larger fraction of assets in the relatively low-yielding reserves.

Another implication of the relationship between the return on deposits and the inflation rate is the effect on the consumption of credit good relative to cash good. In equation (8),

---

[7] The finding that inflation and output growth are inversely related in an endogenous growth model with a reserve requirement is alluded to Jones and Manuelli. In another paper, Haslag (1994) quantifies the inflation rate-output growth relationship for different parameter settings.

changes in the inflation rate affect the marginal rate of substitution between the credit good and the cash good. Indeed, with these specific functional forms, the nominal interest rate is an increasing function of the anticipated inflation rate.[8] Thus, with $\lambda \geq -1$, equation (8) indicates that the ratio of the credit good to the cash good is positively related to changes in the inflation rate. The intuition is straightforward. As the inflation rate rises, the cash good is more heavily taxed in the sense that the currency held by the agent diminishes in value more quickly. The rate at which the agent is willing to substitute the credit good for the cash good depends on whether the goods are gross substitutes ($-1 \leq \lambda \leq 0$) or gross complements ($\lambda \geq 0$). Indeed, $\lim_{\lambda \to \infty} c/cg = \xi$, where ξ is some constant, representing the fixed proportion in which the credit and cash goods are consumed. In short, this limiting condition implies that the two consumption goods are perfect complements and are consumed in fixed proportions.

3. Numerical Simulations I: Consumption allocations

In this section, I quantify the effects that changes in the inflation rate have on two separate issues. First, how do changes in the inflation rate affect the consumption of the cash good relative to the credit good? In addition, I compare the inflation-rate sensitivity of the consumption allocations under different values of λ. Second, I investigate the effects that changes in the inflation rate have on inside versus outside money. The money multiplier is examined to judge the model economy's prediction compared with correlations present in post-war U.S. data. These computational experiments are linked because the assumptions regarding the substitutability of the credit and cash goods--the value of λ selected--bears on the sign of the money multiplier response to different values of the inflation rate.

---

[8] Formally, $\partial R/\partial \pi = [(1-\gamma)(A+1-\delta)] > 0$.

3.1 Calibrating the model

The time period for the model is one year. Accordingly, the model's parameters are set as follows. I assume that the growth rate of technology is 2%. I set $\sigma = 2$. So, with $\gamma = 0$ and $\pi = 1.0$, $r = \beta[A+1-\delta]^{1/\sigma} = 1.02$. With $\delta = 0.10$ and $\beta = 0.9733$, then $A = 0.169$.

The next step is to identify the value of ω. In a nonmonetary version of the model ω is the relative expenditure share. If one had the time series, ω should be measured as the proportion of total consumption (probably measured as consumption on nondurables and services) in which credit (measured as anything other than currency) was used to conduct the transaction. Here, the approach is to take the results obtained from the Federal Reserve's survey on transactions. Commissioned in 1984, the survey results show that roughly 30% of transactions are made using cash.[9] The rate of consumer price inflation was 4.3 percent in 1984. Another survey was commissioned in 1986 in which the proportion of transactions made with currency was nearly identical and the inflation rate fell to 1.9 percent. Two observations do not make for a robust calculation of the mean. In light of the paucity of the data, I use 30 percent as the proportion of consumption purchased with currency. Hence, $cg = 0.3(c+cg)$ and $c = 0.7(c+cg)$, implying that $c/cg = 2.333$. The average inflation rate over the postwar period (1948-93) is 4.2 percent. I also need the average value of the reserve requirement ratio. The average ratio of required reserves to total bank deposits is 0.036 for the period 1959-92. I use $\gamma = 0.036$ in the computational experiments.[10] Thus, equation (8) sets 2.333 =

---

[9] These results are also reported in Cooley and Hansen (1991).

[10] Bank deposits include demand deposits, other checkable deposits, and savings accounts. These items are the types of accounts against which reserves must be held for most of the sample period. One might argue that this is an upper bound for the interpretation of intermediated capital. Alternatively, one could apply the ratio of required reserves to the sum of total deposits plus funds held in mutual funds. Another issue is that I am using the average reserve requirement ratio as a marginal ratio.

$[\omega(1.042)(1.0659)]^{1/1+\lambda}$. I consider two alternative values of λ, one in which the cash good and the credit good are substitutes and another in which these two consumption goods are complements. For $\lambda = -0.5$ (1.0) the cash and credit goods are gross substitutes (complements), so that $\omega =$ 1.3642 (4.897).[11]

3.2 Consumption allocations

The first experiment is to determine what the model predicts regarding the ratio of the credit good to the cash good under various rates of inflation. Figure 1 plots the percentage of total consumption allocated to the cash good at various rates of inflation for two different values of λ. Note that when the goods are gross substitutes ($\lambda = -0.5$), a high inflation rate means a moderate shift toward the credit consumption good. With $\pi = 2.0$ (corresponding to a 100% inflation rate), the cash good represents only about 11% of total consumption, compared with the 30% spent on the cash good at a 4% inflation rate. In contrast, if the goods are gross complements ($\lambda = 1.0$), there is a much smaller change in the ratio of the cash good to total consumption. In effect, the tax on the cash good is then "shared" by the credit good in the sense that the household wants to consume less of the complementary good when the cash good is taxed. In Figure 1, with 100% inflation, 24% of total consumption is spent on the cash good as compared with 30 percent of total consumption when the inflation rate is 4%. What the plot tells us is not too surprising; for a given change in the inflation rate, the consumption of the cash good is related to what the researcher assumes about the substitutability of the cash good for the credit good.

What are the welfare costs of the higher inflation? With two separate motives for

[11] As King and Rebelo note, a necessary and sufficient condition for finite utility is $(\beta\rho)^{1-\sigma} < 1$. This condition is satisfied in each of the experiments run in this paper.

holding money, the household's decisions are distorted along two dimensions: the allocation between the cash good and credit good and the allocation between consumption today and saving affected by a change in the real return on deposits. Welfare costs are calculated as a percentage change in consumption that is necessary for the household to be satisfied as in a economy in which the inflation rate is set equal to zero. Formally, $U(\{cg^0{}_t, c_t^0\}_{t=1}^{\infty}) = U(\{cg^1{}_t, c_t^1\}(1+\phi)_{t=1}^{\infty})$, where the superscript 0 denotes a consumption path for a policy setting ($\pi=1.0$) and the superscript 1 denotes a consumption path for the alternative policy setting. Table 1 reports the value of ϕ for three different inflation rates. For each inflation rate setting, I consider the case in which the two consumption goods are substitutes (λ=-0.5) and complements (λ=1.0). Table 1 shows that the welfare losses are greater than 5 percent of consumption for even moderate inflations when the cash goods and credit goods are substitutes. Table 1 also shows that welfare losses are smaller for the case in which the two consumption goods are gross complements as compared with the case in which the two goods are gross substitutes. The decline in the welfare losses associated with increases in the value of λ should not be too surprising since the inflation distortion declines as the consumption of the goods moves toward a fixed proportion. In contrast to model in which the cash-in-advance constraint is the sole reason for holding money, welfare losses approach a positive lower bound even when the cash and credit goods are perfect complements. As Jones and Manuelli find, in a simple cash-in-advance model, assuming that the cash and credit goods are perfect complements effectively eliminates the distortion between the cash and credit goods so that the welfare losses approach zero as the two consumption goods approach perfect complmentarity.

3.3 Money multiplier

The second experiment quantifies the effect that a change in the inflation rate has on the money multiplier. I define the money multiplier as the ratio of nominal deposits to fiat money; that is, $mm_t = p_t d_t / m_t$. With deposits increasing at the rate $\rho = (\beta r)^{1/\sigma}$, it follows immediately from the money market equilibrium condition (equation 10) that $mm_t/mm_{t-1} = \hat{mm} = 1$, or the growth rate of the money multiplier is zero. The question is how the level of the money multiplier responds to differences in anticipated rates of inflation.

