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Agency Costs, Fiscal Policy, and Business Cycle Fluctuations*

Burçin Kısacıkoğlu†

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Abstract

This paper studies the relationship between fiscal policy, financial market frictions and business cycle fluctuations. It is shown that in an economy where balance sheets play a role in the propagation of shocks, using countercyclical fiscal policy net worth and output fluctuations can be reduced. After the realization of a negative shock, countercyclical fiscal policy reduces agency costs which would make entrepreneurs increase investment. By this increase, financial fragility decreases, which reduces the slowdown of economic activity.

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1 Introduction

Financial accelerator models incorporate the financial issues to the business cycle models, which the business cycle literature have largely ignored. According to these models, financial frictions are the reason of the long lived business fluctuations which are costly. The purpose of this paper is to propose a stabilization policy to be undertaken by the government via fiscal measures so that the effects of the financial frictions are reduced and fluctuations are dampened. Government uses countercyclical fiscal policy (countercyclical in terms of transfer payments), i.e. government distributes transfer payments to entrepreneurs in bad times and levies tax on the profits of the entrepreneurs in good times as a policy tool. With this policy, government transfers resources to the financially constrained entrepreneurs in bad times so that the financial constraints can be eased.

For the students of business cycle research, the propagation mechanism behind the fluctuations is an important question. In order to understand the propagation mechanism properly, starting with the seminal work of Kydland and Prescott (1982), microfounded business cycle models have been constructed. Eventhough these early attempts were seen as important steps towards understanding the long lived responses of main macroeconomic variables to shocks, it was shown by Cogley and Nason (1993, 1995) that the canonical real business cycle models could not replicate the hump-shaped behavior of the time series data due to the lack of an internal propagation mechanism.

The poor performance of the real business cycle models against the time series data made economists search for the models that could explain and replicate the long lived responses of the economy to exogenous shocks. Investigating the role of financial market frictions in the business cycle propagation is the offspring of this search. These models incorporated the endogenous propagation mechanism through a credit market, so that they could replicate the persistent movements in the data. Broadly, these models show that the balance sheet conditions of the entrepreneurs are an important source of the propagation of shocks due to the agency costs arising from the financial market imperfections. This class of models is called financial accelerator models.

A seminal contribution to this line of research was made by Bernanke and Gertler (1989). This study developed a simple neoclassical model of business cycle where the balance sheet of the entrepreneurs amplifies the upturn in good times and worsens the downturn in bad times. Following this study, Bernanke and Gertler (1990) showed that high agency costs decrease the amount and the efficiency of the investment and this leads to financial fragility. Carlstrom and Fuerst (1997) constructed a general equilibrium model with financial market frictions and showed that financial accelerator models can replicate the long lived responses observed in the time series.

The persistent fluctuations generated by these models not only describe the world we live in, they also imply welfare costs for the consumers due to the fluctuations in the consumption. Otrok (2001) shows that the welfare cost of business cycles can be as high as 40% of total consumption. Imrohoroğlu (2008) points out that the economies with high consumption volatility have higher welfare losses. Since the fluctuations in financial accelerator models are highly persistent and amplified, one can expect the welfare costs of business cycles to be high for this particular class of models.

The undesirability of the business cycle fluctuations due to the welfare costs strenghtens the need for a stabilization policy in order to dampen the fluctuations. If financial accelerator models can describe the world correctly, the stabilization policy should take those into account. Then the goal of the stabilization policy should be to reduce the effects of the frictions so that the fluctuations will be less persistent and dampened.

The results show that a simple fiscal rule can smooth the fluctuations in entrepreneurs net worth and lessen the output volatility, while respecting the government budget constraint. The government borrows from households in response to a negative shock, gives a transfer payment to entrepreneurs, who are taxed in the next period enough to fulfill the repayment obligation inclusive of the riskless interest rate. This turns out to be a boost for entrepreneurs because they effectively get to borrow at the riskless rate via government at bad economic times, whereas they would have to pay a high external finance premium to borrow directly. This interest rate subsidy increases investment and leads to a faster recovery of investors net worth despite the subsequent tax burden.

The paper is organized as follows: Section 2 gives the details of the model, section 3 gives the impulse responses and we conclude in section 4.

2 The Model

The model utilized in this paper is a standard cashless financial accelerator model following Carlstrom and Fuerst (1997, 1998, 2001) with the inclusion of taxation. This is a general equilibrium model which includes entrepreneurs, households, government, consumption good producing firms owned by households and financial intermediaries as economic agents.

In the context of the model, entrepreneurs are investment good producing agents with low internal funds. To be able to undertake investment good production, they rely on external financing supplied by the lenders, namely the households. This borrowing made via financial intermediaries is typically limited since entrepreneurs do not have enough net worth to collateralize their debt. So lenders and entrepreneurs form a financial contract that assumes costly state verification (CSV) which will be explained in detail in the next subsection. Financial contract implies that higher net worth leads to higher borrowing as a result higher investment and output. So fluctuations in net worth will be an important determinant of the business cycle fluctuations.

