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MONETARY POLICY AND THE DISTRIBUTION OF INCOME*

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Abstract

This paper represents a first attempt at a tractable analysis of how monetary policy influences the income distribution in an economy. It presents a monetary growth model in which inflation affects credit market efficiency, and via this link, influences capital accumulation, and the income distribution. In the model, a fraction of the population is capitalists, who have access to a risky but high return capital production technology. Capital investment must be partially externally financed via workers' savings, and is subject to a costly state verification (CSV) problem. Successful capitalists leave bequests to their offspring which serve as internal finance, more of which promotes credit market efficiency and capital formation. Inflation acts as an unavoidable tax on the capital incomes of the capitalists thereby reducing their bequests and worsening the CSV friction. Computational experiments reveal that in the model economy, irrespective of whether the government rebates the proceeds of the inflation tax to capitalists or workers, inflation decreases the steady-state capital stock, although the capital stock is highest when all transfers go to workers. The regime where workers get the entire transfer is shown to be "superior" in many respects to one where the capitalists get all the transfer. When monetary policy is instead implemented via changes in the reserve requirement, the effects are largely similar except that the regime where seigniorage is rebated to workers is clearly preferred by all workers and all capitalists.

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1 Introduction

This paper produces a structure in which the effects of anticipated inflation on a wide variety of long run economic variables (including the distribution of income) can be meaningfully studied. It develops a neoclassical model of capital accumulation in which inflation affects the payoffs to economic agents in financial markets, which in turn impacts upon their incomes and well-being via its effect on long-run real activity in the economy. It represents a first attempt at a tractable analysis of how inflation affects the distribution of income especially in the modern general-equilibrium optimizing-agent paradigm.

   To that end, a neoclassical growth model is constructed in which some capital investment must be partially externally financed, and external finance is subject to a standard costly state verification (CSV) problem.[1] Some fraction of the population is entrepreneurs (capitalists), who have access to a risky but high return capital production technology. Successful capitalists leave bequests to their offspring which are then used by the latter to internally fund some part of their own investment projects. However, some external finance is also required and this is provided by a financial intermediary that pools the young labor income of workers and makes loans on their behalf. All contracts are set up in real terms. There is also a government which conducts monetary policy by printing money and by imposing legal restrictions on currency holdings. In particular, a given fraction of the deposit base of the intermediary must be held in the form of return-dominated currency. Even though inflation is perfectly anticipated, it can have real effects in the economy via the effect it has on the real returns to lending activities. More specifically, inflation forces the intermediary to charge a inflation premium so that it can preserve the real value of its payoff from lending.

   In the setting described above, it is well-understood that the greater the ability of capitalists to provide internal finance, the less severe is the CSV problem. Thus bequests help mitigate the severity of the contracting friction and thereby promote credit market efficiency and capital formation. The inflation premium charged by the intermediary erodes the incomes of the entrepreneurs, thereby reducing their bequests (future collateral), raising agency costs, and worsening credit market efficiency. The binding reserve requirement also serves to reduce the supply of loanable funds into the credit market thereby reducing credit market activity. On the one hand, the transfer to the young capitalists reduces their need for external funds thereby reducing the severity of the information friction (a reduction in aggregate monitoring costs). On the other hand, the government transfer to young workers removes the effect of the reserve requirement, restoring their savings to a level identical to what is was in the benchmark setting with no money.

   We go onto study four different nested models depending on the treatment accorded to any seigniorage revenue that is collected by the government. These are a) the model with no reserve requirement, and hence no seigniorage, b) the model with no transfers (where the seigniorage may be thought of as being discarded), c) the model where the seigniorage is entirely rebated to the workers, and finally d) the model where all the transfers go to the capitalists. By construction, the benchmark model is the one with no money. Numerical computations reveal that the average monitoring probability, an estimate of the economy-wide "bankruptcy probability" rises in each case, but the level is the lower in the transfers-to-capitalist regime than in the transfers-to-workers regime. Transfers to capitalists enhance their internal finance and this reduces their probability of being monitored.

   Within each regime, inflation causes a decline in real activity.[2] The decline is lowest in the transfers-to-workers regime because the transfer to the workers essentially nullifies the deleterious effect of a binding reserve requirement. There is still a small decline because even when the amount of loanable

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[1]The literature has established a strong positive relationship between bank lending activity and long-run real economic performance [see King and Levine, 1993 for example].

[2]On average, sustained high rates of inflation are known to be detrimental to long-run economic performance as discussed in Huybens and Smith (1999).

funds is restored to the benchmark level, higher inflation continues to erode the incomes of capitalists via its effect on the real return on loans. Relative to the regime in which all seigniorage is discarded, the capital stock is far higher in either the transfers-to-capitalist regime or the transfers-to-workers regime.

It is interesting to note that inflation increases the income inequality (measured by the gini coefficient) among all capitalists in each regime. Curiously, the effect of inflation on income inequality among capitalists is most muted in the transfers-to-workers regime. Similarly, the income gap between capitalists and workers (the ratio of average capitalist income to the wage rate) is highest in the transfers-to-capitalist regime when compared to the transfers-to-workers regime. The welfare of workers, not surprisingly, is highest in the transfers-to-workers regime. The numerical analysis indicates that the supply of loanable funds is, in some sense, more important for capital formation when compared to policy-induced reductions in economy-wide agency costs. Finally, at least from a steady state comparison view-point, it appears that the worker regime is "superior" to the capitalist regime in that it produces a less-unequal income distribution (both within capitalists and across capitalists and workers) without compromising on capital formation.

In keeping with the spirit of Romer and Romer (1998), the above results also suggest a new long run role for predictable monetary policy, namely, reducing income inequality. Of course, proper coordination between the monetary wing and the fiscal wing of the government is necessary to achieve this; after all, the decisions taken by the fiscal wing with respect to the transfer payment schedules has a strong impact on the overall effect of inflation on the economy. As an aside, the analysis also suggests the deleterious effect of inflation on the capital accumulation process (and on income distribution) may be largely muted by appropriate rebating of the seigniorage revenue.

Many researchers, dating back to Ascheim (1959), and more recently, Haslag and Hein (1995) have asked the question: does it matter how monetary policy is implemented. In other words, monetary policy may be thought of as either affecting the inflation tax rate (via the money growth rate) or the inflation tax base (via changes in the reserve requirement). The question then becomes: are the two instruments very different in terms of their effects on real variables in the economy? Consistent with a popular view among central bankers and academics, it turns out the reserve requirement is indeed a very "blunt" instrument in my model. For example, with the inflation rate fixed at 10%, an increase in the reserve requirement from 10% to 20% in the no-transfers regime reduces the steady state capital-labor ratio by almost 22%. Moreover, when monetary policy is implemented via changes in the reserve requirement, from a steady-state comparison view-point, it appears that the transfers-to-workers regime is "superior" to the no-transfers regime in that it produces a less-unequal income distribution (both within capitalists and across capitalists and workers) without compromising on capital formation; additionally, all capitalists and all workers prefer the transfers-to-workers regime in a stationary welfare sense.

The paper makes contributions to several other strands in the literature. First, it adds to the literature on the tax-related costs of inflation. In this paper, inflation acts as a tax on capital income and therefore serves to raise the "effective tax rate" on capital. The novelty is that a new cost has been added to the list of items that are known to increase the effective tax rate: the decline in the availability of internal funds that gets reflected in higher economy-wide agency costs. Second, unlike many models studying the welfare costs of inflation, this one is immune to the standard Lucas critique. Here all financial contracts are endogenously derived and take account of changes in the government's monetary policy. It is important to point out here that the above results are established for an economy in which nominal contracts are unimportant. In the real world, of course, inflation may have additional effects arising purely out of the non-indexed nature of many financial contracts. Moreover, if capital income taxes are levied on nominal rather than real income, inflation may have an indirect effect on capital income tax rates (via the mechanism described earlier) that may exceed the more direct effect.

The rest of the paper is organized as follows. Section 2 discusses the related literature. Section 3 outlines the environment while Section 4 discusses trade in the credit, labor, and capital markets. Section 5 discusses the steady state distribution of bequests and income while Section 6 discusses the determination of the steady state capital stock and the rate of interest. Section 7 contains the main analytical results concerning the effects of inflation on capital formation, and on the incomes of agents. Section 8 studies the impact of various seigniorage rebate schemes using computational tools, Section 9 concludes the paper. The proofs of certain key results are collected in the appendices.

2   The related literature

The issues discussed in the current paper have antecedents from several different strands in the literature (see Romer and Romer, 1998 for a detailed survey.) I now discuss these in turn, with a view to isolating the novel aspects of my approach.