As noted above, Freeman and Huffman examined the effect of a change in anticipated inflation on the money multiplier. Freeman and Huffman emphasize the role of money as a substitute asset for capital in their model. As noted above, changes in anticipated inflation affect the money multiplier in their paper through the Tobin effect; the money multiplier is positively related to changes in the anticipated inflation rate because agents substitute deposits (intermediated capital) for money. One way to distinguish this model from Freeman and Huffman model is with regards to why agents hold money.[12] In the model specified here, money's serves two roles, it is necessary for exchange purposes and to satisfy legal restrictions necessary to acquire capital through an intermediary. Here, when higher anticipated inflation causes people to economize on their money balances, consumption and deposit accumulation are both affected in the same direction. Hence, economizing on money balances in the Freeman-Huffman model results in greater capital holding. Based on the different motives for holding money, the question is how the results derived from the alternative view proposed in this paper differ from those found in Freeman and Huffman.

To formally examine the effect that a change in the anticipated inflation rate will have on the money multiplier, I rewrite the money market equilibrium condition as $m_t = p_t cg_t + \gamma d_t$. This expression substitutes the cash-in-advance constraint for currency and the binding reserve

---

[12] Another important distinction is the empirical observation explained by these two papers. Freeman and Huffman were attempting to explain the inside money-output relationship at business cycle frequencies, whereas here the time frame is for low-frequency data.

requirement for reserves. Substituting this expression for m_t in the money multiplier definition yields

$$\frac{d_t}{\gamma d_t + cg_t}$$

The issue then is to determine how changes in the anticipated inflation rate affect deposits relative to the sum of reserves plus consumption of the cash good. After differentiating, the expression for the money multiplier's response to a change in anticipated inflation is:

$$sgn\left(\frac{dmm}{d\pi}\right) = sgn\left[\frac{\partial d/\partial\pi}{d} - \frac{\partial cg/\partial\pi}{cg}\right]$$

where the first term inside the brackets is the elasticity of deposits with respect to the inflation rate and the second term is the elasticity of the cash good with respect to the inflation rate. Both deposits and the consumption of the cash good are inversely related to changes in the inflation rate so that the bracketed expression is qualitatively ambiguous. Clearly, the researcher's assumptions affects the outcome in the sense that whether the cash and credit goods as gross substitutes determines the change in the marginal rate of substitution between the cash good and the credit. Provided that the demand for cash goods is a continuous function in the inflation rate and λ, there exists a value of λ for which the sum of the elasticities will equal zero.

I solve for the value of the money multiplier, using the binding reserve requirement constraint and the aggregate consistency condition, $y_t = c_t + cg_t + x_t$. Figure 2 plots the values of the money multiplier for different inflation rates and for different values of λ. The numerical experiments indicate a relatively large positive association exists between the inflation rate and the money multiplier when the cash good and credit goods are gross substitute goods. If, however, the two goods are gross complements, the relationship between the money multiplier and the inflation rate could be positive or negative. For the case in which the two goods are "close" complements ($\lambda = 3.0$), the value of the money multiplier declines over the entire range of the inflation rate considered. There is simply not enough change in the consumption of the cash good to offset the decline in deposits for a given change in the inflation rate. For the case in which the two goods are "moderate" complements ($\lambda = 1.0$), the value of the money multiplier declines as the inflation rate increases from 0% to 6%. For inflation rates above 6%, Figure 2 shows that the value of the money multiplier increases as the inflation rate rises.

What do we observe in the data? Table 2 reports the results from a linear regression of the money multiplier and the inflation rate.[13] As Table 2 shows, the money measure chosen affects the regression results. There is a small negative association between the M1 money multiplier and the inflation rate, but there is no significant relationship between the M2 money multiplier and the inflation rate.

The empirical evidence offers some guidelines for setting the model's parameters. To replicate the correlations found in the data, the model economies studied must specify that the cash and credit consumption goods are at least moderate complements. Note that for cases in which $\lambda < 1.0$, the association between the anticipated inflation rate and the money multiplier is positive. What this implies for the model is that λ must in the 1.0-1.5 range in order to replicate the negative association observed in the U.S. data. For λ in the 0.9 to 1.0 range, one would get be able to match the statistically insignificant association observed between the M2 money

[13] The money multiplier is the ratio of M1 or M2 to high-powered money. The inflation rate is calculated as the December-to-December changes in the consumer price index. Each of the money multiplier regressions include one lagged value of the money multiplier. The reason for including this lagged value is account for the unit root present in each multiplier.

multiplier. At very low rates of inflation, the money multiplier is negatively related to the inflation rate, and is slightly positive for moderate inflation rates between 5% and 10%. Since the postwar U.S. inflation rate experience generally lies in the 0% to 10% range, the values of λ near, but slightly below one seem capable of yielding sufficiently mixed results so that the statistical relation is not significantly different from zero.

4. Numerical Simulations II: Disintermediation

In this section, I focus on the effect that changes in anticipated inflation have on the intermediated capital. Specifically, I introduce a second type of capital, one which does not require an intermediary. Here, unintermediated capital has a declining marginal product, which results in all capital eventually being intermediated as a limiting condition. This also means that presence of unintermediated capital with declining marginal product does not materially affect the results obtained in the simple model represented in the previous section.

Introducing this type of capital does permit one to study the effects of changes in the inflation rate on disintermediation. I am thinking of disintermediation as the household's act of substituting direct capital purchases for bank deposits. In this setup, the fraction of intermediated capital is an endogenous decision. Indeed, if capital stocks are too low, banks will operate. If a banking industry exists, the limiting condition is that all capital will eventually be financed through an intermediary.

A change in the anticipated inflation rate has two effects on the intermediation process. First, the immediate effect of the higher inflation results is that households substitute unintermediated capital for intermediated capital. Second, over time, permanently higher inflation causes households to accumulate intermediated capital at a slower rate.

The second type of capital is unintermediated in the sense that households can directly lend the funds to the firm. Hence, the gross real return (dividend payment) is paid directly to households, bypassing the bank and the reserve requirement. Firms purchase unintermediated capital, which produces output according to the following technology

(11) $$B(k^{u})^{\alpha}$$

Substituting this in the representative firm's profit functions, one gets

(12) $$pr^{f} = pf(k) + pB(k^{u})^{\alpha} - r(k + k^{u})$$

With the assumption that the two types of capital are perfect input substitutes, the profit maximizing firm will choose the composition of capital such that

(13) $$f'(k) = \alpha B(k^{u})^{\alpha-1}$$

where equation (13) is a simple arbitrage condition. Households will purchase unintermediated until the marginal products of each type of capital are equal. Consider the special case in which $f(k) = Ak$. As in the case in which only intermediated capital exists, the return offered on deposits, $q = (A+1-\delta)$. Utility maximizing agents, therefore, will buy unintermediated capital until its return is equal to the return offered by deposits. In short, $q = [(1-\gamma)(A+1-\delta) + \gamma/\pi] = [\alpha Bf(k^{u})^{\alpha-1} + 1-\delta]$.

The total capital stock may respond very differently to changes in the anticipated inflation rate, especially as compared with to the case in which all capital is intermediated. Consider, for example, the case in which the anticipated inflation rate rises. As discussed above, the real return on intermediated capital declines and the stock of capital would fall. With unintermediated capital, the decline in the real return on intermediated capital induces households to purchase more capital directly. Depending on the elasticity of substitution between unintermediated and intermediated capital, it is possible that the total capital stock rises in response to an increase in the anticipated inflation rate.