The undesirability of the fluctuations makes room for the economic policy options that can reduce the fluctuations in the net worth and output. This paper will try to show that using fiscal policy tools, countercyclical transfer payments in this case, net worth fluctuations can be dampened. So, also fluctuations in investment and output will be reduced. Details of the fiscal policy will be explained in the further subsections.

For informative purposes the sequence of events is given the table below:

Table 1: Sequence of Events

1. Entrepreneurs start with net worth n_t at time t.
2. Productivity parameter θ_t is realized.
3. Firms choose labor and capital to produce consumption goods.
4. Firms decide how much capital to purchase from CMFs.
5. Entrepreneurs borrow from CMFs and produce capital.
6. Idiosyncratic shock ω_t is realized.
7. Entrepreneurs repay their contractual obligations.
8. Household owned firms produce consumption goods.
9. Transfer payments are distributed/ Taxes are collected.
10. Solvent entrepreneurs and households make their consumption decisions
11. n_{t+1} is accumulated by entrepreneurs.
12. θ_{t+1} is realized.

Since θ_t is known at the beginning of period t, there is no aggregate risk in the economy and firms choose their labor and capital demand accordingly. To meet the demand of the firms and households, entrepreneurs borrow consumption goods from the CMFs and undertake capital production. With the produced capital and supplied labor, firms produce consumption goods. After the production of the consumption goods the idiosyncratic shock ω_t is realized. Since CMFs distribute loans to infinitely many entrepreneurs, due to the realization of ω_t some entrepreneurs declare bankruptcy and some repay their contractual obligations. Contingent on the realization of θ_t, government either distributes transfer payments to the entrepreneurs or levy taxes on them after the contractual obligations are paid by the entrepreneurs. Finally solvent entrepreneurs and households make their consumption decisions.

2.1 The Financial Contract

The financial contract consists of two parties: entrepreneurs and lenders. Entrepreneurs have a sufficiently small net worth $n_t > 0$ and rely on external financing for investment good production. Lenders provide external financing to the entrepreneurs. Both agents are risk neutral.

The entrepreneur has access to a stochastic technology that transforms i_t consumption goods into $\omega_t i_t$ units of capital, where ω_t is the idiosyncratic shock with distribution Φ, and characterized by density ϕ and mean unity. Agency costs are introduced to the model by assuming that the idiosyncratic shock ω is a private information for the entrepreneur and other agents can observe it at a cost of μi_t units of capital. This set-up is the one that is first studied by Townsend (1979) and then by Gale and Hellwig (1985). They show that in such a CSV framework, the optimal contract is a standard debt contract where the borrower pays a fixed rate if she can and default if she cannot in which case the lender confiscates all the returns from the project.

The entrepreneur borrows $(i_t - n_t)$ units of consumption goods and agrees to repay $\left(1 + r_t^k\right)(i_t - n_t)$ units of capital goods to the lender, where $\left(1 + r_t^k\right)$ is the contractual interest rate. The entrepreneur defaults if the realization ω_t is less than the threshold level $\bar{\omega}_t$, in which case lenders monitor the outcome and confiscate all returns from the project. If the realized value of ω_t is higher than the threshold level, than the entrepreneur will repay the fixed amount that is specified in the contract. The threshold level $\bar{\omega}$ is therefore the value which equalizes the return from the project and the amount that is need to be repaid, i.e.

$$\begin{aligned} \bar{\omega}_t q_t i_t &= \left(1+r_t^k\right)\left(i_t-n_t\right) \\ \bar{\omega}_t &= \frac{\left(1+r_t^k\right)\left(i_t-n_t\right)}{q_t i_t}. \end{aligned}$$

where q_t is the price of capital.

The optimal contract minimizes the incidence of costly monitoring. Therefore the financial contract should be constructed in such a way that the entrepreneur should announce the true realization of ω, because without monitoring, the asymmetric information creates moral hazard which would make the entrepreneur report failure of project to minimize payments. So the optimal contract is defined on $(i, \bar{\omega})$, where both of the arguments are common knowledge to all agents. The contract is made for one period, to side step the repeated game issues of the model[1].

Under the contract, the expected entrepreneurial income is given by

$$q_t i_t f\left(\bar{\omega}_t\right) = q_t i_t \left[\int_{\bar{\omega}}^{\infty} \omega d\Phi\left(\omega\right) - \bar{\omega}\left(1-\Phi\left(\bar{\omega}_t\right)\right)\right], \tag{1}$$

where $f\left(\bar{\omega}_t\right)$ is the fraction of expected net capital output received by the entrepreneur.

Entrepreneurs are taxed at rate τ_t so the after tax profits of the en-

[1]One can refer to Gertler (1992), for a theoretical analysis of an agency cost model with two period contracts.

trepreneur is,

$$(1-\tau_t)\, q_t i_t f(\bar{\omega}_t) = (1-\tau_t)\left(q_t i_t \left[\int_{\bar{\omega}}^{\infty} \omega \Phi (d\omega) - (1-\Phi(\bar{\omega}_t))\, \bar{\omega}_t\right]\right). \quad (2)$$

Similarly expected income of the lender on such a contract is given by,

$$q_t i_t g(\bar{\omega_t}) = q_t i_t \left[\int_0^{\bar{\omega}} \omega d\Phi(\omega) - \Phi(\bar{\omega_t})\,\mu + \bar{\omega_t}\,(1-\Phi(\bar{\omega_t}))\right], \quad (3)$$

where $g(\bar{\omega}_t)$ is the fraction of the expected net capital output received by the lender. The taxes are paid only by the entrepreneurs.