There exists a large literature of sufficient vintage that addresses the issue of the impact of inflation on the distribution of income and wealth. The standard "mainstream" argument (often summarized as the Keynes-Fisher-Hamilton hypothesis) is that business firms which are net debtors, gain through inflation. This is because many contractual arrangements are arguably fixed in nominal (dollar) terms. Inflation reduces the real value of these nominal obligations thereby benefitting debtors and hurting creditors. Similarly, inflation may transfer resources from workers to capitalists, if it is believed that wages are set in nominal terms and inflation erodes their purchasing power. This set of hypotheses of course relies on three critical assumptions. First, contracts must be set in nominal terms; second, firms are net debtors, and third, all inflation must be unanticipated. Keynes also believed that even perfectly anticipated inflation could act as a tax on the poor. This is possible if the "poor" are primary holders of currency, while the "rich" hold indexed assets which allow them to largely avoid the inflation tax. This paper studies an economy in which nominal contracts are unimportant in the sense that all contracts that are indexed to perfectly anticipated inflation. Given that the effects of unanticipated inflation is well known, such a focus seems appropriate. In addition, since the financial contracts are endogenously determined (and incorporate monetary policy parameters), the current model is immune to the Lucas critique. Moreover, even though the actual brunt of the inflation tax is borne by the workers here, the inflation-induced tax on capital income faced by capitalists is unavoidable and quite significant. [Boyd, Levine, and Smith (2001)]

The relationship between inflation and credit market performance, long a favorite subject of research in finance, has recently received a lot of attention in macroeconomics. In recent years, causal linkages between inflation and financial market efficiency have been provided by Boyd, Choi, and Smith (1996) and many others while Boyd, Levine, and Smith (1996), provide empirical support for the belief that inflation and financial market activity might be negatively correlated. In the words of Boyd, Levine, and Smith (2001), "...there is a significant and economically important negative relationship between inflation and credit market activity". In most of these models, financial markets allocate savings in a world with informational asymmetries. Inflation worsens the severity of these information frictions thereby hampering capital accumulation and growth. The paper that is closest in spirit to the present paper is Huybens and Smith (1999), who among other things, are interested in explaining why inflation and real activity might be negatively correlated in the long run. They employ a similar model where a subset of agents need external finance to run their investment projects in the presence of a CSV problem. There are two crucial differences between these papers. First, in their setup, capital and money coexist because they bear the same rate of return while here, capital dominates money in rate of return and money is held to satisfy a legal restriction. Second, in their model, the government plays a more limited

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role in that it only appropriates goods from the economy, and does not rebate them to the agents.[3]

There is ample evidence that points to a strong relationship between inflation (money growth rates) and real activity. Khan, Senhadji, and Smith (2001) summarize the evidence as follows: "The empirical evidence, particularly that based on time-averaged data, seems to suggest that even permanent and predictable changes in the rate of inflation have real effects." Similarly, evidence on the negative effects of financial repression (which include large increases in the reserve requirements for banks) on real activity, at least in developing countries, has been discussed in Bencivenga and Smith (1992).

In a recent paper, Heer and Süsmuth (2003) study the effect of inflation on the wealth distribution in a general equilibrium multi-period overlapping generations model that is calibrated to the US economy. In their model, poor agents accumulate savings in liquid assets, while rich agents participate in the stock market. They find that an increase of inflation results in a lower stock market participation rate; in addition, the distribution of wealth becomes more unequal. Romer and Romer (1998) find that low inflation (and stable aggregate demand growth) are associated with "improved well-being of the poor in the long run."

The present analysis also shares some similarities with the literature on the Tobin effect. In Tobin (1965), an increase in the inflation rate reduces the real rate of return on currency thereby inducing agents to switch to holding capital. There, increased inflation may actually increase capital accumulation. It is important to note here that Tobin effects are purely monetary in nature in that inflation only affects the return to money. In contrast, in my setup, inflation matters because it acts as a tax on savers who then transfer the burden on to the borrowers. Thus inflation ends up acting as a tax on capital income. Such tax-related costs of inflation may be especially relevant for those developing countries who have large reserves to GDP ratios, and rely heavily on currency seigniorage. There is a growing literature (see Feldstein, 1983, 1996 and Gravelle, 1994 among others) which focus on the fact that inflation may increase the effective tax rate on capital income. In that vein, the current paper may be thought of as adding a previously unexplored cost of inflation: the added cost that is borne by capitalists whose inheritance (and hence internal finance) is lower because of inflation. This paper underscores the possible effect of such inflation-induced capital income taxation on the income distribution between capitalists *as well as* the income distribution between capitalists and workers.

Finally, there is a growing literature connecting changes in the income distribution to long run output in an economy. Many of these papers make use of a credit market imperfection to induce permanent effects of changes in the income distribution on output. Foremost among these, are papers by Galor and Zeira (1993), Banerjee and Newman (1991), and more recently, Matsuyama (2000), among many others. Yet, almost all the papers in this literature do not explicitly model the credit market friction or the environment in which the friction operates, and many do not derive the loan contracts endogenously. Moreover, for reasons of tractability, many of them make assumptions (such as the open economy assumption etc.) to ensure that interest rates remain fixed, thereby precluding any interesting analysis of inflation in their models. Even though there is no "occupational choice" in my model, I am able to overcome some of these aforementioned lacunae.

3 Environment

The model consists of an infinite sequence of two-period lived overlapping generations along the lines of Diamond (1965).[4] There is also a government that lives on forever. At the start of every period, a new generation, consisting of a continuum of agents with measure one, is born. An exogenously specified

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[3]The first of these differences is crucial in explaining why inflation necessarily has a negative effect on long-run real activity in their setup. The second difference precludes any analysis of income distribution in their paper which in any case, is not their focus.

[4]The setup and notation here follows Bhattacharya (1998).

fraction α of any generation is entrepreneurs or "capitalists"; the remainder is lenders or "workers". Capitalists, as a group, are distinguishable from workers in that they have exclusive access to one of the capital investment technologies described below.

3.1 Endowments, technology, and preferences

In each period, there is a single final good, which may either be consumed, or invested in the production of future capital. The final good is produced using a constant returns to scale technology with capital and labor as inputs. If K_t is the time t capital stock and L_t is the time t quantity of labor employed, output at t is given by $F(K_t, L_t)$. Furthermore, let $k_t \equiv \frac{K_t}{L_t}$ denote the capital-labor ratio and $f(k_t) \equiv F(k_t, 1)$ denote the intensive production function. The function $f(.)$ is assumed to satisfy: $f(0) = 0$, $f' > 0 > f''$, and standard Inada conditions. Capital depreciates fully between dates.

I now describe the details of the "superior" capital production technology.[5] Capitalists alone are endowed with access to a stochastic linear technology (called project) that converts q units of the final good at t into κ units of capital at $t + 1$. Each capitalist is endowed with exactly one such project. Ownership of these projects cannot be traded and projects are indivisible, requiring exactly q units of the final good to operate. The amount of capital produced next period is a discrete two-state random variable, i.e., $\kappa \in \{\kappa_1, \kappa_2\}$ with $\kappa_2 > \kappa_1 \geq 0$. I refer to $\kappa = \kappa_2$ as the "good" state and $\kappa = \kappa_1$ as the "bad" state. Let Prob $\{\kappa = \kappa_i\} = \pi_i$; $i = 1, 2$. Project returns are *i.i.d* across agents and time, and the probability distribution of returns is time-invariant. There is no aggregate uncertainty.

With respect to information, all capitalists costlessly observe the realized return on their own projects. However, any other agent (typically a lender) can observe the ex post return realization on a project only by incurring a fixed cost of γ units of capital.[6]

There is also a second, *inferior* technology for producing capital that is available to *all* agents, including workers. One unit of the final good invested in this inferior technology at t returns $r \geq 1$ units of capital at $t + 1$ with probability one.

Finally, there is a government that prints money. Let M_t denote the per capita stock of money outstanding at the end of period t, $\wp_t$ denote the time t price level, and $m \equiv M/\wp$ denote per capita real balances. The government conducts its monetary policy by choosing the gross rate of money growth, σ, once and for all in the first period. The money supply process is therefore described by

$$M_{t+1} = \sigma M_t; \quad \sigma \geq 1, \ M_0 > 0.$$

The seigniorage collected is then rebated back to the agents in a manner to be described below. For now, assume that each capitalist potentially gets a lump sum transfer of amount $T_c \geq 0$ and each worker gets $T_w \geq 0$. Also assume that the government makes no expenditures of its own.[7]

All agents are risk-neutral, and care only about old period consumption. As described earlier, a capitalist also derives utility from leaving bequests to her offspring.[8] I assume that a capitalist

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[5]The specifications of this technology closely follows Bernanke and Gertler (1989) and Bhattacharya (1998).

[6]The assumption that monitoring uses up capital yields a considerable simplification. The specification follows Bernanke and Gertler (1989), Boyd and Smith (1998), and Carlstrom and Fuerst (1997) among others. Empirical backing for the CSV story may be found in Bernanke and Gertler (1989) and Carlstrom and Fuerst (1997,1998).

[7]A side-issue that deserves mention here is the distinction between monetary and fiscal policy. If currency seignorage is used to fund government purchases, and the latter has real effects, then it is not clear whether the overall effects of inflation are the result of monetary action or fiscal policy. Since our focus is on the real effects of monetary policy, it is best to keep government purchases fixed (hold "fiscal policy constant") and investigate the consequences of monetary expansion. To that end, it is appropriate to set government expenditures to zero.