Over time, only intermediated capital will be accumulated. Indeed, as $t \rightarrow \infty$, all capital will be intermediated. With a linear production technology, the marginal product of capital is not dependent on the quantity of intermediated capital. This setup is rationalized as an inherent advantage to intermediated capital. One can think of the difference as a being a product of different costs associated with intermediated and unintermediated capital. For example, suppose the same technology transforms both intermediated and unintermediated capital into units of output. Suppose that the costs of monitoring intermediated capital are constant, but the costs of monitoring unintermediated capital are an increasing function of the quantity of unintermediated capital. This setup could yield a model in which *net* output from unintermediated capital is a diminishing function of its quantity. If the monitoring costs of intermediated are, for example, zero, then the gross production technology for intermediated capital is also the net output technology. In this sense, intermediation has an advantage over unintermediated capital. The limiting condition identified above would follow.[14]

The arbitrage condition implies that k^u is a function of the other parameters in the model; namely, the reserve requirement, the exponent on the Cobb-Douglas production technology (α), the technology constant (B), and the marginal product of intermediated capital

---

[14] There are several modifications which would eliminate this limiting condition. I could assume that there is an externality associated with unintermediated capital. A spillover from unintermediated keeps it valued even in the limit. Alternatively, I could introduce exogenous growth into the technology parameter, B. With careful selection of the parameters, it is possible that the ratio of intermediated to unintermediated capital would be constant over time. While permitting would eliminate the model being rigged toward 100% intermediation in the limit, this feature would not change the results presented in this paper. The balanced growth path would extend to unintermediated capital increasing at rate ρ.

(A+1-δ). Rewriting the arbitrage condition, one obtains

(14)
$$k^{u} = \left[\frac{q-(1-\delta)}{\alpha B}\right]^{\frac{1}{\alpha-1}}$$

I assume that the initial stock of total capital--k^u + k--equals 1. For the computational exercises, the choice of α and B pin down the ratio of unintermediated capital to total capital in the first period. For the models reported here, I choose α = 0.35 and B = 0.35 as the settings largely because these values are typical in the business cycle literature. Numerical solutions indicate that with lower values of α, the ratio of unintermediated to total capital decline. Equation (14) indicates that as the value of B declines, the ratio of unintermediated capital to total capital also declines. Qualitatively, the results of the experiments are unchanged if one considers alternative values of α and B.

Figure 3 examines the effects that changes in the inflation rate have on the ratio of unintermediated capital to total capital. Intuitively, as the inflation rate rises, the return offered by deposits falls. By (14), the quantity of unintermediated capital rises. A lower return on deposits induces households to buy more capital directly until the last unit returns the same as intermediated capital offers. As Figure 3 shows, for the baseline parameter settings, an increase in π from 1.01 to 2.0 results in unintermediated capital rising from slightly more than 64% of total capital to roughly 77%. Because the parameter values for B and α were chosen somewhat arbitrarily, Figure 3 is not intended to serve as a measure of the size of the inflation-rate effect. Rather, the figure is a graphical display of the effect that disintermediation has due to an increase in the anticipated rate of inflation. This finding is consistent with the conventional wisdom; changes in the anticipated inflation rate do affect the size of intermediated capital relative to total capital. What is somewhat noteworthy is that such disintermediation occurs in a model without interest rate ceilings. Instead, reserve requirements are sufficient to yield this result.

How do changes in the anticipated rate of inflation affect capital accumulation over time? In this setup, the ratio of k^u to $k^u + k$ will fall as the quantity of intermediated capital grows endogenously over time. In anther computational experiment, I look at how the total capital stock evolves for different values of the inflation rate. Specifically, I run the model for 100 periods. I narrow the range of inflation rates since there is simply no historical experience in which the inflation rate has been at 100% for 100 consecutive years. So, I look at inflation rates between 0 and 10%.

Figure 4 plots the total capital stock ($k^u + k$) - inflation rate combination at date m, where m = 1, 2, ...,100. The height of the surface at each date measures the total capital stock. As moves along the inflation rate axis for a given data, the differences in the total capital stock measure the effect that a change in the inflation rate has on total capital accumulated by that date. At t = 100, for example, the surface measures the date-100 capital stocks at inflation rates between 0% and 10%. The upward slope in the surface as one moves from 1.1 to 1 on the inflation rate axis indicates that a larger amount of capital stock is accumulated in the low-inflation economies than in the high-inflation economies. In the model economy, the date-1 stock of intermediated capital appears negligibly different for 10% inflation rates than for 0% inflation rates. Figure 4, however, suggests that the rate of intermediated capital accumulation appears more substantial. After 100 periods, the total capital stock is about 15% higher in the model economy with 0% percent inflation as compared with the model economy with 10% inflation. After periods as short as fifty years, the capital stock in the 0% inflation-rate case is 5.8% higher than the stock in the 10% inflation-rate case. Thus, Figure 4 shows that even moderate sustained inflation can diminish capital accumulation quite dramatically when measured over time.

Thus far, this analysis has neglected the effects that different reserve requirements have on the economies. It is straightforward to show that for a given increase in the inflation rate, the gross return on deposits falls by a larger amount when the reserve requirement ratio is greater.[15] By equation (9), the rate of growth in the model economy is, therefore, more sensitive to changes in the inflation rate when the reserve requirement is greater. To illustrate the effects of higher reserve requirements, Table 3 reports the value of the period-100 capital stocks for several different reserve requirement ratios. As with the simulations in Figure 4, the inflation rates are 0% and 10% for the purposes of these comparisons. One can immediately see the effect that a higher reserve requirement ratio has on capital accumulation by looking down a column in Table 3. The decline in date-100 capital stocks is indicative of the effect that a change in reserve requirements has on the growth rate of the economies. Except for the last row of Table 3, one sees that the percentage-difference between the capital stocks gets larger as the reserve requirement ratio increases. At the 3.6% reserve requirement, the capital stock is about 15% larger for the case in which the inflation is 0% as compared with the case in which the inflation rate is 10%. Yet, for a 20% reserve requirement, the percentage change in the capital stock is about 59% larger in the 0% inflation-rate environment than in the 10% inflation-rate environment. The last row in Table 3 is indicative of disintermediation resulting from high reserve requirements. With a 50% reserve requirement the total capital stock is only 3% higher in the 0% inflation-rate economy. Indeed, the total capital stock is equal to one in the high-inflation-rate economy, the same as the initial capital stock. In this experiment, all capital is unintermediated. In the 0% inflation rate case, a small quantity of capital is intermediated, and

[15] This can be seen by differentiating the gross real return on deposits with respect to γ and taking the partial derivative of the resulting expression with respect to π. In short, $\partial r/\partial\gamma\partial\pi = -1/\pi^2 < 0$.

grows so slowly that after 100 periods the total capital stock has increased by only 3%. Some countries have used high reserve requirement ratios to stabilize financial markets. Table 3 results suggest some of the potential detrimental effects associated with high reserve requirements in terms of lowering capital accumulation and development of intermediaries.[16]

The final question addressed in this paper is whether the model is capable of replicating Goldsmith's finding. In his book, Goldsmith presents evidence indicating that the ratio of aggregate bank assets to output rises over time. This finding uses data from 1863-1960 and is offered for over 20 countries. Thus, the question is whether the model matches this rather robust stylized fact. Figure 5 plots the ratio of intermediated capital, the bank's largest asset, to output for three different values of the inflation rate; namely, 0%, 10%, and 50%. As Figure 5 shows, the ratio of intermediated capital to output does increase over time, though at a bit slower rate for higher inflation rates. This result is largely due to fact that the technology parameter, A, is less than one. With $A < 1$, output is smaller than the capital stock. Though both quantities grow at the same rate along the balanced growth path, the change in intermediated capital is relatively larger so that k/y increases over time. As such, the model is capable of replicating Goldsmith's result.