Note that,

$$f(\bar{\omega_t}) + g(\bar{\omega_t}) = 1 - \Phi(\bar{\omega_t})\,\mu. \quad (4)$$

So on average, $\Phi(\bar{\omega_t})\,\mu$ units of capital is destroyed by monitoring.

Now, the optimal contract is given by the $(i, \bar{\omega})$ pair that maximizes the entrepreneur's expected return subject to the lender being indifferent between loaning the funds and keeping them. So, the optimal contract is given by the solution to the following maximization problem,

$$\max\,(1-\tau_t)\, q_t i_t f(\bar{\omega_t}) \text{ subject to } q_t i_t g(\bar{\omega_t}) \geq (i_t - n_t)\,. \quad (5)$$

This constraint the lenders will lend their resources to the entrepreneurial activity. The participation constraint for the entrepreneurs, $(1-\tau_t)\, q_t i_t f(\bar{\omega_t}) \geq$

n_t should also be satisfied. So the optimality conditions are,

$$q_t = \frac{1}{\left(1-\Phi\left(\bar{\omega_t}\right)\mu+\phi\left(\bar{\omega_t}\right)\mu\left[\frac{f\left(\bar{\omega_t}\right)}{f'\left(\bar{\omega_t}\right)}\right]\right)} \tag{6}$$

$$i_t = \frac{n_t}{1-q_t g\left(\bar{\omega_t}\right)} \tag{7}$$

Multiplying both sides of equation (7) by $(1-\tau_t)\, q_t f\left(\bar{\omega_t}\right)$, we have

$$(1-\tau_t)\, q_t i_t f\left(\bar{\omega_t}\right) = \frac{(1-\tau_t)\, q_t f\left(\bar{\omega_t}\right)}{1-q_t g\left(\bar{\omega_t}\right)} n_t \tag{8}$$

The coefficient $\frac{q_t f\left(\bar{\omega_t}\right)}{1-q_t g\left(\bar{\omega_t}\right)}$ on n_t is the expected return on internal funds of the entrepreneur. This return must be greater than the riskless return, $(1+r)$, in order to make the entrepreneur to devote all of its resources to the investment good production. Otherwise, the entrepreneur would simply hold on to her resources and does not undertake the investment good production.

2.2 Households and Consumption Good Producing Firms

The economy consists of a continuum of agents. The agents are of two types: entrepreneurs (fraction $1-\eta$) and household (fraction η). As mentioned before the entrepreneurs produce the investment good. Entrepreneurs receive external financing needed for production from households via intermediaries, namely the capital mutual funds (CMFs), which are assumed to be risk neutral. If a household wishes to purchase capital, she must fund entrepreneurial projects, and these projects are subject to agency costs. Furthermore, CMFs take advantage of the law of large numbers by funding a large number of entrepreneurs to eliminate the idiosyncratic entrepreneurial uncertainty. So the households earn one unit of capital with the expenditure of q_t consumption goods, which is implied by the riskless return of unity and they earn a risky return of $q_t\left(1+r_t^k\right)$, if their funds are lended to the entrepreneurs. There are also consumer good producing firms, which are not subject to the agency costs. So we are not interested with their behavior.

Households are infinitely lived with the following utility function

$$U\left(c_t, 1-h_t\right)=\ln\left(c_t\right)+\nu\left(1-h_t\right)$$

The maximization problem of the household is

$$\max E_0 \sum_{t=0}^{\infty} \beta^t\left(\ln\left(c_t\right)+\nu\left(1-h_t\right)\right),\ 0<\beta<1 \tag{9}$$

subject to the budget constraint

$$w_t h_t+r_t k_t^h+\left(1+r_t\right) b_{t-1} \geq b_t+c_t+q_t i_t \tag{10}$$

Here k_t^h denotes the household stock of capital, c_t denotes the household consumption with its price assumed to be unity, h_t is the household labor rented to the consumer good producing firms, w_t labor wage, r_t is the return on capital rented to consumer good producing firms, b_t is the government borrowing at the time t from the households, q_t is the price of capital and i_t is the investment.

The first order conditions of the problem are,

$$
\begin{aligned}
q_t/c_t &= \beta E_t \left\{ \frac{1}{c_{t+1}} \left[q_{t+1} (1-\delta) + r_{t+1} \right] \right\} && (11) \\
\nu c_t &= w_t && (12)
\end{aligned}
$$

where δ is the depreciation rate.

The consumption good producing firms in this economy produce consumption goods by utilizing a constant returns to scale production function:

$$
Y_t = \theta_t K_t^{\alpha} (H_t)^{1-\alpha-\Omega} H_t^{e\Omega} \quad (13)
$$

where θ_t is the stochastic productivity factor, H_t^e is the aggregate supply of entrepreneurial labor and H_t is the aggregate supply of household labor. Competition in the factor market implies that wages and rental rates are equal to their respective marginal products. It is important to note that these firms are not subject to agency costs.