[8]Two points deserve mention here. First, bequests have been shown to be quantitatively quite significant in explaining the intergenerational transmission of wealth. Kessler and Masson (1989) also document the dominant role of bequests in capital formation. Second, allowing workers to leave bequests would not affect the qualitative nature of the results that follow.

consuming c_t when old, and leaving a bequest with a real value of b_t, derives utility[9] equal to

$$U(c_t, b_t) = \min\ (c_t, \beta b_t),\ \beta > 0. \tag{1}$$

4 Trade

4.1 Factor Markets

Young workers are endowed with one unit of labor, which they supply inelastically. They earn the competitive real wage rate ω_t at t where

$$\omega_t \equiv \omega(k_t) = f(k_t) - k_t f'(k_t);\qquad \omega'(.) > 0 \tag{2}$$

I assume that f is such that the resulting wage function is concave, or that

$$\omega''(.) < 0 \quad \forall k_t. \tag{A.1}$$

Capital is also traded in competitive markets and earns the rental rate of ρ_t at t where

$$\rho_t = f'(k_t). \tag{3}$$

Since entrepreneurs have no labor endowment when young, and old workers are retired, clearly $k_t = K_t/(1 - \alpha)$.

4.2 Credit Markets

Funds are available to capitalists from two sources; bequests left by the previous generation, if any, and loans from workers. Lending by workers may be regarded as being intermediated. In other words, I assume that there exists a financial intermediary that pools the young incomes of all workers and lends on their behalf. For future reference, note that the entire deposit base of the bank is $(1 - \alpha)\omega(k_t)$.[10] Credit issuance by the intermediary is subject to a currency reserve requirement, λ, which is set by the government at time 0. More specifically,

$$m \geq \lambda(1 - \alpha)\omega(k_t) \tag{4}$$

must hold.[11] This acts as a lower-bound restriction on the demand for real money balances in the economy.

I also assume that there is an oversupply of loanable funds. This is implied by

$$\alpha q \leq (1 - \alpha) \left[\omega(k_t) + T_w\right]. \tag{A.2}$$

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[9] The introduction of bequests as a "warm glow" in the utility function is standard (see Galor and Zeira (1993) for example). In the sequel, I will provide a precise characterization of the optimal loan contracts in the presence of an information friction. To that end, all that is needed is that capitalists be risk neutral. The specific Leontief form of the utility function is assumed solely for analytical simplicity.

[10] Since the transfer T_w is funded by the seigniorage, we assume it does not enter the reservable deposit base of the bank.

[11] Reserve requirements of this form are commonly employed across a vast cross section of countries. This "legal restriction" is simply a convenient way to guarantee a positive demand for real balances even when currency is dominated in rate of return. In our setting, this restriction is nothing more than a fairly standard cash-in-advance constraint. Huybens and Smith (2001), somewhat unsatisfactorily, instead equate the returns to holding money and capital. Also note that given our assumption that agents care only about old-age consumption, it is not possible to generate a positive demand for money in our setup by introducing money into the utility function.

Henceforth, I focus on k that satisfy (A.2). Assumption (A.2) rules out the possibility of credit rationing and considerably simplifies the analysis. To foreshadow, any non-reserved funds remaining after all lending to potential borrowers is completed, is invested in the inferior capital production technology.

Borrowers obtain credit by offering loan contracts to lenders. Such contracts must (a) specify the amount to be borrowed, (b) spell out a set of state-dependent payments to the lender, and (c) provide a complete specification of how and when state verification will occur. Contracts specify a probability $p_t \in [0, 1]$ that monitoring will occur if the borrower announces that the low return state has occurred.[12] In addition contracts specify the amount retained by the borrower in the bad state in the event of an audit, y_t^a, as well as the amount retained in announced state i if no audit occurs, y_{it}. Since in state i the goods value of an investment is $\rho_t \kappa_i$, the payment to the lender in the event of an audit is $\rho_t \kappa_i - y_t^a$, and the payment to a lender in state i if no audit occurs is $\rho_t \kappa_i - y_{it}$.

A borrower with the ex post income level y chooses a consumption level, c, and a bequest, b, to maximize $U(c, b) = \min(c, \beta b)$ subject to $c + b \leq y$. At an optimum, borrowers set $c = \beta b$ and hence, optimal consumption is $c = \left(\frac{\beta}{1+\beta}\right) y$. Thus the utility of a borrower, is a linear function of y given by $[\beta/(1 + \beta)]y$.

If the inferior capital production technology dominates money in rate of return,

$$r\rho > \frac{\wp_t}{\wp_{t+1}} \tag{5}$$

holds; then the reserve requirement on the intermediary is binding, and (4) holds as an equality. I focus on this situation throughout. The financial intermediary may therefore be thought of as holding a portfolio (consisting of loans and reserves) with a weight of $(1 - \lambda)$ attached to loans, and a weight, λ, attached to currency reserves.

Let R_t denote the (gross real) market rate of return charged on loans between t and $t + 1$. Since (4) holds with equality, I can rewrite the return on the bank's portfolio as $\left[\lambda\left(\frac{\wp_t}{\wp_{t+1}}\right) + (1 - \lambda)R_t\right]$. Since workers have access to the inferior technology, in equilibrium, it must be the case that their deposits with the intermediary earn the same return as what they would have earned had they instead invested their savings in the inferior technology. This implies that

$$\left[\lambda\left(\frac{\wp_t}{\wp_{t+1}}\right) + (1 - \lambda)R_t\right] = r\rho_{t+1} \tag{6}$$

must hold. In other words, if workers utilize the commonly available technology, the market return on loans will be given by

$$R_t \equiv R_t(\rho; \sigma) = \frac{r\rho_{t+1} - \lambda\left(\frac{\wp_t}{\wp_{t+1}}\right)}{1 - \lambda}.$$

It follows then that an increase in the inflation rate, ceteris paribus, causes R to rise. In other words, lenders charge an inflation premium arising purely from the fact that they are forced to hold return-dominated currency. As stated earlier, this premium is fully anticipated by all agents. Also notice that the return to the inferior technology is assumed to be invariant to the inflation rate.

Borrowers announce contract terms, consisting of the vector $(p_t, y_t^a, y_{1t}, y_{2t})$ to maximize their own expected utility, subject to a set of constraints described below. First, a borrower at t, with an inheritance of b_{t-1}, must raise $(q - b_{t-1})$ units of funds externally. Announced loan contract terms must yield a lender an expected return of $R_t(q - b_{t-1})$. The pertinent constraint is

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[12]Several points deserve mention here. First, following Williamson (1987), p may be interpreted as the probability of bankruptcy. Second, the assumption of stochastic monitoring precludes the existence of standard debt contracts arising in equilibrium. Third, Boyd and Smith (1994) show that, quantitatively speaking, the assumption of stochastic monitoring, is not restrictive.

$$\pi_1\{\rho_{t+1}\kappa_1 - p_t(y_t^a + \gamma) - (1 - p_t)y_{1t}\} + \pi_2\{\rho_{t+1}\kappa_2 - y_{2t}\} \geq R_t(q - b_{t-1} - T_c). \qquad (7)$$

Moreover, the borrower must have an incentive to announce truthfully when the good state has occurred. The incentive constraint implied by this stricture is

$$(1 - p_t)(\rho_{t+1}\kappa_2 - \rho_{t+1}\kappa_1 + y_{1t}) \leq y_{2t}. \qquad (8)$$

Finally, the borrower's income must be non-negative, so that

$$y_t^a \geq 0, \quad y_{1t} \geq 0, \quad y_{2t} \geq 0,$$

must hold, along with $p_t \in [0, 1]$. Since a borrower's expected utility is simply proportional to

$$\pi_1[p_t y_t^a + (1 - p_t)y_{1t}] + \pi_2 y_{2t},$$

a borrower with an inherited bequest of b_{t-1} chooses a vector $(p_t, y_t^a, y_{1t}, y_{2t})$ to maximize this expression, subject to (7), (8) and the "limited-liability" non-negativity constraints.

Two additional restrictions need to be imposed here. First, it is assumed that the superior investment technology — inclusive of monitoring costs — yields an expected return superior to that on the inferior technology, even if $p_t = 1$. More specifically,

$$\rho\left[\pi_2\kappa_2 + \pi_1\kappa_1 - \pi_1\gamma\right] > Rq. \qquad (A.3)$$

Second, I assume that

$$Rq > \rho\kappa_1. \qquad (A.4)$$

Assumption (A.4) guarantees that some monitoring occurs in the low return state.

Under the assumptions (5), (A.3) and (A.4), the following result is easily established.

Proposition 1 *An equilibrium loan contract is defined by*

$$p_t = \frac{R_t(q - b_{t-1} - T_c) - \rho_{t+1}\kappa_1}{\pi_2\rho_{t+1}(\kappa_2 - \kappa_1) - \pi_1\rho_{t+1}\gamma} \qquad (9)$$

$$y_{1t}^a = y_{1t} = 0 \qquad (10)$$

$$y_{2t} = \rho_{t+1}(1 - p_t)(\kappa_2 - \kappa_1). \qquad (11)$$

The proof of this result follows arguments presented in Bernanke and Gertler (1989) and is hence omitted. Some noteworthy features of the contract deserve mention here. The optimal contract minimizes expected monitoring costs while ensuring the market return on loans to the lender. Unsuccessful capitalists earn zero income. Additionally, note that the contractual arrangement is specified in *real* terms. Also, inheritance plays an important role in determining the probability of bankruptcy for a given firm; Blanchflower and Oswald (1990) provide evidence in support of this implication.