5. Discussion

In this paper, a general equilibrium model is specified in which I examine the effects that movements in the inflation rate have on various aspects of financial intermediation. The model is one in which growth is endogenous. There is a well-defined demand for currency via a cash-in-advance constraint and a well-defined demand for reserves via a reserve requirement. Money

[16] Argentina, for example, has a marginal reserve requirement ratio of 50% on demand deposits

then has both an exchange motive and a legal restrictions motive. The fiat money in this monetary growth model is naturally interpretable as high-powered money.

In this setup, inflation retards the intermediation process. An increase in the anticipated rate of inflation results in deposits being accumulated at a slower pace because the presence of a reserve requirement; the return on intermediated capital/deposits being is inversely related to the inflation rate.

I conduct more specific experiment using the model. First, I examine the effect that changes in anticipated inflation have on the money multiplier. The purpose is to determine what parameter settings will permit the model to replicate low-frequency correlations between inflation and the money multiplier. The data indicate that the inflation rate is inversely related to the M1 money multiplier, but that no significant relationship holds between the M2 money multiplier and inflation. Because the demand for currency is also inversely related to inflation, the money multiplier may either rise or fall in response to a higher inflation rate. Numerical analyses show that the cash good and the credit good must be close enough complements for the model to replicate the weak negative correlation between the money multiplier and inflation. In this setup, the response by the money multiplier precedes to a same-direction response in output by one period. Hence, the model is capable of matching the positive correlation between the money multiplier and future output found in Robert G. King and Charles I. Plosser (1983). Instead of real financial innovations, the model accounts for this correlation as the result of endogenous responses in both output and the money multiplier to changes in the anticipated inflation rate.

In the second part of the paper, the emphasis is on capital accumulation and the intermediation process. I introduce a second type of capital that does not require intermediation services. Thus, intermediated capital only exists when capital demand are large enough. In this model, higher anticipated inflation results in disintermediation; agents shift from intermediated to unintermediated capital. Thus, the model explains the bouts of disintermediation as features of a model with reserve requirements. In general, the model also explains how a combination of inflation and reserve requirements can retard the growth of intermediated capital over time. Finally, the model economy is capable of replicating Goldsmith's empirical result that the ratio of deposits to income rises.

In general, the model shows that the existence of reserve requirements results in anticipated movements in money growth/inflation being a source of shocks to the economy at relatively low frequencies. In the paper, I focus on correlations between inflation and fairly broad measures of an intermediary's liability and asset structure. The model is a simple one. As such, one would like to ask additional questions with a more detailed model specification. One issue is that this model is not capable of generating interesting transition dynamics. It would be interesting to study the impact that movements in the anticipated inflation rate would have on the model economy as it moves from one steady state to another. Another issue is the composition of the intermediary's liabilities. One of the more interesting developments in banking has been the creation of new liabilities to circumvent reserve requirements. In this setup, one could treat this as simply a lowering of reserve requirements, but a fuller treatment would examine compositional issues. One could perhaps solve for the rate of financial innovation as a function of preferences, technologies, and policies.

References

Bencivenga, Valerie R. and Bruce D. Smith. "Financial Intermediation and Endogenous Growth," *Review of Economic Studies*, 1991, 58, pp.195-209.

Boyd, John H. and Mark Gertler. "Are Banks Dead? Or are the Reports Greatly Exaggerated?," Federal Reserve Bank of Minneapolis *Quarterly Review*, 1994, Summer, 2-23.

Cameron, Rondo E. *Banking in the Early Stages of Industrialization: A Study in Comparative Economic History*, New York: Oxford University Press, 1967.

Cooley, Thomas F. and Gary D. Hansen. "The Inflation Tax in a Real Business Cycle Model," *American Economic Review*, 1989, 79(4), pp. 733-48.

----- and -----, "The Welfare Costs of Moderate Inflation," *Journal of Money, Credit, and Banking*, 1991, 23(3) pt.2, pp. 483-503.

Diamond, Douglas W. and Philip H. Dybvig. "Bank Runs, Deposit Insurance, and Liquidity," *Journal of Political Economy*, 1983, 91, pp. 401-19.

Freeman, Scott and Gregory Huffman. "Inside Money, Output, and Causality," *International Economic Review*, 1991, 32(3), pp. 645-68.

Friedman, Milton. "Nobel Lecture: Inflation and Unemployment," *American Economic Review*, 1977, 85, pp. 451-72.

Gurley, John G. and Edward S. Shaw, *Money in a Theory of Finance*, Washington, D.C., 1960.

Goldsmith, Raymond W. *Financial Structure and Development*, New Haven, Conn: Yale University Press, 1969.

Gomme, Paul. "Money and Growth Revisited: Measuring the Costs of Inflation in an Endogenous Growth Model," *Journal of Monetary Economics*, 32, pp. 51-77.

Greenwood, Jeremy and Gregory Huffman, 1987. "A Dynamic Equilibrium Model of Inflation and Unemployment, *Journal of Monetary Economics*, 19, pp. 23-38

Greenwood, Jeremy and Boyan Jovanavic. "Financial Development, Growth, and the Distribution of Income," *Journal of Political Economy*, 1990, 98(5) pt.1, pp 1076-1107.

Haslag, Joseph H. "The Effects of Monetary Policy in a Model with Reserve Requirements," unpublished manuscript.

Ireland, Peter N. "Money and Growth: An Alternative Approach," *American Economic Review*, 1994, 84(1), pp. 47-65.

Jones, Larry E. and Rodolfo Manuelli, "Growth and the Effects of Inflation," *Journal of*

Economic Dynamics and Control, 1995, forthcoming.

King, Robert G. and Sergio Rebelo. "Public Policy and Economic Growth: Developing Neoclassical Implications," *Journal of Political Economy*, 1990, pp. S126-S150.

Kormendi, Roger C, and Philip G. Meguire. "Macroeconomic Determinants of Growth: Cross Country Evidence," *Journal of Monetary Economics*, 16, pp. 141-63.

MacKinnon, Ronald I. *Money and Capital in Economic Development*, Washington, D.C.: Brookings Institute, 1973.

Meltzer, Allan H. "Money, Intermediation, and Growth," *Journal of Economic Literature*, 1969,

Rebelo, Sergio. "Long-Run Policy Analysis and Long-Run Growth," *Journal of Political Economy*, 1991, 99, pp. 500-21.

Shaw, Edward S. *Financial Deepening in Economic Development*, New York: Oxford University Press, 1973.

Sidrauski, Miguel. "Rational Choice and Patterns of Growth in a Monetary Economy," *American Economic Review*, 51, pp. 534-44.

Stockman, Alan. "Anticipated Inflation and the Capital Stock in a Cash-in-Advance Economy," *Journal of Monetary Economics*, 8, pp. 387-93.

Tobin, James. "Money and Economic Growth," *Econometrica*, 1965, 33(4), pp. 671-84.

Townsend, Robert M. "Financial Structures and Economic Activity," *American Economic Review*, 1983, 73(5), pp. 895-911.

Wynne, Mark A. "Price Stability and Economic Growth," *The Southwest Economy* Federal Reserve Bank of Dallas, 1993, May/June, pp. 1-5.