Finally θ_t has the following stochastic dynamics:

$$
\theta_t = (1-\rho)\,\theta^* + \rho\theta_{t-1} + \varepsilon_t \quad (14)
$$

where ε_t is an i.i.d shock and θ^* is the nonstochastic steady state of the productivity factor which is equal to 1.

2.3 Entrepreneurs

Now, we will focus on the entrepreneur behavior. In this setup, the entrepreneurs are long-lived. Furthermore, since the return on internal funds is greater than the riskless return, there is a possibility that they may postpone their consumption and accumulate enough funds to self-finance their production activities.[2] Introducing an additional discount factor, γ, makes entrepreneurs consume more than households in a given period[3] and guarantees a nondegenerate lending equilibrium at all dates.

The maximization problem of the entrepreneur is,

$$\max E_0 \sum_{t=0}^{\infty} (\beta\gamma)^t c_t^e, \ 0 < \beta < 1, \ 0 < \gamma < 1 \tag{15}$$

subject to the budget constraint

$$(1-\tau_t) q_t i_t f(\bar{\omega}_t) + x_t \geq c_t^e + q_t z_{t+1} \tag{16}$$

where, x_t is the entrepreneurial wage, c_t^e is the entrepreneurial consumption, z_t is the capital holdings of entrepreneur. Solving this problem yields the following Euler equation,

$$q_t = (1-\tau_t) \beta\gamma E_t \left\{ \{(1-\delta) q_{t+1} + r_{t+1}\} \left[\frac{q_{t+1} f(\bar{\omega}_{t+1})}{1 - q_{t+1} g(\bar{\omega}_{t+1})} \right] \right\} \tag{17}$$

To raise internal funds, the entrepreneur rents his capital and labor, which

[2] Another reason of the possibility of fund accumulation is the linearity of the utility function of the entrepreneur in consumption.

[3] Another modelling technique is to assume that the certain fraction of the entrepreneurs die in each period and sell their accumulated capital stock to households. The modified version of the presented model can be found in Carlstrom and Fuerst (1996).

is inelastic, to the consumption good producing firms. After time t goods have been produced by the firms and households make consumption decisions, entrepreneurs sell their undepreciated capital to the financial intermediary for the consumption goods in order to use them in investment good production. Furthermore entrepreneurs receive transfer payments from government in case of a negative (below the mean) aggregate productivity shock is realized. After these transactions, the net worth of the entrepreneur is

$$n_t = x_t + [r_t + q_t (1 - \delta)] z_t + tr_t \tag{18}$$

where r_t is the return on capital, q_t is the price of capital, z_t is the entrepreneurial capital, x_t is the entrepreneurial wage and tr_t is the transfer payments received from the government at time t.

Here the entrepreneurial wage, x_t, is assumed to be small but positive so that net worth is never zero. If the net worth is zero for any time period, then the entrepreneurs would not be able to borrow. As a result, optimal contract problem will not be well defined.

The entrepreneur uses the net worth as basis for the loan contract. Note that, net worth does not appear in the Euler equation meaning that it holds for all entrepreneurs either solvent or bankrupt. Using the budget constraint we can derive the rule of motion for the entrepreneurial capital, z_t:

$$z_{t+1} = \eta \frac{(1 - \tau_t) f(\bar{\omega}_t)}{1 - q_t g(\bar{\omega}_t)} n_t - \eta \frac{c_t^e}{q_t} \tag{19}$$

2.4 Government Policy

Government raises revenue using proportional taxes levied on the profits of the entrepreneur and borrows from the households. For simplicity, the households are not subject to taxes. The revenues generated via taxation and borrowing made by the government are used to distribute transfer payments to the entrepreneurs when a negative aggregate productivity shock is realized and to repay the debt to the households.[4] Again, the purpose of this paper is to show that countercyclical fiscal policy rules can dampen the fluctuations in the output, through reducing the fluctuations in net worth without making any claims about the optimality or welfare improvement. One important point is that the ad hoc tax rules should satisfy the intertemporal budget constraint.

The intertemporal budget constraint for the government to be satisfied is as follows:

$$\eta\sum_{t=0}^{\infty}\frac{tr_t}{(1+r)^t} + (1-\eta)(1+r)\,b_{t-1} \leq \eta\sum_{t=0}^{\infty}\frac{\tau_t q_t i_t f(\bar{\omega}_t)}{(1+r)^t} \tag{20}$$

This intertemporal budget constraint implies that the present discounted value of tax revenues, $\eta\sum_{t=0}^{\infty}\frac{\tau_t q_t i_t f(\bar{\omega}_t)}{(1+r)^t}$, should be greater or equal to the present discounted value of the transfer payments, $\eta\sum_{t=0}^{\infty}\frac{tr_t}{(1+r)^t}$, and the repayment of the government obligations to households, $(1-\eta)(1+r)\,b_{t-1}$. One important point to emphasize is only one period borrowing is allowed for the government, i.e. government should repay the debt accrued next period after the

[4]Note that, since entrepreneurial uncertainty is eliminated by the capital mutual funds, only productivity shocks will have aggregate effects.