An additional implication of these contractual terms is that for a given level of bequest, b, an increase in the market return on loans, R, increases the probability of being monitored if the capitalist is unsuccessful. The intuition for this is simple: an increase in R reduces the payoff to the borrower in the good state making it more attractive to misreveal the state; hence she must be monitored with a higher probability. Ceteris paribus, therefore, higher market return on loans imply a higher bankruptcy probability (and higher auditing costs) and hence, *lower* credit market efficiency. Finally, note that an increase in the level of bequest left by the previous generation, b_{t-1}, ceteris paribus, reduces the probability of being monitored, and raises y_{2t} (the income of a successful capitalist who receives a bequest b_{t-1}). This link between bequests and credit market efficiency is explored more fully below.

5 The Distribution of Bequests

Given the link between the volume of internal finance (bequests) and the costs of state verification (and hence credit market efficiency) noted above, it is important to characterize the distribution of bequests given a rate of return, ρ, on capital. Bequests are linked to a family's success with the superior capital production technology; families that have had a large string of "good draws" will leave large bequests to their children who in turn will use these inheritances to attract better credit terms on the credit market. To that end, let j denote the successive number of times the good state has been drawn within a family since the last failure. Also let b_{t-1}^{j-1} denote the level of bequests received at date t by an agent whose parent is the family's $j-1$ th successive success. If successful, her second period income (from Proposition 1) is $y_{2t}^{j} = \rho_{t+1}(1-p_t^j)(\kappa_2 - \kappa_1)$.[13] She would then leave a bequest of $b_t^j = \left(\frac{1}{1+\beta}\right) y_{2t}^j$. Therefore,

$$b_t^j = \left(\frac{1}{1+\beta}\right) \rho_{t+1}(\kappa_2 - \kappa_1) \left[1 - \frac{R_t(q - b_{t-1} - T_c) - \rho_{t+1}\kappa_1}{\pi_2 \rho_{t+1}(\kappa_2 - \kappa_1) - \pi_1 \rho_{t+1}\gamma}\right]. \tag{12}$$

Equation (12) expresses the level of bequests left by a capitalist, if successful, as a function of the bequests she received. It formalizes our earlier intuition that larger inheritances *received* tend to raise the bequests *left*.[14]

5.1 Remarks

Several other implications of the analysis so far needs to be noted. First, the contract described in Proposition 1 implies that, given ρ, an increase in the inflation rate raises R and hence raises p. In other words, ceteris paribus, the model predicts a positive relationship between the bankruptcy rate and the inflation rate. This prediction is in line with some scattered empirical evidence. For example, Wadhwani (1986) using U.K data for 1964-81 finds "strong confirmation" for the hypothesis that higher inflation is accompanied by an increase in the overall bankruptcy rate. Freixas et. al (1994) find evidence of a similar link with more recent Spanish data.

Second, the model predicts that younger firms (those with low j indices) need more external funding than those that are older. Rajan and Zingales (1998) provide evidence in support of this. As a corollary to this, the model also predicts higher bankruptcy rates (higher p) for younger firms than older ones, and this feature too is consistent with much evidence.[15]

5.2 The Distribution of Income

I concentrate on steady states below. Using Proposition 1, and for a given ρ, it is possible to formally describe the steady state income of a capitalist who is the j th successive success in her lineage.[16] Define $x \equiv \pi_2(\kappa_2 - \kappa_1) - \pi_1\gamma$.

Lemma 1 *Let*

$$A \equiv A(\rho; \sigma) = (\kappa_2 - \kappa_1) \left[\rho - \frac{R(q - T_c)}{x} + \frac{\rho\kappa_1}{x}\right] > 0$$

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[13]Notice that, unlike in the setting explored by Carlstorm and Fuerst (1997), the bankruptcy probability here varies across capitalists with differing inherited wealths. In particular, offspring of "rich" capitalist families face lower bankruptcy probabilities.

[14]Kessler and Masson (1989) report that for France, 36% of the population receive any inheritances, and those who do, are about 2.4 times richer than the representative household.

[15]For 1996, US data on bankruptcies reported in Dun and Bradsheet reveal that around 44% of all businesses aged five years or less fail, as compared to 24% for businesses aged 6-10 years.

[16]Since unsuccessful capitalists earn zero income, I drop the i subscripts below.

$$B \equiv B(\rho; \sigma) = \frac{R(\kappa_2 - \kappa_1)}{(1 + \beta)x} > 0$$

and define $y^0 = 0$. Then

$$y^j = A + By^{j-1}. \tag{13}$$

The proof of Lemma (1) follows straightforwardly from Proposition 1 and (9). The solution to (13) describes the (partial equilibrium) steady state income distribution among capitalists. Equation (13) links the income earned (in the event of a success) by a capitalist who is the jth success with her immediate predecessor.

In order to validate the assumption that some amount of external finance is required for all capitalists, or in other words, for $q > b^j$ for all j to hold, it is clearly necessary that

$$B < 1. \tag{A.5}$$

Under Assumption (A.5), the solution to (13) is given by

$$y^j = \left(\frac{A}{1 - B}\right)\left[1 - B^j\right]; \ \forall j. \tag{14}$$

Given the relative price of capital, ρ, (14) provides a complete description of the steady state distribution of income among old capitalists. For future reference, note that firms that are the first success in a lineage since the last failure earn an income A. [17] These will be among the youngest surviving firms. As noted earlier, their "age" will also make them the most susceptible to bankruptcy in the credit market. To foreshadow, inflation will have a stronger impact on these fledgling firms when compared to older firms.

As stated above, I assume that no agent receives a large enough bequest to finance her project without some external funding. Since an agent of index j receives a bequest of $\left(\frac{1}{1+\beta}\right)y^j$, and since $y^j \leq \left(\frac{A}{1-B}\right) \forall j$, this assumption is validated by the following condition:

$$q > \left(\frac{1}{1 + \beta}\right)\left(\frac{A}{1 - B}\right). \tag{A.6}$$

In other words, project scale is large enough that all capitalists require some external funding. (A.6) is maintained henceforth.

6 General Equilibrium

The intermediary's per capita real holdings of money balances is computed from (4) at equality. Then, the total amount of goods collected by the government via money creation is given by $\lambda(1 - \alpha)\omega(k)$. Suppose a fraction ϕ of these goods is transferred to the capitalists, i.e.,

$$\alpha T_c = \phi\lambda(1 - \alpha)\omega(k).$$

It follows therefore that

$$(1 - \alpha)T_w = (1 - \phi)\lambda(1 - \alpha)\omega(k).$$

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[17]Those succeeding again will earn $\left(\frac{A}{1-B}\right)\left(1 - B^2\right)$ and so on. Of course, the actual number of firms earning this income will be less than the number of firms earning the income A.

I now proceed to describe the determination of the equilibrium steady state capital stock and the various factor prices. First note that in steady states, $\frac{\wp_t}{\wp_{t+1}} = \frac{1}{\sigma}$ holds. Under (A.2), projects of all capitalists are funded. Since the expected return on these projects is $\bar{\kappa} \equiv \pi_1 \kappa_1 + \pi_2 \kappa_2$, $\alpha \bar{\kappa}$ units of capital are produced by capitalists, *gross* of monitoring costs.

The intermediary provides the external finance that capitalists require. Capitalists of index $j-1$ receive a bequest of $\left(\frac{1}{1+\beta}\right) y^{j-1}$, and hence require external finance in the amount of $q - \left(\frac{1}{1+\beta}\right) y^{j-1}$. Since the fraction of capitalists who are the $j-1$ th successive success is given by $\pi_1(\pi_2)^{j-1}$, the aggregate amount of external funding required by capitalists (and, in the absence of credit rationing, entirely supplied by the bank) is $\alpha \left[q - \pi_1 \sum_{j=1}^{\infty} (\pi_2)^{j-1} \left(\frac{1}{1+\beta}\right) y^{j-1} \right]$.