Table 1

Welfare Costs of Inflation

π	1.10	1.25	1.50
$\lambda = -0.5$	0.068	0.174	0.357
$\lambda = 1.0$	0.035	0.085	0.164

Table 2

Regression Results for money multiplier and inflation rate, 1959-94

$$mm_t = \alpha_0 + \alpha_1 \, mm_{t-1} + \alpha_2 \, \pi_t$$

(1) $$m1m_t = \underset{(0.248)}{1.486} + \underset{(0.085)}{0.499} \, m1m_{t-1} - \underset{(0.003)}{0.019} \, \pi_t$$

(2) $$m1m_t = \underset{(0.315)}{0.821} + \underset{(0.035)}{0.916} \, m1m_{t-1} + \underset{(0.019)}{0.010} \, \pi_t$$

Table 3

Date-100 Total Capital Stocks
at 10% and 0% Inflation Rates under
various Reserve Requirement Ratios

γ	$\pi = 1.0$	$\pi = 1.10$
0.036	2.55	2.21
0.10	2.12	1.49
0.20	1.64	1.04
0.50	1.03	1.00

Figure 1

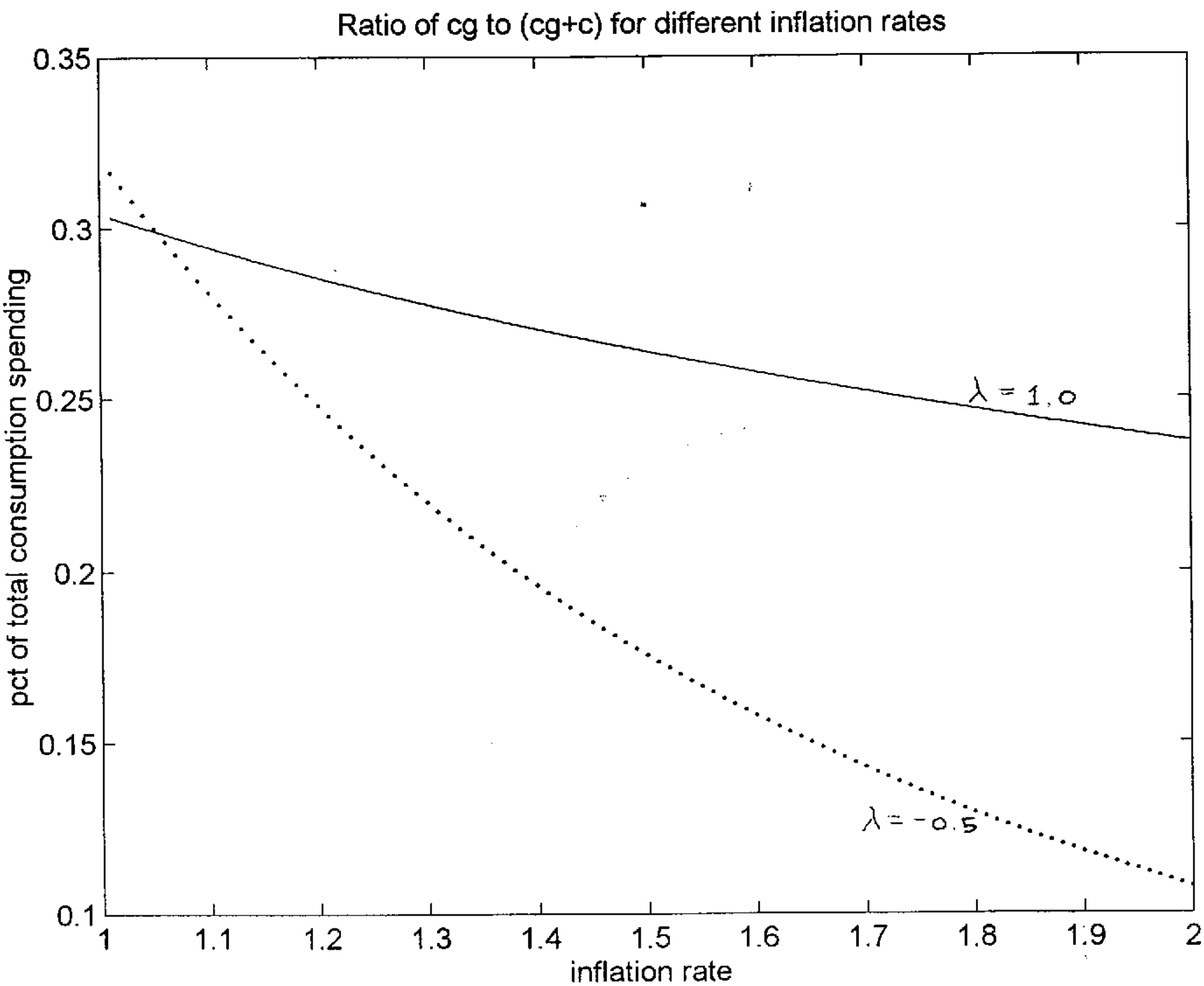

Ratio of cg to (cg+c) for different inflation rates
0.35
0.3
0.25
0.2
0.15
0.1
pct of total consumption spending
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
inflation rate
λ = 1.0
λ = -0.5