borrowing. The above intertemporal budget constraint is derived by using the following no-Ponzi condition:

$$\lim_{n\to\infty} \frac{b_{t+n}}{(1+r)^{t+n-1}} = 0. \tag{21}$$

Now the two period budget constraint can be written as follows[5]:

$$\tau_t q_t i_t f(\bar{\omega}_t) + b_t = tr_t + (1+r)\, b_{t-1}. \tag{22}$$

The idea behind the two period budget constraint is simple. Assume that government commits to a countercyclical policy rule such that it will distribute transfer payments to the entrepreneurs when a negative technology shock is realized and will not tax them until the shock returns to zero. Now assume that a negative aggregate productivity shock is realized at date t. Then at this period government should distribute transfer payments but do not have resources for the distribution due to the countercyclical fiscal rule. So government borrows from the households and distributes them to the entrepreneurs as transfer payments. Then in this case since tax revenues and debt repayment, $(1+r)\, b_{t-1}$, are zero and borrowing of the government will be equal to the transfer payments, i.e. $b_t = tr_t$ for the period t. However, government should repay the debt accrued at period t, next period. Since the technology shock will be zero, government will not distribute transfer payments but rather collect tax revenues to repay the debt. As a result, the tax revenues collected in period $t+1$ will be used to repay the debt

[5] In this paper, η is normalized to 0.5. This normalization has no effect on the dynamics of the model or the conclusions of the paper.

with the interest to the household, i.e. $\tau_{t+1}q_{t+1}i_{t+1}f(\bar{\omega}_{t+1}) = (1+r)b_t$ for $t+1$. In short, government will transfer resources to the entrepreneurs by borrowing from households at time t and chooses an appropriate tax rate to repay the debt at $t+1$. Clearly this policy rule is a two period fiscal rule that satisfies a two period budget constraint as well as the intertemporal budget constraint. Furthermore, we can independently pin down the values of b_t and τ_t using the budget constraint. This two period fiscal policy rule along with the budget constraint is useful and tractable in making inferences about the policy options.

Since we are considering state contingent fiscal rules, the transfer payments can be dependent on the aggregate productivity parameter, θ, under the implicit assumption that government can react to the aggregate productivity changes. This assumption is problematic since the aggregate productivity can be observed with a lag. So making the transfer payments contingent to the technology shock will be more appropriate for our purposes.

2.5 Equilibrium

This subsection will present the market clearing conditions and the competitive equilibrium of the model. Since there are two agents in the economy with different capital stocks, the total capital stock in the economy is.

$$k_t = \eta z_t + (1-\eta)\,k_t^h \tag{23}$$

which has the rule of motion,

$$k_{t+1} = (1-\delta) k_t + \eta i_t [1 - \Phi(\bar{\omega}_t) \mu] \tag{24}$$

To close the model, we need to state the equilibrium conditions. There are four markets in the economy: a consumption goods market, a capital goods market and two labor markets. The clearing conditions are given by,

$$H_t = (1-\eta) h_t \tag{25}$$

$$H_t^e = \eta \tag{26}$$

$$Y_t = (1-\eta) c_t + \eta c_t^e + \eta i_t + \eta \tau q_t i_t f(\bar{\omega}_t) + (1-\eta)(b_t - (1+r) b_{t-1}) \tag{27}$$

$$k_t = \eta z_t + (1-\eta) k_t^h \tag{28}$$

The equations (25) and (26) are labor market clearing conditions for households and entrepreneurs, respectively. Equation (27) is the consumption goods market clearing condition and equation (28) is the capital goods market clearing condition.

A recursive competitive equilibrium is defined by decision rules for K_{t+1}, Z_{t+1}, H_t, q_t, n_t, i_t, $\bar{\omega}_t$, c_t^e, c_t, b_t, τ_t where the decision rules are stationary functions of (K_t, Z_t, θ_t) and satisfy the following:

$$
\begin{aligned}
\nu c_t &= (1-\alpha-\Omega)\frac{Y_t}{H_t} && (29)\\
q_t/c_t &= \beta E_t\left\{\frac{1}{c_{t+1}}\left[q_{t+1}(1-\delta)+\alpha\frac{Y_{t+1}}{K_{t+1}}\right]\right\} && (30)\\
k_{t+1} &= (1-\delta)k_t+\eta i_t\left[1-\Phi(\bar{\omega}_t)\mu\right] && (31)\\
q_t &= \frac{1}{\left(1-\Phi(\bar{\omega}_t)\mu+\phi(\bar{\omega}_t)\mu\left[\frac{f(\bar{\omega}_t)}{f'(\bar{\omega}_t)}\right]\right)} && (32)\\
i_t &= \frac{n_t}{1-q_t g(\bar{\omega}_t)} && (33)\\
n_t &= \Omega\frac{Y_t}{H_t^e}+\left[\alpha\frac{Y_t}{K_t}+q_t(1-\delta)\right]z_t+tr_t && (34)\\
z_{t+1} &= \frac{(1-\tau_t)f(\bar{\omega}_t)}{1-qg(\bar{\omega}_t)}\left(\Omega\frac{Y_t}{H_t^e}+\left[\alpha\frac{Y_t}{K_t}+q_t(1-\delta)\right]z_t\right)-\frac{c_t^e}{q_t} && (35)\\
q_t &= \beta\gamma E_t\left\{\left\{(1-\delta)q_{t+1}+\alpha\frac{Y_{t+1}}{K_{t+1}}\right\}\left[\frac{(1-\tau_t)q_{t+1}f(\bar{\omega}_{t+1})}{1-q_{t+1}g(\bar{\omega}_{t+1})}\right]\right\} && (36)\\
tr_t &= (b_t-(1+r)b_{t-1})+\tau_t q_t i_t f(\bar{\omega}) && (37)
\end{aligned}
$$