All worker savings in excess of the amount lent to capitalists (plus that which is held in the form of money) is invested in the inferior capital production technology, yielding r units of capital per unit invested. Since the total amount of loanable funds for the bank is $(1 - \lambda)(1 - \alpha)\omega(k) + (1 - \alpha)T_w$, this form of investment yields $r \left[(1 - \lambda)(1 - \alpha)\omega(k) + (1 - \alpha)T_w - \alpha q + \alpha \pi_1 \sum_{j=1}^{\infty} (\pi_2)^{j-1} \left(\frac{1}{1+\beta}\right) y^{j-1} \right]$ units of capital each period, in a steady state.[18]

I now compute the amount of capital used up in the monitoring process in each period. As noted previously, a fraction $\pi_1(\pi_2)^{j-1}$ of capitalists have the index $j-1$; they are monitored in their second period (if unsuccessful) with probability p^j. Let p denote the average probability with which any capitalist is monitored. Then p is given by

$$p = \sum_{j=1}^{\infty} (1 - \pi_2)^2 (\pi_2)^{j-1} p^j. \tag{15}$$

Equation (9) gives an expression for the monitoring probability p^j given a bequest level b^{j-1}. Substituting (9) into (15) and using $b^{j-1} = \left(\frac{1}{1+\beta}\right) y^{j-1}$, the average monitoring probability satisfies

$$p = \frac{1}{x} \sum_{j=1}^{\infty} (1 - \pi_2)^2 (\pi_2)^{j-1} \left[\frac{R(q - T_c)}{\rho} - \frac{Ry^{j-1}}{(1+\beta)\rho} - \kappa_1 \right]$$

$$= \frac{\pi_1}{x} \left[\frac{R(q - T_c)}{\rho} - \kappa_1 \right] - \left(\frac{1}{1+\beta} \right) \frac{\pi_1^2 R}{x\rho} \sum_{j=1}^{\infty} (\pi_2)^{j-1} y^{j-1}. \tag{16}$$

Denote

$$\psi \equiv \psi(\rho; \sigma) = \frac{\pi_1 \left[\frac{R(q - T_c)}{\rho} - \kappa_1 \right]}{x}, \quad \chi \equiv \chi(\rho; \sigma) = \left(\frac{1}{1+\beta} \right) \frac{\pi_1^2 R}{x\rho}$$

and

$$H(\rho; \sigma) \equiv \sum_{j=1}^{\infty} (\pi_2)^{j-1} y^{j-1} = \frac{A(\pi_2/\pi_1)}{(1 - \pi_2 B)} > 0. \tag{17}$$

Below, we show that the long-run mean income of all capitalists is given by $\pi_1 H(\rho; \sigma)$. In a steady state,

$$p \equiv p(\rho; \sigma) = \psi - \chi H(\rho; \sigma) \tag{18}$$

then defines the average "bankruptcy" probability among all capitalists in the economy. Of course, $p \in (0, 1)$ must hold in a valid equilibrium.

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[18]The total amount of loanable funds available to the bank is given by $(1 - \lambda)(1 - \alpha)\omega(k) + (1 - \phi)\lambda(1 - \alpha)\omega(k)$. When $\phi = 0$, all the seigniorage is rebated back to the workers, implying that the amount of loanable funds is given by $(1 - \alpha)\omega(k)$, the same as in a version of our economy with no money.

The steady state aggregate capital stock is then given by the sum of capital produced by the capitalists (net of monitoring costs) using the superior technology and the capital produced using the inferior technology. In other words,

$$K = \alpha[\overline{\kappa} - \pi_1 \gamma p(\rho; \sigma)] + r \left[(1 - \lambda)(1 - \alpha)\omega(k) + (1 - \alpha)T_w - \alpha q + \alpha \pi_1 \sum_{j=1}^{\infty} (\pi_2)^{j-1} \left(\frac{1}{1 + \beta} \right) y^{j-1} \right]. \tag{19}$$

Dividing both sides of (19) by $(1 - \alpha)$, noting that $k \equiv K/(1 - \alpha)$, and using (17), I obtain

$$k = \left(\frac{\alpha}{1 - \alpha} \right) [\overline{\kappa} - \pi_1 \gamma p(\rho; \sigma)] + \left(\frac{r}{1 - \alpha} \right) \; [(1 - \lambda)(1-\alpha)\omega(k) + (1 - \phi)\lambda(1-\alpha)\omega(k) - \alpha q + \frac{\alpha \pi_1}{1 + \beta} H(\rho; \sigma)]. \tag{20}$$

For future reference, the size distribution of income among capitalists, in steady states, is completely summarized by the sequence $\{y^j\}$. The long-run mean income of all capitalists is given by

$$\mu(\rho) = \sum_{j=1}^{\infty} \pi_1 \pi_2^{j-1} y^{j-1} = \frac{\pi_2 A(\rho)}{1 - \pi_2 B(\rho)} = \pi_1 H(\rho; \sigma). \tag{21}$$

The steady state income of all workers is trivially $\omega(k)$.

The model we have described above nests four interesting different models depending on the treatment accorded to any seigniorage revenue that is collected by the government. These are a) the model with no reserve requirement ($\lambda = 0$) and hence no seigniorage, b) the model with no transfers (where the seigniorage may be thought of as being discarded), c) the model where all the transfers go to the workers, and finally d) the model where all the transfers go to the capitalists. The model with $\lambda = 0$ has been analyzed in some detail in Bhattacharya (1998). Given the richness of the structure, it is in general impossible to algebraically characterize the analytics of the other models in general equilibrium. Below, I report on some analytical progress in the study of the model with seigniorage but no transfers. In the sequel, I will also report on the results of some illustrative numerical experiments conducted in the last two models.

7   Analytics in the model with no transfers

We begin by reporting conditions under which there exists a unique stationary capital-labor ratio in the model without transfers. Here, $\lambda > 0$ and $\sigma > 1$ and seigniorage is collected, but then discarded [i.e., $T_c = T_w = 0$]. This is the only case analyzed in Huybens and Smith (1999).

Proposition 2 *Suppose* $\left(1 - \frac{q}{x} \frac{r}{1-\lambda} + \frac{\kappa_1}{x} \right) > 0$, $1 - r(1 - \lambda)\omega'(0) > 0$, *and that γ is sufficiently small. Then, there exists a unique solution to (20) and (3).*

I now investigate the effect of an increase in the rate of money creation (an increase in the steady state inflation rate) on the steady state capital stock, and the incomes of workers and capitalists (as a group). To presage, ceteris paribus, inflation forces the intermediary to charge capitalists a higher real rate of interest on loans. This erodes the incomes of successful capitalists, which in turn causes them to leave smaller bequests thereby impairing the ability of the next generation of capitalists to provide internal finance for their capital investments. Consequently, the contracting friction becomes more severe, agency costs rise, and the capital stock falls.

The effects of an increase in the rate of money creation, σ, (and hence the steady state rate of inflation) on the partial equilibrium average incomes of the capitalists, is summarized in the next lemma.

Lemma 2 *Given a rental rate on capital ρ, an increase in the rate of money creation, σ, leads to a fall in the average incomes of the capitalist class, i.e., $\pi_1 \frac{\partial H(\sigma)}{\partial \sigma}|_\rho \leq 0$.*

It is now possible to investigate the effect of an increase in the steady state rate of inflation on the partial equilibrium steady state capital stock.

Proposition 3 *Given a rental rate on capital ρ, an increase in the rate of money creation, σ, leads to a fall in the steady state capital-labor ratio, i.e., $\dfrac{\partial k(\sigma)}{\partial \sigma}|_\rho \leq 0$.*

Once ρ is allowed to change in response to a change in σ, it becomes impossible to analytically characterize the overall effect of inflation on the capital stock and on the distribution of income among capitalists. From this point, I resort to numerical simulations. Below, I compare the effects of inflation on real variables in the aforementioned four models. The underlying mechanisms are clear. For a given rental rate on capital, an increase in the money growth rate raises the "inflation premium" charged by the bank, which as we have seen, erodes the incomes of capitalists as a group, thereby raising the aggregate amount of resources that gets wasted in the monitoring process. On the one hand, the transfer to the young capitalists reduces their need for external funds thereby reducing the severity of the information friction (a reduction in aggregate monitoring costs). On the other hand, the government transfer to young workers removes the effect of the reserve requirement, restoring their savings to a level identical to what is was in the benchmark setting with no money. Relative to a setting where capitalists get all the transfer or seigniorage is discarded, this increases the availability of loanable funds on the credit market thereby ameliorating the credit friction. The overall net effect on the long run capital stock, and hence on the income distribution between capitalists and workers is, in general, ambiguous.

8 Computational experiments

8.1 Changing the inflation rate

The parameters of the model economy are as follows: $\alpha = 10\%$, $\beta = 10$, $\lambda = 17\%$, $\gamma = 9.12$, $f(k) = 10k^{0.53}$, $\pi_1 = 0.430$, $\pi_2 = 0.569$, $r = 1.016$, $q = 152.15$, $\kappa_1 = 2.12$, and $\kappa_2 = 339.12$. Some statements about the choice of these numbers for the model economy is in order.[19] A choice of $\beta = 10$ implies that parent-capitalists bequeath about 9% of their lifetime earnings to their children, which ties in well with numbers reported in Altonji and Villaneuava (2002). While reserve requirements vary widely over countries, quite a few of them (the U.S. included) use a legal reserve-ratio of near 10%, with a world average of about 17% as reported in Click (1998). Boyd and Smith (1994) report that monitoring costs (γ) is roughly 6% of the total assets (q) of the firm. They also use $r = 1.016$ as a risk-free return. Denardi and Cagetti (2002), using Survey of Consumer Finances Data, find that entrepreneurs are roughly 10% of the sampled population. The parameters chosen also imply that the ratio of seigniorage revenue to GDP in the model economy stays near 2.0%. Click (1998) documents that between 1971-90, in a wide cross-section of countries, currency seigniorage as percent of GDP ranged from 0.3% to 14% with an average around 2%.

The results are reported in Figures 1 and 2 below. The inflation rate increases from 0% to 65%. Four regimes are explored, the baseline (no money), the regime with positive seigniorage but no transfers, the regime where all transfers go to workers, and finally, the regime where all transfers go to capitalists. In the baseline regime, inflation, by definition has no effect on any real variable. As the figures illustrate, inflation raises real market return on loans (R) charged by the intermediary in each regime. The average

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[19]The simulation results reported below are not intended to represent a full-blown calibration exercise. Such an exercise would not be very illuminating in any case in a two-period OG model.

monitoring probability, an estimate of the economy-wide "bankruptcy probability" rises in each case, but the level is the lower in the transfers-to-capitalist regime than in the transfers-to-workers regime. Transfers to capitalists enhance their internal net worth and this reduces their probability of being monitored.