Figure 2

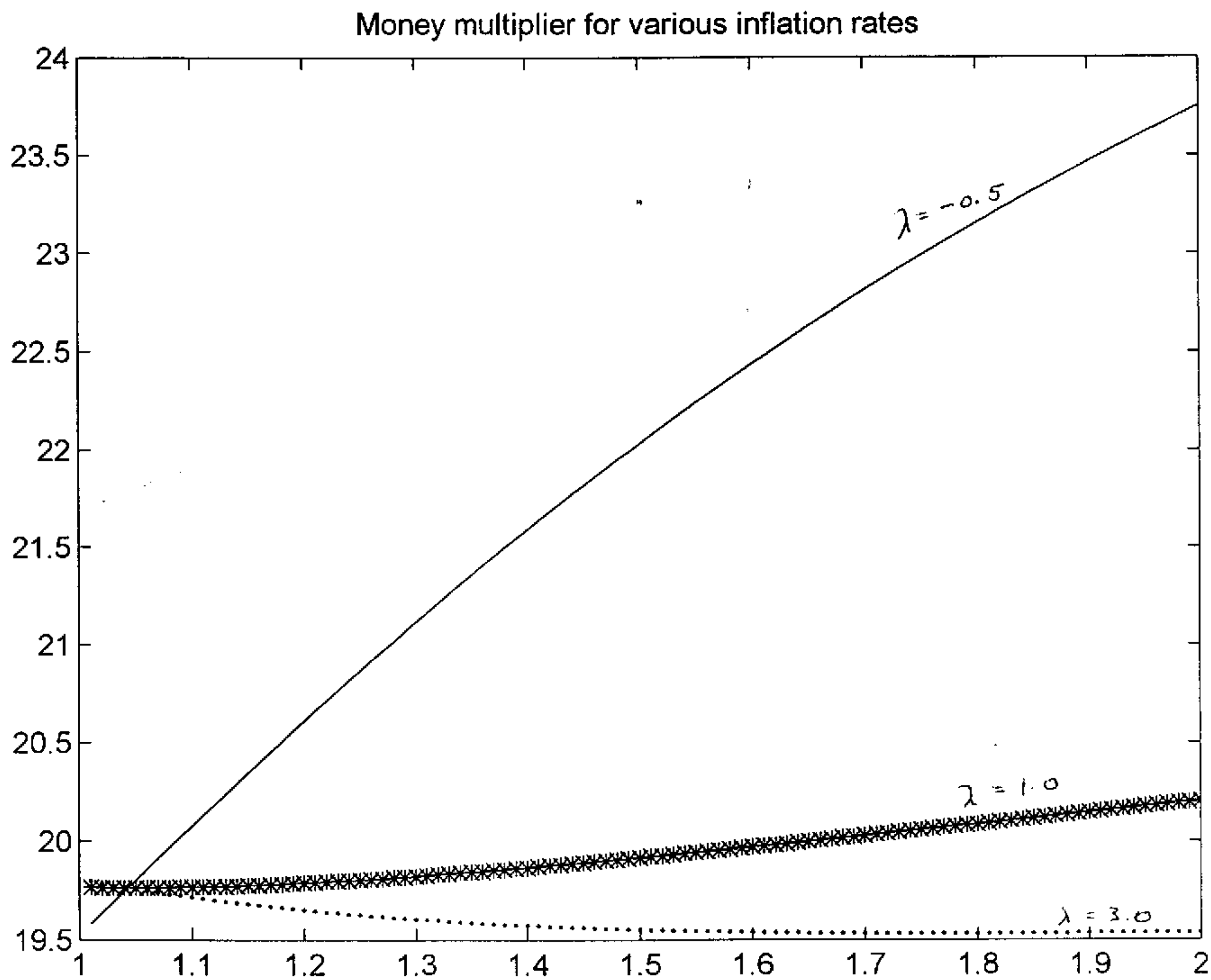
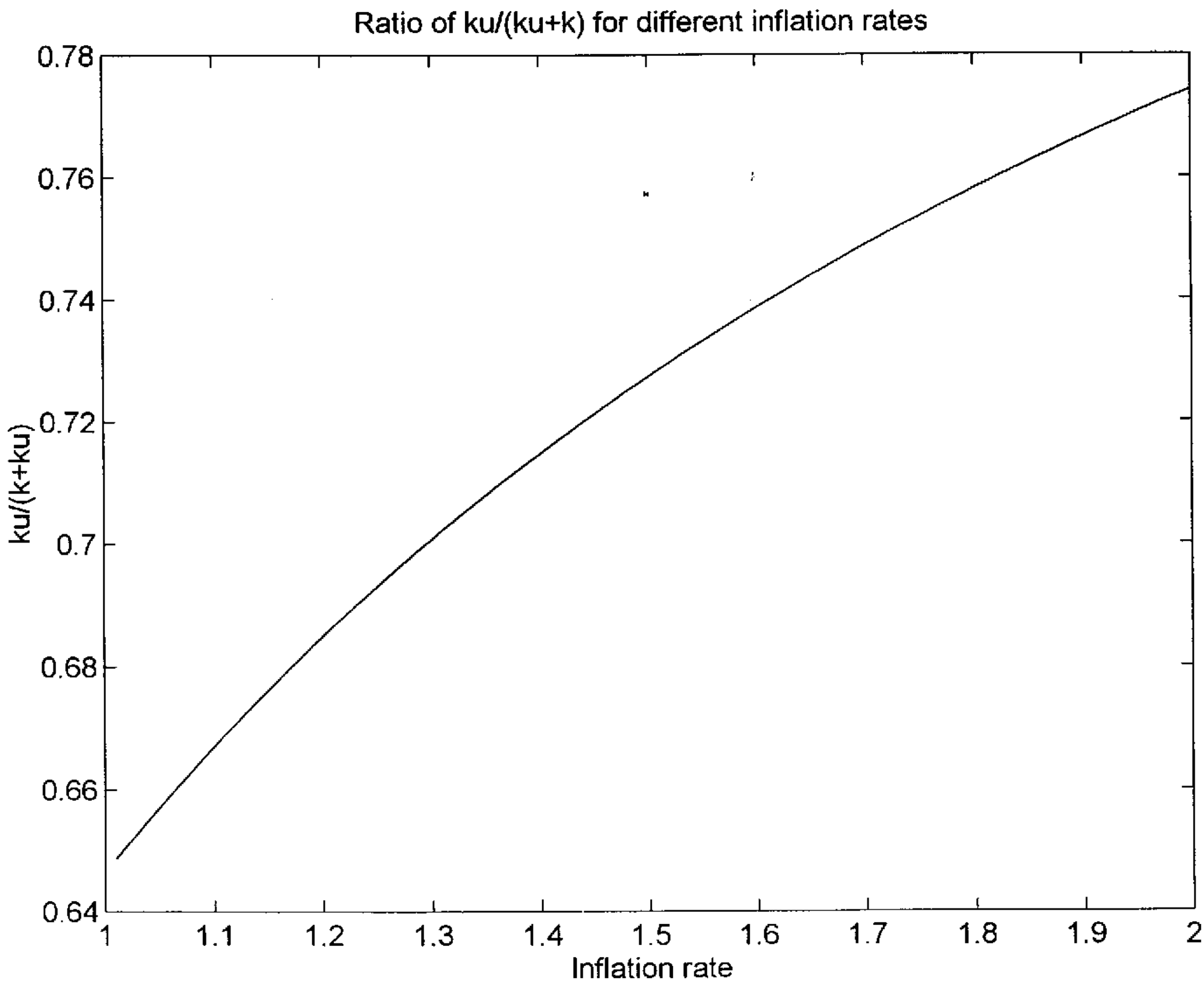

Money multiplier for various inflation rates
24
23.5
23
22.5
22
21.5
21
20.5
20
19.5
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
λ = -0.5
λ = 1.0
λ = 3.0

Figure 3



Ratio of ku/(ku+k) for different inflation rates
ku/(k+ku)
0.78
0.76
0.74
0.72
0.7
0.68
0.66
0.64
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
Inflation rate