Once again, equations (29) and (30) are labor supply decision and Euler equation for households, respectively. Equation (31) is the rule of motion for aggregate capital. Equations (32) and (33) are optimality conditions from the optimal financial contracting problem. Equations (34) and (35) are evolution of net worth and entrepreneurial capital, respectively. Equation (36) is the Euler equation for entrepreneurs and finally equation (37) is the two period government budget constraint.

3 Simulations

The parameters are calibrated to roughly match their empirical counterparts. The table below gives the calibrated values of:

v	β	α	Ω	δ	η	μ	$\Phi(\bar{\omega})$	γ	ρ
2.89	0.99	0.36	0.0001	0.025	0.5	0.25	0.00974	0.974	0.95

The calibrations above are consistent with Carlstrom and Fuerst (1997). The constant v in the household utility function is chosen so that steady state household labor supply, h, is 0.3. We set $\beta = 0.99$ implying that steady state return on capital is around 4 percent annually. The consumption production technology is Cobb-Douglas with capital share of 0.36, a household labor share of 0.6399, and an entrepreneurial labor share, Ω, of 0.0001. Note that entrepreneurial labor share needs to be positive to ensure that entrepreneurs earn a positive amount of wage to make net worth positive at all dates. The depreciation rate, δ, is set to be equal to 0.025, ρ is set to 0.95 as usual and η is just a normalization which does not alter the conclusions of the paper. Following Carlstrom and Fuerst (1997) we set $\mu = 0.25$. Now the last two parameters, γ and σ, are calculated to match bankruptcy rate given in the above table, $\Phi(\bar{\omega})$, and the risk premium rate $q_t\left(1 + r^k\right) - (1 + r)$ where $q_t\left(1 + r^k\right)$ is the risky return to households and $(1 + r)$ is the riskless rate. So γ and σ are found to be 0.947 and 0.207, respectively.

Now we will compute the impulse responses for the model with agency costs and for the model without agency costs ($\mu = 0$). The latter is essentially the canonical real business cycle model. The importance of this experiment is to be able make comparisons of the two models in terms of persistency and amplification of the shocks. Figure 1 below gives the impulse responses of output, entrepreneurial consumption, household consumption and labor, net worth, and investment to a one standard deviation negative technology shock.