Within each regime, inflation causes a decline in real activity. The decline is lowest in the transfers-to-workers regime because the transfer to the workers essentially nullifies the deleterious effect of a binding reserve requirement. There is still a small decline because even when the amount of loanable funds is restored to the benchmark level, higher inflation continues to erode the incomes of capitalists via its effect on R. Relative to the regime in which all seigniorage is discarded, the capital stock is far higher in either the transfers-to-capitalist regime or the transfers-to-workers regime.

It is interesting to note that inflation increases the income inequality (measured by the gini coefficient) among all capitalists in each regime.[20] Curiously, the effect of inflation on income inequality among capitalists is most muted in the transfers-to-workers regime. Similarly, the income gap between capitalists and workers (the ratio of average capitalist income to the wage rate) is highest in the transfers-to-capitalist regime when compared to the transfers-to-workers regime. The steady state welfare of workers (measured here as $r\rho\omega(k)$), not surprisingly, is highest in the transfers-to-workers regime.

Overall, it seems that the importance of agency costs in the model economy is dwarfed by the effect of the aggregate supply of loanable funds. Put differently, the numerical analysis indicates that the supply of loanable funds is, in some sense, more important for capital formation when compared to policy-induced reductions in economy-wide agency costs.

Finally, at least from a steady-state (non-welfare) comparison view-point, it appears that the transfers-to-workers regime is "superior" to the transfers-to-capitalist regime in that it produces a less-unequal income distribution (both within capitalists and across capitalists and workers) without compromising on capital formation.

8.2 Changing the reserve requirement

Many commentators, dating back to Ascheim (1959), and more recently, Haslag and Hein (1995) have asked the question: does it matter how monetary policy is implemented. For example, in my setup, monetary policy may be thought of as either affecting the inflation tax rate (via the money growth rate) or the inflation tax base (via changes in the reserve requirement). The question then is: are the two instruments very different in terms of their effects on real variables in the economy?

I now report on the consequences of changing the reserve requirement, keeping the money growth rate fixed. The parameters of the model economy are as follows: $\alpha = 11\%$, $\beta = 10$, $\gamma = 5.6$, $f(k) = 10k^{0.54}$, $\pi_1 = 0.5$, $\pi_2 = 0.5$, $r = 1.016$, $q = 93.44$, $\kappa_1 = 8.53$, and $\kappa_2 = 235.73$. The results are reported in Figure 3 below. The reserve requirement increases from 0% to 35%. Four regimes are explored, the baseline (no money), the regime with positive seigniorage but no transfers, the regime where all transfers go to workers, and finally, the regime where all transfers go to capitalists. In the regimes with valued money, the money growth rate is held fixed at 10%. In each regime, increases in the reserve requirement causes a decline in real activity. The decline is lowest in the transfers-to-workers regime because the transfer to the workers essentially nullifies the deleterious effect of a binding reserve requirement. Consistent with a popular view among central bankers and academics, it turns out the reserve requirement is indeed a very "blunt" instrument in my model. For example, with the inflation rate fixed at 10%, an increase in the reserve requirement from 10% to 20% in the no-transfers regime reduces the steady state capital-labor ratio by almost 22%.

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[20]Our result on the connection between inflation and income inequality is strongly supported by evidence presented in Al-Mahrubi (2000) and Bulir (2001) using cross section data for a large number of countries.

It is interesting to note that increases in the reserve requirement, much like increases in the money growth rate, increases the income inequality among all capitalists in each regime. Again, the effect of inflation on income inequality among capitalists is the least in the transfers-to-workers regime, and is very high in the no-transfers and transfers-to-capitalist regime. Interestingly enough, the income gap between capitalists and workers (the ratio of average capitalist income to the wage rate), for reserve requirements above 25% is lower in the no-transfers regime than even in the baseline no-money regime. The income gap is highest in the transfers-to-capitalist regime when compared to the transfers-to-workers regime. The steady state welfare of workers, not surprisingly, is highest in the transfers-to-workers regime.

Finally, I undertake a comparison between the no-transfers regime and the transfers-to-workers regime as it pertains to welfare of individual capitalists. Fix the reserve requirement at $\lambda = 0.35$. Then, it is clear from the figure that all the capitalists prefer the transfers-to-workers regime to the no-transfers regime since each of their incomes is higher in the former regime. This was not the case in the case where monetary policy was implemented via changes in the inflation rate. There, all capitalists always (at even high inflation rates) preferred the no-transfers regime to the transfers-to-workers regime. It can be easily checked that when monetary policy is implemented via changes in the reserve requirement, all capitalists prefer the transfers-to-capitalist regime when compared to the transfers-to-workers regime.

In sum, when monetary policy is implemented via changes in the reserve requirement, from a steady-state comparison view-point, it appears that the transfers-to-workers regime is "superior" to the no-transfers regime in that it produces a less-unequal income distribution (both within capitalists and across capitalists and workers) without compromising on capital formation; additionally, all capitalists and all workers prefer the transfers-to-workers regime in a stationary welfare sense.

9   Conclusion

Recent times have witnessed a general tendency for worsening income inequities around the world. It is also becoming increasingly clear that the distribution of income may have serious consequences for the long-run level of real activity in an economy. A natural question that arises in this context is: does activist government policy have any serious role in influencing the path for the distribution of income? This paper is an attempt at answering such a question. I have developed a model in which expansionary monetary policy affects credit market efficiency, and via this link, capital accumulation and the incomes (and welfare) of agents. Even perfectly anticipated monetary policy is shown to have effects on long-run real activity via changes in the "effective tax rate" on capital incomes. Consequently, inflation affects the distribution of income. Somewhat surprisingly, a regime in which the revenue from the inflation tax is rebated to the suppliers of loanable funds (as opposed to the producers of capital) produces a higher level of long-run real activity and less income inequality when compared to other regimes.

In passing, I discuss two caveats. First, the analysis presented here is incapable of confronting empirical evidence concerning "threshold effects" of inflation: the effects of inflation below and above a certain threshold are supposedly very different. Huybens and Smith (1999) produce a model that is well-equipped to study this issue. Second, the current paper makes no attempt to study the short-run effects of inflation. Romer and Romer (1998) present evidence suggesting that the short run and the long run relationship between monetary policy and income inequality go in "opposite directions". The present model is ill-suited to shed light on such a complex issue.

Appendix

A   Proof of Proposition 2

I start by investigating the sign of $H_1(\rho; \sigma)$. From (17), straightforward differentiation yields

$$H_1(\rho; \sigma) = (\frac{\pi_2}{\pi_1}) \left[\frac{1}{\{1 - \pi_2 B(\rho; \sigma)\}} \right]^2 [\pi_2 B_1(\rho; \sigma) A(\rho; \sigma) + A_1(\rho; \sigma) (1 - \pi_2 B)]. \qquad (B.1)$$

It is easy to check that

$$R_1(\rho; \sigma) = \left(\frac{r}{1 - \lambda} \right) > 0$$

$$B_1(\rho; \sigma) = \left(\frac{\kappa_2 - \kappa_1}{x(1 + \beta)} \right) R_1(\rho; \sigma) > 0$$

and

$$A_1(\rho; \sigma) = \left(1 - \frac{q}{x} \frac{r}{1 - \lambda} + \frac{\kappa_1}{x} \right) (\kappa_2 - \kappa_1) R_1(\rho; \sigma) > 0$$

under the assumptions of the proposition. It follows from (B.1) that $H_1(\rho; \sigma) > 0$. For future reference, also note that

$$\frac{\partial}{\partial \rho} \left(\frac{R}{\rho} \right) = \left(\frac{\lambda}{1 - \lambda} \right) \left(\frac{1}{\rho^2 \sigma} \right) > 0$$

$$\chi_1(\rho; \sigma) = \left(\frac{1}{1 + \beta} \right) \frac{\pi_1^2}{x} \frac{\partial}{\partial \rho} \left(\frac{R}{\rho} \right) > 0$$

and

$$\psi_1(\rho; \sigma) = \frac{\pi_1 q}{x} \frac{\partial}{\partial \rho} \left(\frac{R}{\rho} \right) > 0.$$

I now turn to (19) and (20). Setting $T_w = T_c = 0$, it is possible to rewrite (20) as

$$k = \left(\frac{\alpha}{1 - \alpha} \right) [\overline{\kappa} - \pi_1 \gamma p(\rho; \sigma)] + \left(\frac{r}{1 - \alpha} \right) [(1 - \lambda)(1 - \alpha)\omega(k) - \alpha q + \frac{\alpha \pi_1}{1 + \beta} H(\rho; \sigma)]$$

or,

$$k = V + \Phi(\rho; \sigma) + r(1 - \lambda)\omega(k) \qquad (B.2)$$

where

$$V \equiv \left(\frac{\alpha}{1 - \alpha} \right) (\overline{\kappa} - rq) > 0$$

and

$$\Phi(\rho; \sigma) \equiv \left(\frac{\alpha \pi_1}{1 - \alpha} \right) \left[\left(\frac{r}{1 + \beta} \right) H(\rho; \sigma) + \gamma \chi(\rho; \sigma) H(\rho; \sigma) - \gamma \psi(\rho; \sigma) \right].$$