Figure 4

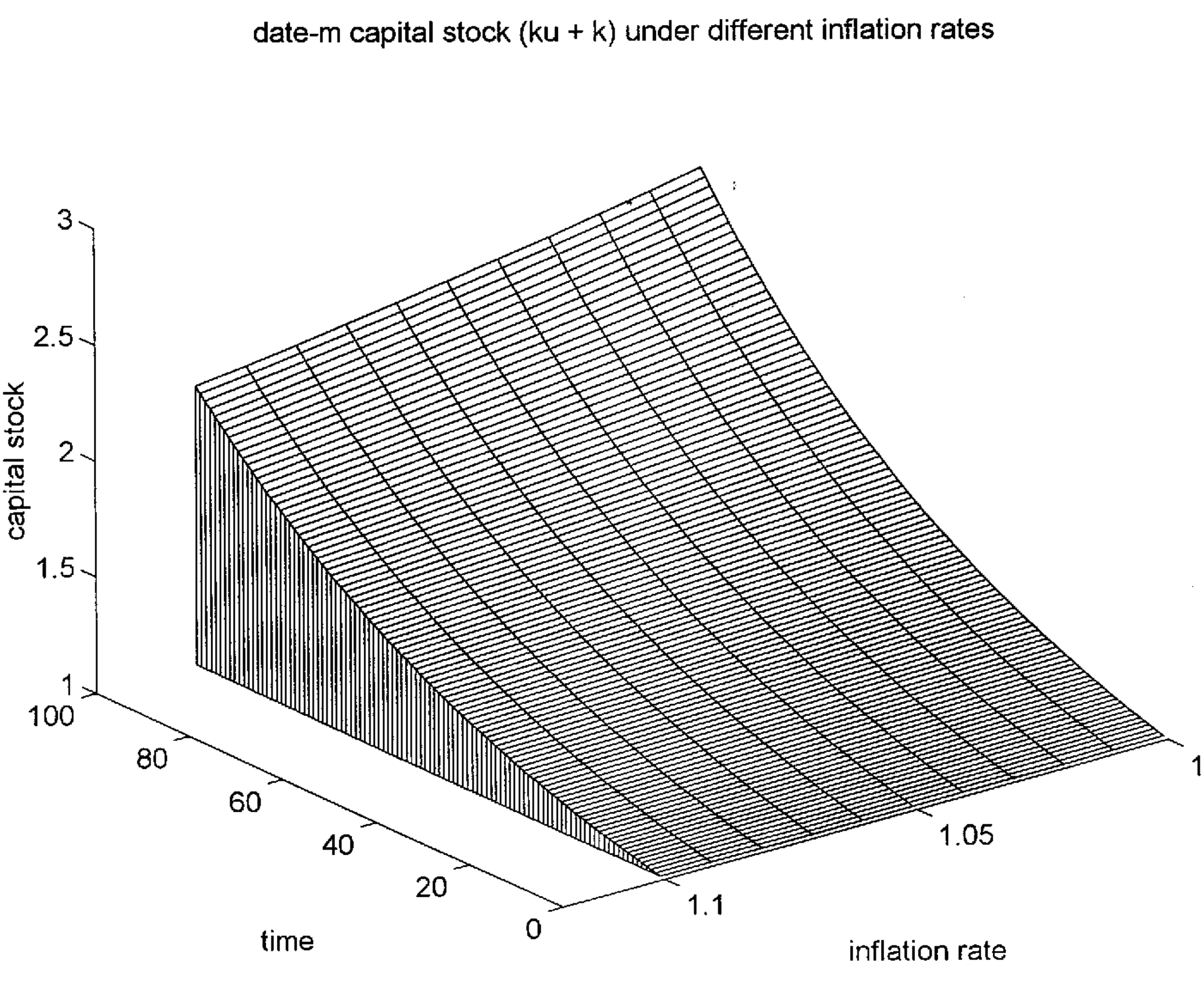
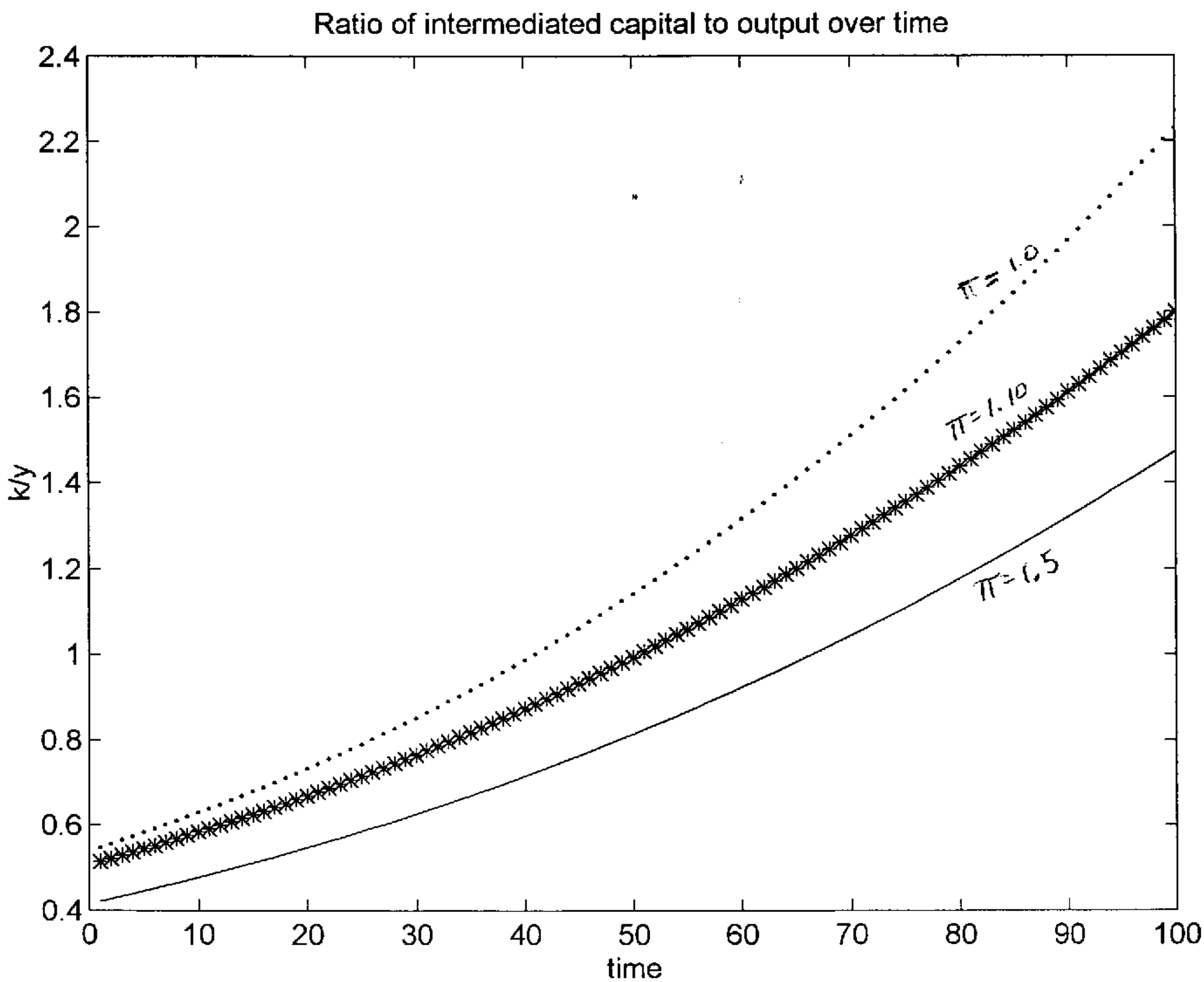

date-m capital stock (ku + k) under different inflation rates
capital stock
3
2.5
2
1.5
1
100
80
60
40
20
0
time
1.1
1.05
1
inflation rate

Figure 5


Ratio of intermediated capital to output over time
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
k/y
0
10
20
30
40
50
60
70
80
90
100
time
π = 1.0
π = 1.10
π = 1.5

RESEARCH PAPERS OF THE RESEARCH DEPARTMENT
FEDERAL RESERVE BANK OF DALLAS

Available, at no charge, from the Research Department
Federal Reserve Bank of Dallas, P. O. Box 655906
Dallas, Texas 75265-5906

Please check the titles of the Research Papers you would like to receive:

___	9201	Are Deep Recessions Followed by Strong Recoveries? (Mark A. Wynne and Nathan S. Balke)
___	9202	The Case of the "Missing M2" (John V. Duca)
___	9203	Immigrant Links to the Home Country: Implications for Trade, Welfare and Factor Rewards (David M. Gould)
___	9204	Does Aggregate Output Have a Unit Root? (Mark A. Wynne)
___	9205	Inflation and Its Variability: A Note (Kenneth M. Emery)
___	9206	Budget Constrained Frontier Measures of Fiscal Equality and Efficiency in Schooling (Shawna Grosskopf, Kathy Hayes, Lori L. Taylor, William Weber)
___	9207	The Effects of Credit Availability, Nonbank Competition, and Tax Reform on Bank Consumer Lending (John V. Duca and Bonnie Garrett)
___	9208	On the Future Erosion of the North American Free Trade Agreement (William C. Gruben)
___	9209	Threshold Cointegration (Nathan S. Balke and Thomas B. Fomby)
___	9210	Cointegration and Tests of a Classical Model of Inflation in Argentina, Bolivia, Brazil, Mexico, and Peru (Raul Anibal Feliz and John H. Welch)
___	9212	The Analysis of Fiscal Policy in Neoclassical Models[1] (Mark Wynne)
___	9213	Measuring the Value of School Quality (Lori Taylor)
___	9214	Forecasting Turning Points: Is a Two-State Characterization of the Business Cycle Appropriate? (Kenneth M. Emery & Evan F. Koenig)
___	9215	Energy Security: A Comparison of Protectionist Policies (Mine K. Yücel and Carol Dahl)
___	9216	An Analysis of the Impact of Two Fiscal Policies on the Behavior of a Dynamic Asset Market (Gregory W. Huffman)
___	9301	Human Capital Externalities, Trade, and Economic Growth (David Gould and Roy J. Ruffin)
___	9302	The New Face of Latin America: Financial Flows, Markets, and Institutions in the 1990s (John Welch)
___	9303	A General Two Sector Model of Endogenous Growth with Human and Physical Capital (Eric Bond, Ping Wang, and Chong K. Yip)
___	9304	The Political Economy of School Reform (S. Grosskopf, K. Hayes, L. Taylor, and W. Weber)
___	9305	Money, Output, and Income Velocity (Theodore Palivos and Ping Wang)
___	9306	Constructing an Alternative Measure of Changes in Reserve Requirement Ratios (Joseph H. Haslag and Scott E. Hein)
___	9307	Money Demand and Relative Prices During Episodes of Hyperinflation (Ellis W. Tallman and Ping Wang)
___	9308	On Quantity Theory Restrictions and the Signalling Value of the Money Multiplier (Joseph Haslag)
___	9309	The Algebra of Price Stability (Nathan S. Balke and Kenneth M. Emery)
___	9310	Does It Matter How Monetary Policy is Implemented? (Joseph H. Haslag and Scott Hein)
___	9311	Real Effects of Money and Welfare Costs of Inflation in an Endogenously Growing Economy with Transactions Costs (Ping Wang and Chong K. Yip)
___	9312	Borrowing Constraints, Household Debt, and Racial Discrimination in Loan Markets (John V. Duca and Stuart Rosenthal)
___	9313	Default Risk, Dollarization, and Currency Substitution in Mexico (William Gruben and John Welch)
___	9314	Technological Unemployment (W. Michael Cox)
___	9315	Output, Inflation, and Stabilization in a Small Open Economy: Evidence from Mexico (John H. Rogers and Ping Wang)
___	9316	Price Stabilization, Output Stabilization and Coordinated Monetary Policy Actions (Joseph H. Haslag)