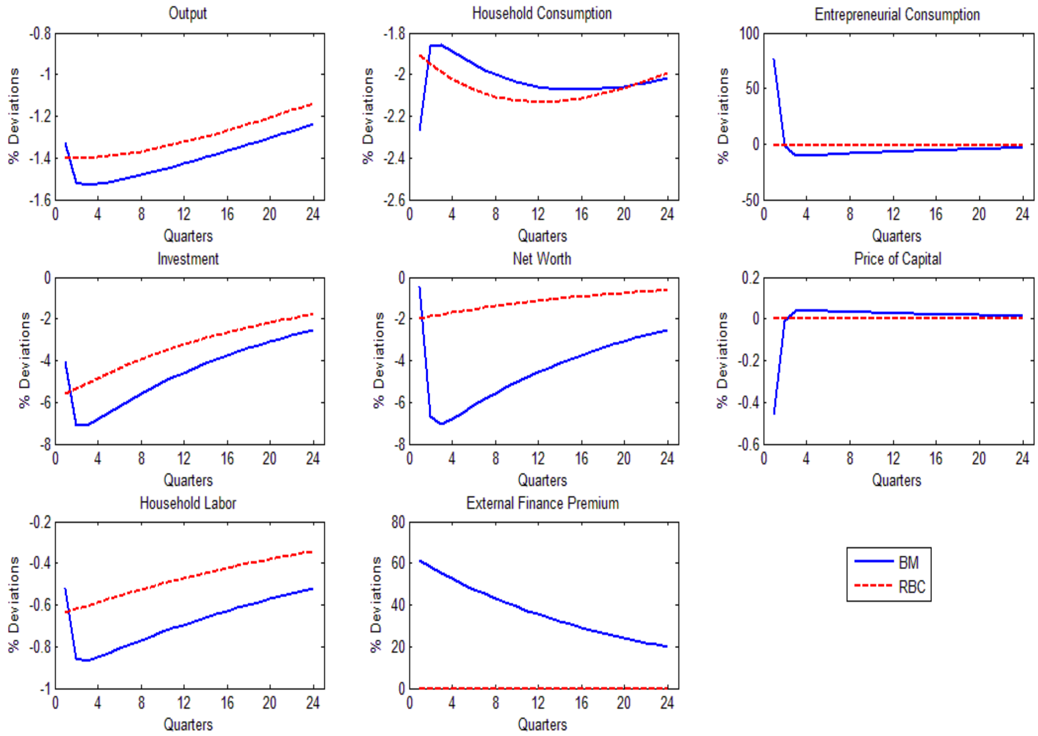


Figure 1: Impulse Responses of the Benchmark and the RBC Model

In the above figure, dotted line represents impulses of the canonical real business cycle model and solid line represents the impulses of the financial accelerator model. The dynamics of the real business cycle model is highly familiar. A negative aggregate productivity shock decreases the rental rate of capital and as a result investment decreases. As investment decreases, output and net worth falls. So both households and entrepreneurs reduce their consumption.[6] Since $\mu = 0$ for the real business cycle model, it implies that price of capital is equal to 1, so we do not see any deviation in the price of capital. Finally variables move to their steady state as productivity starts picking up towards its steady state.

However, in the financial accelerator model the dynamics are quite different. The impulses exhibit hump-shaped responses observed in the time series but not in the canonical real business cycle model due to the missing internal propagation mechanism. The reason behind the hump-shapes in the responses can be explained by the behavior of the net worth. As the negative shock hits the economy, investment falls which decreases the price of capital. As a result, net worth and output decreases slightly with the fall in investment. Decrease in net worth increases external finance premium, which makes borrowing costly for the entrepreneurs. Due to the limited borrowing investment falls again, leading to a further decrease in net worth and output. As a result, output exhibits hump-shapes similar to net worth and investment.

The maximum percentage deviations of household consumption, investment, entrepreneurial consumption, net worth, price of capital and output from their steady state values are given in the table below for the financial accelerator model:

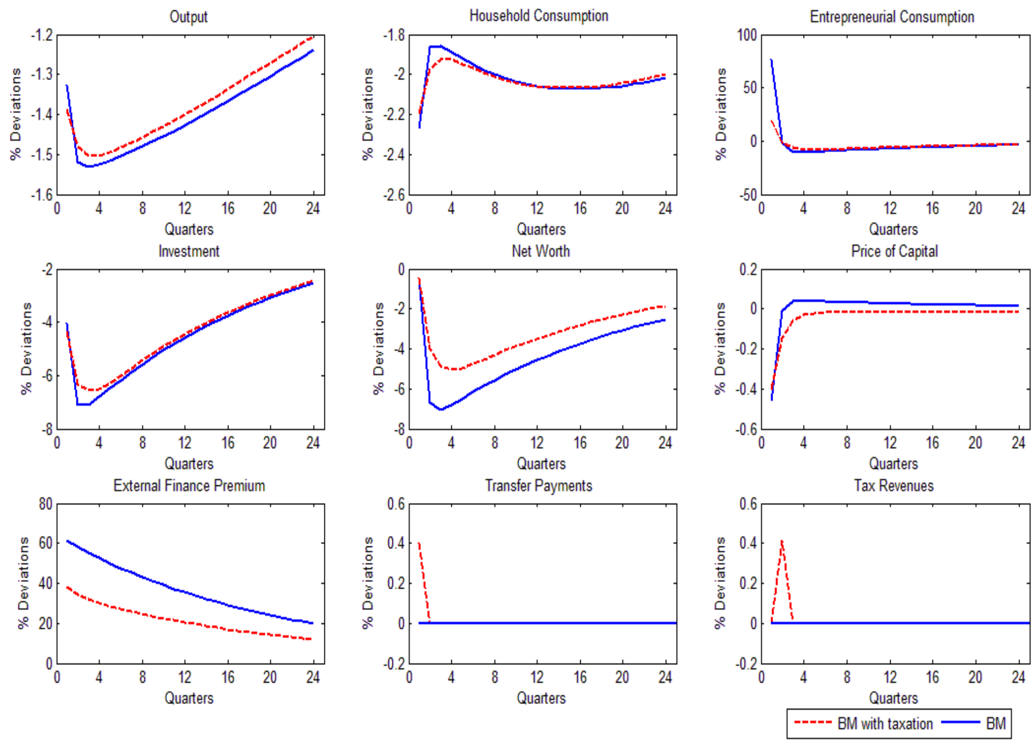
H. Con.	*Ent.Con.*	*Inv.*	*Net Worth*	*P. of Cap.*	*Output*
-2.27%	*76.9%*	*-7.1%*	*-7.06%*	*-0.46%*	*-1.53%*

[6]The decline in the entrepreneurial consumption is about 2%, but since the spike in the agency cost model is extremely high we do not see the deviation of entrepeneurial consumption for the RBC model.

In this model the accelerator mechanism is at work: An adverse shock to the economy reduces the price of capital and the net worth of the financially constrained entrepreneurs. Since the entrepreneurs cannot find enough funds to undertake investment due to the agency costs, both investment and output fall which leads to the further reduction of the net worth. That leads to a persistent and amplified slowdown of economic activity. These persistent and amplified responses are highly consistent with the time series data. This is the reason why this class of models are attractive for the business cycle students.