Differentiating, I get

$$\Phi_1(\rho; \sigma) = \left(\frac{\alpha \pi_1}{1 - \alpha} \right) \left[\left(\frac{r}{1 + \beta} \right) H_1(\rho; \sigma) + \gamma \chi_1(\rho; \sigma) H(\rho; \sigma) + \gamma \chi(\rho; \sigma) H_1(\rho; \sigma) - \gamma \psi_1(\rho; \sigma) \right].$$

It is easy to verify that if $\gamma \to 0$, $\Phi_1(\rho; \sigma) \geq 0$ would hold, and therefore, by continuity, $\Phi_1(\rho; \sigma) \geq 0$ holds for sufficiently small γ. Also recall that $\omega'(.) > 0$ implies that $k - r(1 - \lambda)\omega(k) > 0$ holds under the conditions of the proposition. Then, it follows that the right hand side of (B.2) is increasing in ρ. This along with the fact that (3) is downward sloping completes the proof. ∎

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B   Proof of Lemma 2

For future reference, note that

$$R_1(\sigma; \rho) = \left(\frac{\lambda}{1-\lambda}\right)\left(\frac{1}{\sigma^2}\right) > 0$$

$$\psi_1(\sigma; \rho) = \frac{\pi_1 q}{x\rho} R_1(\sigma; \rho) > 0 \tag{C.0}$$

and

$$\chi_1(\sigma; \rho) = \left(\frac{1}{1+\beta}\right)\frac{\pi_1^2}{x\rho} R_1(\sigma; \rho) > 0.$$

Also,

$$A_1(\sigma; \rho) = (\kappa_2 - \kappa_1)\left(-\frac{q}{x}\right) R_1(\sigma; \rho) < 0$$

and

$$B_1(\sigma; \rho) = \frac{(\kappa_2 - \kappa_1)}{x(1+\beta)} R_1(\sigma; \rho) > 0.$$

It follows that $A_1(\sigma; \rho) = -(1+\beta)q B_1(\sigma; \rho)$. From (17), straightforward differentiation yields

$$H_1(\sigma; \rho) = (\frac{\pi_2}{\pi_1})\left[\frac{1}{\{1 - \pi_2 B(\sigma; \rho)\}}\right]^2 [\pi_2 B_1(\sigma; \rho)A(\sigma; \rho) + A_1(\sigma; \rho)(1 - \pi_2 B)]. \tag{C.1}$$

Now, $[\pi_2 B_1(\sigma; \rho)A(\sigma; \rho) + A_1(\sigma; \rho)(1 - \pi_2 B)]$ may be rewritten as

$$\left[\pi_2 B'A + A' - \pi_2 BA'\right] = \pi_2 B'A + (\pi_2 B - 1)q(1+\beta)B'$$

where the "$'$" denotes the partial derivative with respect to σ. I am interested in the sign of $\pi_2 B'A + (\pi_2 B - 1)q(1+\beta)B'$. To prove the result, I need this expression to be negative. Suppose, on the contrary, the sign of $\pi_2 B'A + (\pi_2 B - 1)q(1+\beta)B'$ is positive. Then, it follows that

$$\pi_2 B'A - (1 - \pi_2 B)q(1+\beta)B' > 0$$

or, since $B' > 0$,

$$\pi_2 A - (1 - \pi_2 B)q(1+\beta) > 0$$

or,

$$q < \left(\frac{1}{1+\beta}\right)\frac{\pi_2 A}{(1 - \pi_2 B)}$$

From (A.6), we know, $q > \left(\frac{1}{1+\beta}\right)\frac{A}{1-B}$. This implies that

$$\left(\frac{1}{1+\beta}\right)\frac{A}{1-B} < q < \left(\frac{1}{1+\beta}\right)\frac{\pi_2 A}{1 - \pi_2 B}$$

should hold. In other words,

$$\left(\frac{1}{1+\beta}\right)\frac{\pi_2 A}{1 - \pi_2 B} > \left(\frac{1}{1+\beta}\right)\frac{A}{1-B}$$

should hold. This would imply

$$\pi_2 A - \pi_2 AB > A - \pi_2 AB$$

Since $\pi_2 AB > 0$, this implies

$$\pi_2 A - A > 0$$

should hold. Since $A > 0$, and $\pi_2 < 1$, we have the desired contradiction. Hence $[\pi_2 B'A + A' - \pi_2 BA'] < 0$ holds and therefore it follows from (C.1) that $H_1(\sigma; \rho) \le 0$ holds. ∎

C   Proof of Proposition 3

Rewrite (20) as

$$k - r\left(1 - \lambda\right)\omega(k) = \left(\frac{\alpha}{1-\alpha}\right)[\overline{\kappa} - rq] - \left(\frac{\alpha}{1-\alpha}\right)\pi_1\gamma p(\sigma;\rho) + \left(\frac{\alpha}{1-\alpha}\right)\frac{r\pi_1}{1+\beta}H(\sigma;\rho)]. \qquad \text{(D.0)}$$

Note that

$$p_1(\sigma;\rho) = \psi_1(\sigma;\rho) - \chi_1(\sigma;\rho)H(\sigma;\rho) - \chi H_1(\sigma;\rho)$$

which is positive from (C.0) and Lemma 2. Then, assuming $1 - r(1 - \lambda)\omega'(.) > 0$, it follows that the right hand side of (D.0) is falling in σ. ∎