___ 9317 An Alternative Neo-Classical Growth Model with Closed-Form Decision Rules (Gregory W. Huffman)
___ 9318 Why the Composite Index of Leading Indicators Doesn't Lead (Evan F. Koenig and Kenneth M. Emery)
___ 9319 Allocative Inefficiency and Local Government: Evidence Rejecting the Tiebout Hypothesis (Lori L. Taylor)
___ 9320 The Output Effects of Government Consumption: A Note (Mark A. Wynne)
___ 9321 Should Bond Funds be Included in M2? (John V. Duca)
___ 9322 Recessions and Recoveries in Real Business Cycle Models: Do Real Business Cycle Models Generate Cyclical Behavior? (Mark A. Wynne)
___ 9323* Retaliation, Liberalization, and Trade Wars: The Political Economy of Nonstrategic Trade Policy (David M. Gould and Graeme L. Woodbridge)
___ 9324 A General Two-Sector Model of Endogenous Growth with Human and Physical Capital: Balanced Growth and Transitional Dynamics (Eric W. Bond, Ping Wang,and Chong K. Yip)
___ 9325 Growth and Equity with Endogenous Human Capital: Taiwan's Economic Miracle Revisited (Maw-Lin Lee, Ben-Chieh Liu, and Ping Wang)
___ 9326 Clearinghouse Banks and Banknote Over-issue (Scott Freeman)
___ 9327 Coal, Natural Gas and Oil Markets after World War II: What's Old, What's New? (Mine K. Yücel and Shengyi Guo)
___ 9328 On the Optimality of Interest-Bearing Reserves in Economies of Overlapping Generations (Scott Freeman and Joseph Haslag)
___ 9329* Retaliation, Liberalization, and Trade Wars: The Political Economy of Nonstrategic Trade Policy (David M. Gould and Graeme L. Woodbridge) (Reprint of 9323 in error)
___ 9330 On the Existence of Nonoptimal Equilibria in Dynamic Stochastic Economies (Jeremy Greenwood and Gregory W. Huffman)
___ 9331 The Credibility and Performance of Unilateral Target Zones: A Comparison of the Mexican and Chilean Cases (Raul A. Feliz and John H. Welch)
___ 9332 Endogenous Growth and International Trade (Roy J. Ruffin)
___ 9333 Wealth Effects, Heterogeneity and Dynamic Fiscal Policy (Zsolt Becsi)
___ 9334 The Inefficiency of Seigniorage from Required Reserves (Scott Freeman)
___ 9335 Problems of Testing Fiscal Solvency in High Inflation Economies: Evidence from Argentina, Brazil, and Mexico (John H. Welch)
___ 9336 Income Taxes as Reciprocal Tariffs (W. Michael Cox, David M. Gould, and Roy J. Ruffin)
___ 9337 Assessing the Economic Cost of Unilateral Oil Conservation (Stephen P.A. Brown and Hillard G. Huntington)
___ 9338 Exchange Rate Uncertainty and Economic Growth in Latin America (Darryl McLeod and John H. Welch)
___ 9339 Searching for a Stable M2-Demand Equation (Evan F. Koenig)
___ 9340 A Survey of Measurement Biases in Price Indexes (Mark A. Wynne and Fiona Sigalla)
___ 9341 Are Net Discount Rates Stationary?: Some Further Evidence (Joseph H. Haslag, Michael Nieswiadomy, and D. J. Slottje)
___ 9342 On the Fluctuations Induced by Majority Voting (Gregory W. Huffman)
___ 9401 Adding Bond Funds to M2 in the P-Star Model of Inflation (Zsolt Becsi and John Duca)
___ 9402 Capacity Utilization and the Evolution of Manufacturing Output: A Closer Look at the "Bounce-Back Effect" (Evan F. Koenig)
___ 9403 The Disappearing January Blip and Other State Employment Mysteries (Frank Berger and Keith R. Phillips)
___ 9404 Energy Policy: Does it Achieve its Intended Goals? (Mine Yücel and Shengyi Guo)
___ 9405 Protecting Social Interest in Free Invention (Stephen P.A. Brown and William C. Gruben)
___ 9406 The Dynamics of Recoveries (Nathan S. Balke and Mark A. Wynne)
___ 9407 Fiscal Policy in More General Equilibriium (Jim Dolman and Mark Wynne)
___ 9408 On the Political Economy of School Deregulation (Shawna Grosskopf, Kathy Hayes, Lori Taylor, and William Weber)
___ 9409 The Role of Intellectual Property Rights in Economic Growth (David M. Gould and William C. Gruben)
___ 9410 U.S. Banks, Competition, and the Mexican Banking System: How Much Will NAFTA Matter? (William C. Gruben, John H. Welch and Jeffery W. Gunther)
___ 9411 Monetary Base Rules: The Currency Caveat (R. W. Hafer, Joseph H. Haslag, and Scott E. Hein)
___ 9412 The Information Content of the Paper-Bill Spread (Kenneth M. Emery)

___ 9413 The Role of Tax Policy in the Boom/Bust Cycle of the Texas Construction Sector (D'Ann Petersen, Keith Phillips and Mine Yücel)

___ 9414 The P* Model of Inflation, Revisited (Evan F. Koenig)

___ 9415 The Effects of Monetary Policy in a Model with Reserve Requirements (Joseph H. Haslag)

___ 9501 An Equilibrium Analysis of Central Bank Independence and Inflation (Gregory W. Huffman)

___ 9502 Inflation and Intermediation in a Model with Endogenous Growth (Joseph H. Haslag)

Name:	**Organization:**
Address:	**City, State and Zip Code:**
Please add me to your mailing list to receive future Research Papers: ____ Yes ____ No	

Research Papers Presented at the
1994 Texas Conference on Monetary Economics
April 23-24, 1994
held at the Federal Reserve Bank of Dallas, Dallas, Texas

Available, at no charge, from the Research Department
Federal Reserve Bank of Dallas, P. O. Box 655906
Dallas, Texas 75265-5906

Please check the titles of the Research Papers you would like to receive:

____ 1 A Sticky-Price Manifesto (Laurence Ball and N. Gregory Mankiw)

____ 2 Sequential Markets and the Suboptimality of the Friedman Rule (Stephen D. Williamson)

____ 3 Sources of Real Exchange Rate Fluctuations: How Important Are Nominal Shocks? (Richard Clarida and Jordi Gali)

____ 4 On Leading Indicators: Getting It Straight (Mark A. Thoma and Jo Anna Gray)

____ 5 The Effects of Monetary Policy Shocks: Evidence From the Flow of Funds (Lawrence J. Christiano, Martin Eichenbaum and Charles Evans)

Name:	Organization:
Address:	City, State and Zip Code:
Please add me to your mailing list to receive future Research Papers:	_____ Yes _____ No