Next simulation will introduce a procyclical taxation rule with countercyclical transfer payments, which reduces the net worth fluctuations. The countercyclicality of the transfer payments is important since the government will subsidize the entrepreneurs when a below the mean aggregate productivity shock is realized. Consider the transfer payment rule, which government subsidizes the entrepreneurs by $\varepsilon_t^{-0.4}$ when an adverse shock or below the mean aggregate productivity shock, hits the economy. This rule has the implicit assumption that the government can respond to the technology shocks. It is important once again to point out that the tax rule should satisfy the two period budget constraint. Government will borrow from the households as much as the amount of the transfer payment in the period of the negative productivity shock is realized and tax revenue will be zero for this period. In the next period, government should repay the debt with interest to the households. This repayment will be covered by the tax revenues, since the technology shocks are one period in length.

Figure 2 below gives the impulse responses of the benchmark financial accelerator model without taxation and with taxation to the same negative technology shock studied in figure 1:



In the above figure the solid line represents the impulses of the benchmark model without taxation and dotted line represents the impulses of the benchmark model with taxation. First thing to notice is that fiscal policy can significantly dampen the fluctuations caused by the financial market frictions. When the negative technology shock is realized, it affects net worth through reduction in the entrepreneurial wage and rental rate of capital. But this initial decrease in net worth is dampened by the transfer payments distributed by the government in the period of the shock. This dampened decrease in net worth also reduces the increase in the external finance premium, which allows entrepreneurs to borrow more to undertake investment good production. This relative increase in borrowing, dampens the fall in the investment. As a result, price of capital decreases less and entrepreneurial consumption increases less in the period of the shock. Finally output falls less than the benchmark case. Since a negative shock is realized, tax revenue is zero in the first period.

However in the second period, after the shock is back to zero, government levies tax on the profits of the entrepreneurial projects in order to repay the debt to the households, since government is allowed to borrow only for one period. As tax revenue increases, net worth falls further since it is still below the steady state level but above the benchmark model. As net worth decreases further, investment decreases further but less than the benchmark model. The further decrease of net worth and investment makes output fall further, but still staying above the benchmark model and exhibiting a hump-shaped response. Then economy starts pick up to the steady state levels with tax revenue going to zero.

The maximum percentage deviations of household consumption, investment, entrepreneurial consumption, net worth, price of capital and output from their steady state values are given in the tables below for the financial accelerator model with taxation is as follows:

H. Cons.	*Ent. Cons.*	*Inv.*	*Net Worth*	*P. of Cap.*	*Output*
-2.17%	*18.11%*	*-6.5%*	*-5.01%*	*-0.42%*	*-1.49%*

When a procyclical taxation rule is introduced, the fluctuations are dampened. Moreover, the hump-shaped responses of the variables are preserved by the behavior of the net worth. A one time negative productivity shock increases the transfer payments, since transfer payments are countercyclical. Transfer payments distributed by the government makes net worth decrease less and helps net worth to pick up more quickly. This reduced decrease in net worth makes agency costs increase less relative to the benchmark model. So the entrepreneurs can benefit more from the investment opportunities. Eventhough decrease in rental capital decreases investment demand, a smaller decrease in net worth, smaller increase in borrowing rates makes entrepreneurs undertake investment projects, which dampens the decrease in the investment demand as well as in the increase in the entrepreneurial consumption. As a result, the price of capital and the entrepreneurial capital decreases less. Since the fluctuations in the net worth and investment are dampened, output decreases less.

Another important result of the model is about persistence of fluctuations. Since transfer payments to entrepreneurs decreases the effects of financial market imperfections by preventing agency costs to increase a lot, the fluctuations in net worth become less persistent. As a result, investment and output reach their steady state in a shorter period of time compared to the benchmark model. Furthermore, by reducing the fluctuations in net worth and entrepreneurial consumption we can say that fiscal policy has a positive impact on the welfare of the entrepreneurs. By reducing the consumption fluctuations, welfare cost of business cycle decreases since entrepreneurs can smooth out their consumption path.

4 Conclusions and Directions for Future Work

This paper extended a simple real business cycle model where fiscal policy has a role in the business cycle fluctuations due to the financial frictions. The critical insight is that distributing transfer payments dampens the decrease in net worth, which decreases the fluctuations in investment and output. As a result, agency costs increase less due to the smaller fall in the net worth and entrepreneurs can benefit more from the investment opportunities and vice versa in good times. Furthermore, as the effects of financial frictions are reduced with the fall in the agency costs, the fluctuations become less persistent. These results re-emphasize in the importance of economic policy in times of financial distress. A countercyclical fiscal policy in terms of transfer payments, can reduce financial distress by making the balance sheets less vulnerable to financial market conditions and to the adverse productivity shock.

One important point to emphasize is that this paper did not talk about whether the tax rule is optimal or welfare improving. If we were dealing with lump-sum taxation, then any tax that reduces the fluctuations are to be welfare improving, since the steady state is not distorted. For this model we are dealing with a distorted steady state, which makes the answer of the welfare question is non-trivial. The next step is, obviously, to derive the welfare criterion for the agents and to try to find a welfare improving tax rule, or directly solve the Ramsey problem to find the optimal taxation. While most of the optimal taxation problems only have households as a taxed agent, this model will need some non-trivial modifications since there are heterogenous agents present.

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