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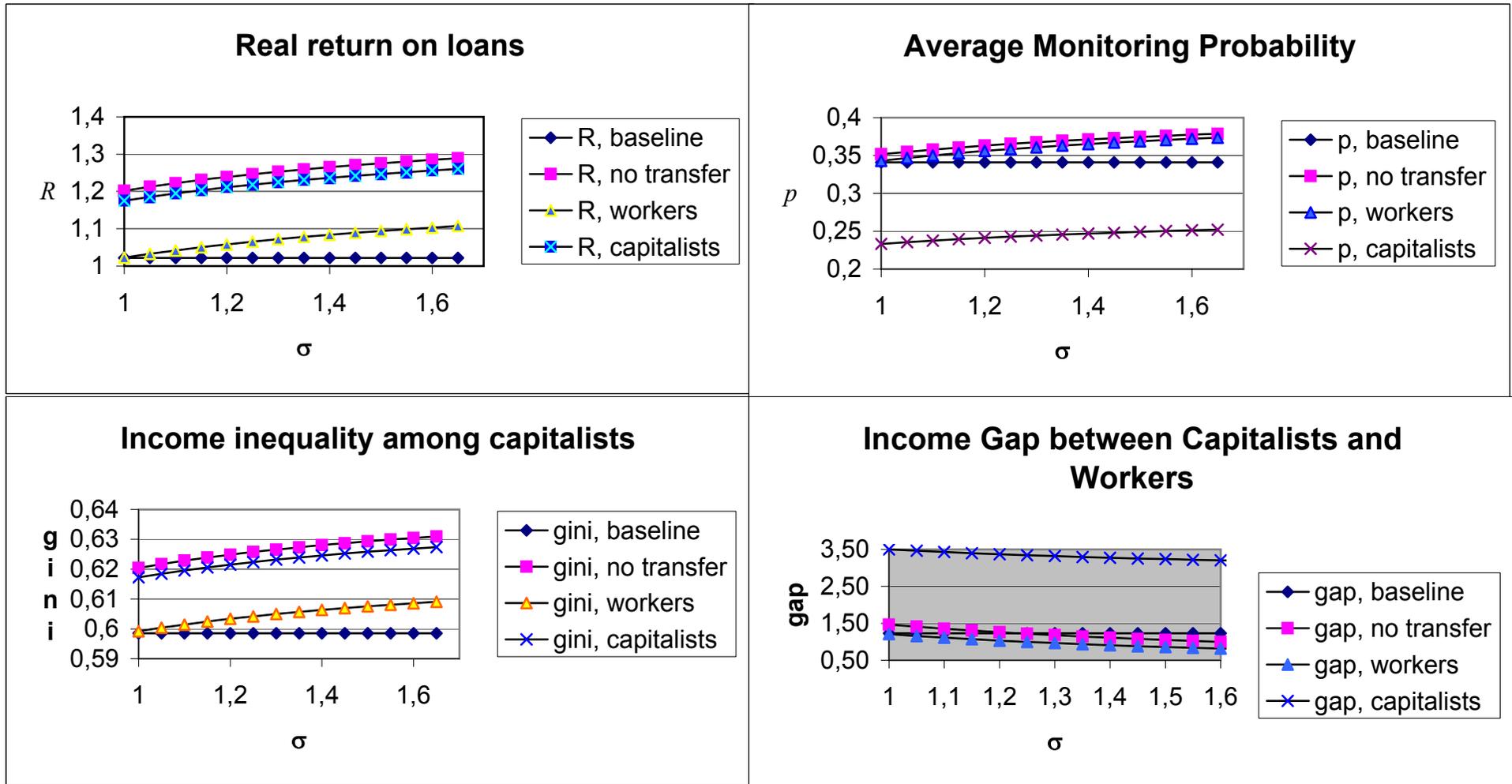
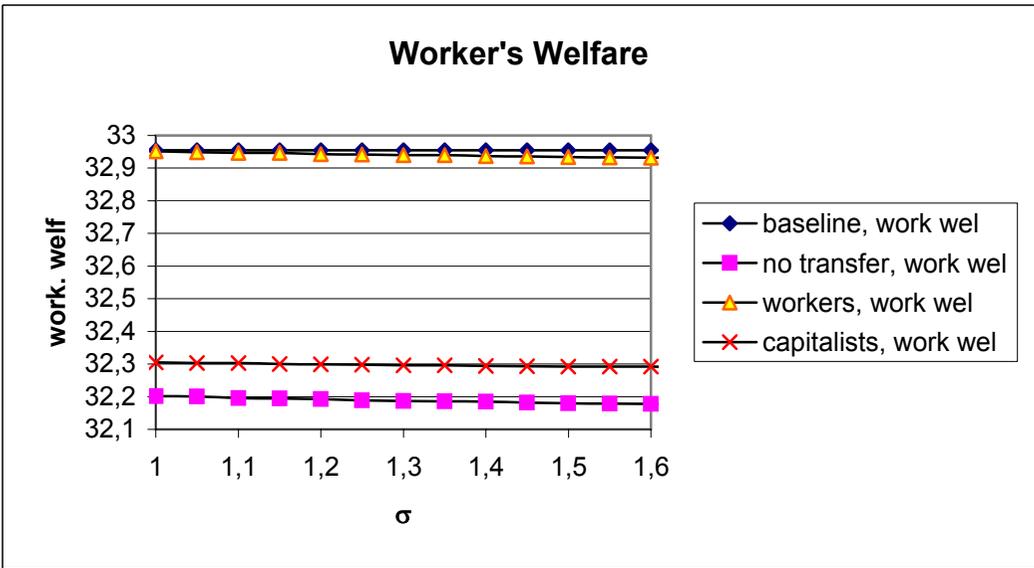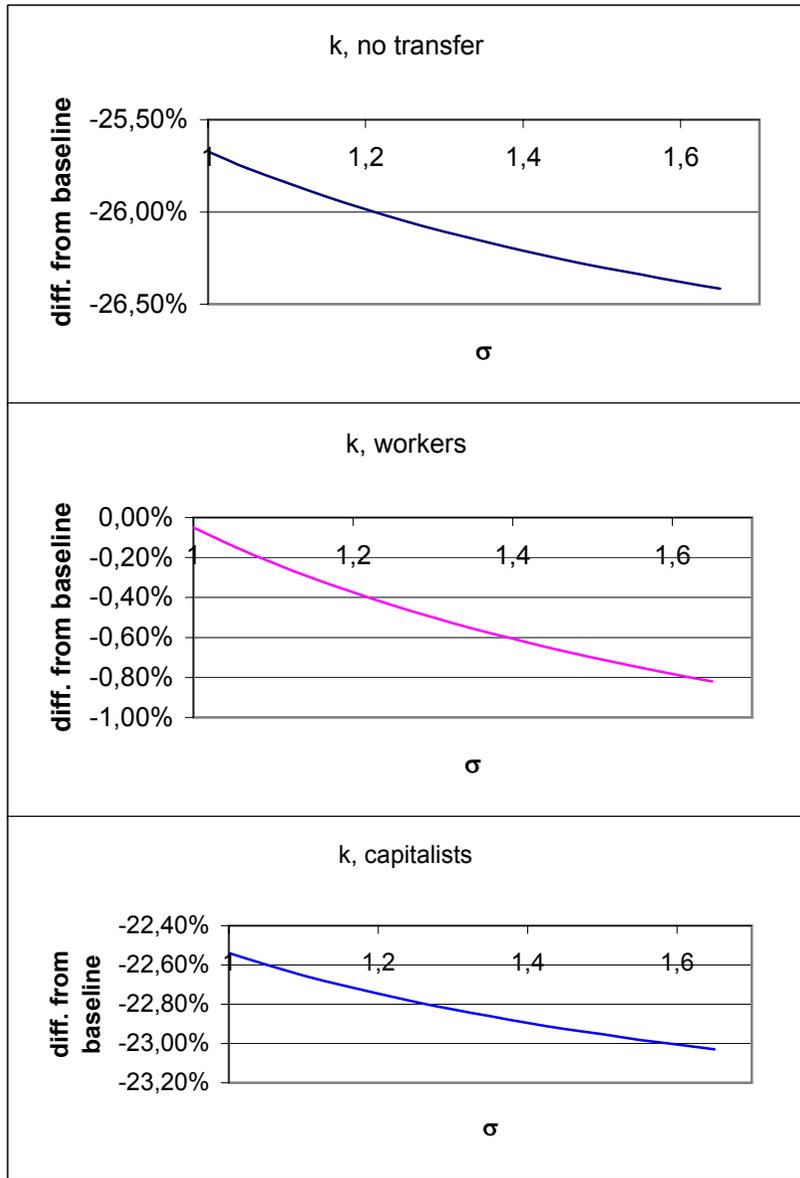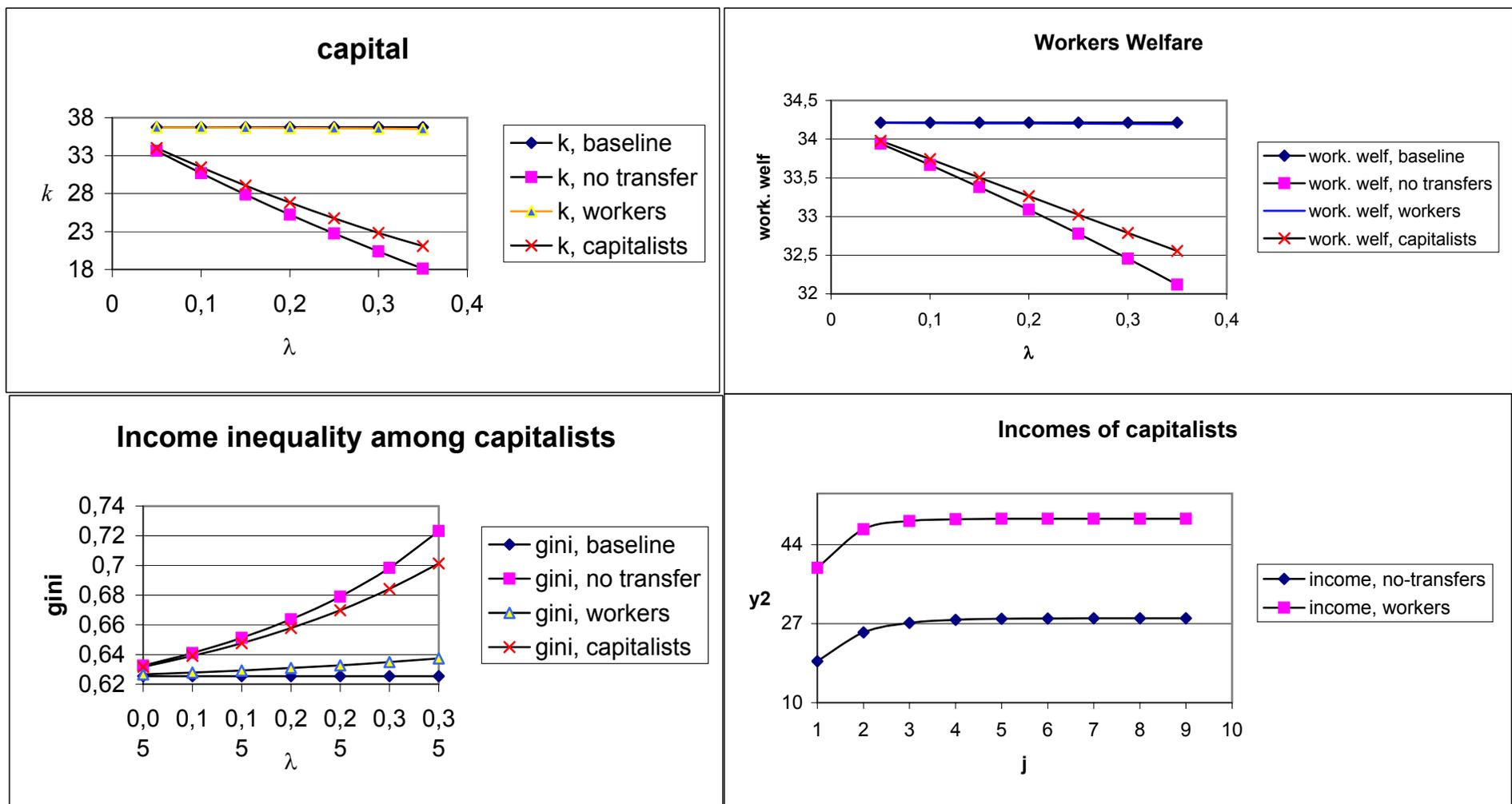Figure 1: Steady state consequences of changing the money growth rate

Figure 1 (continued)

Figure 2: Steady state consequences of changing the reserve requirement