# To Create or Redistribute? That is the Question

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**Abstract**

This study attempts to explain the post-crisis low corporate investment despite aggressive easing in the financial conditions. Agents can utilize funding by either investing in capital or by redistributing existing assets. The former increases total income and employment while the latter alters the distribution of wealth among agents. We document empirically and explain theoretically that wealth redistribution increases while capital investment decreases during recessions because it is less risky for banks and more profitable for investors to redistribute existing wealth rather than create new. This exacerbates recessions and slows recoveries as it starves entrepreneurs from funding affecting capital creation. In addition, the paper seeks to explain rising inequality in recessions and explain why inequality can be harmful. As asset redistribution is a privilege of the rich, an increase in inequality encourages more income redistribution making recessions more severe. Macroprudential policies promoting access to finance to the "good-production" sector and discouraging asset redistribution can potentially boost recoveries.

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# 1 Introduction

The financial crisis of 2007 is followed by weak recoveries not only in the US but also in nearly all of the developed countries. The conventional and some unconventional tools of monetary policy, although effective in tackling the crisis, have not responded to their full potential (Engen, Laubach and Reifschneider 2015). It has been particularly puzzling that corporate investment has been stubbornly low despite the easing in financial conditions by central banks. As corporate investment is vital for economic growth, our aim is to provide an explanation for this phenomenon. For this purpose, the paper investigates a new friction, namely the tendency to divert funds to purchase existing assets rather than creating new assets or income. Excess funds can be used to create new assets through productive investments in the real economy. Alternatively, the same funds can be utilized for redistributing already existing assets in the economy between agents. Specifically, we examine how the incentives to create new wealth or redistribute existing wealth changes along the business cycle and how it affects investment in capital formation.

Using various VARs on US data, this study documents that in downturns, relatively more funds are directed to the redistribution of assets rather than towards the creation of new assets in the economy. It implies that in downturns, relatively more funds are occupied by financial firms that redistribute income rather than new startups or productive investments.

To investigate this empirical finding, this study proposes a theoretical model. The model distinguishes between two different types of agents: the entrepreneurs and the hedge funds; the former representing the investments for producing new goods and services and thus the introduction of new assets and the latter the investment in existing asset redistribution. Those two types of agents compete for credit from banks. The banks asses the profitability and riskiness of such investments and earmark funds to entrepreneurs or hedge funds accordingly. In essence, the model explores the dynamics of the profitability of investing in the production of additional goods and services, against the profitability of investing in redistributing existing assets. Standard representative agent models cannot capture these dynamics as they assume that as agents are identical and thus redistribution of income or assets does not have a real effect. We show that the ability to redistribute assets across different types of agents affects capital investment, prolonging recessions and exacerbating inequality.

The behavior of those agents changes along the business cycle and specifically, during recessions, the opportunities to redistribute assets are more promising than the creation of new assets. Both banks and the hedge funds favor the use of more credit for asset reallocation, while the entrepreneurs are starved from credit at the moment the economy is in need of more firms and jobs. Nonetheless, this behavior is optimal during a recession, because high uncertainty in the economy favors redistribution of existing wealth rather than the creation of additional wealth. New ideas and firms start small and their owners seek to diversify across time. In a recession, entrepreneurs are more eager to sell part of the wealth they create to others, in an attempt to hedge their position. This gives the advantage to the hedge funds to accumulate even more wealth by purchasing equity from the firm "creators", the entrepreneurs. Stated otherwise, increased uncertainty[1] (or lower return per unit of risk) during recessions has two effects: It decreases investment in new firms directly but also gives the opportunity for specific finance firms to profit from asset redistribution. This exacerbates the fall in investment as the limited credit is utilized for repurchases of existing assets in recessions.

To address these adverse effects of investment incentives, we show that a simple policy tool can make it easier for entrepreneurs to secure loans in downturns which eventually reduces business cycle fluctuations. Specifically, policies that favor the access to credit for productive purposes instead of asset redistribution during recessions can reduce the severity of recessions considerably. Those could include macroprudential tools such as pro-cyclical LTV ratios for entrepreneurs for example. Such a tool can increase lending for productive purposes in recessions while increasing the incentive for asset redistribution in expansions. Alternatively, dealing with escalating inequality in the aftermath of the 2007 crisis, central banks can promote access to finance by providing liquidity to commercial banks to fund loans for "productive" purposes or earmarking specific loan amounts for investment purposes. As a consequence, the policymaker will be able to direct funds from asset redistribution to the production sector, reviving the economy and avoiding a prolonged recession.

We contribute to the literature that focuses on tackling the financial crisis and boosting growth and specifically on providing an answer to the inertia of investment and capital formation given an increasingly cheaper financial environment. This provides a different perspective for analyzing recessions as asset redistribution within the economy has a real effect, unlike models with homogenous agents. To the extent of our knowledge, this is the only

[1] In our model riskiness is unchanged but since both expected returns and risk matters for projects, if expected returns change but risk is unchanged this can be considered as a change in riskiness of the project because what matters is the expected return per unit of risk.

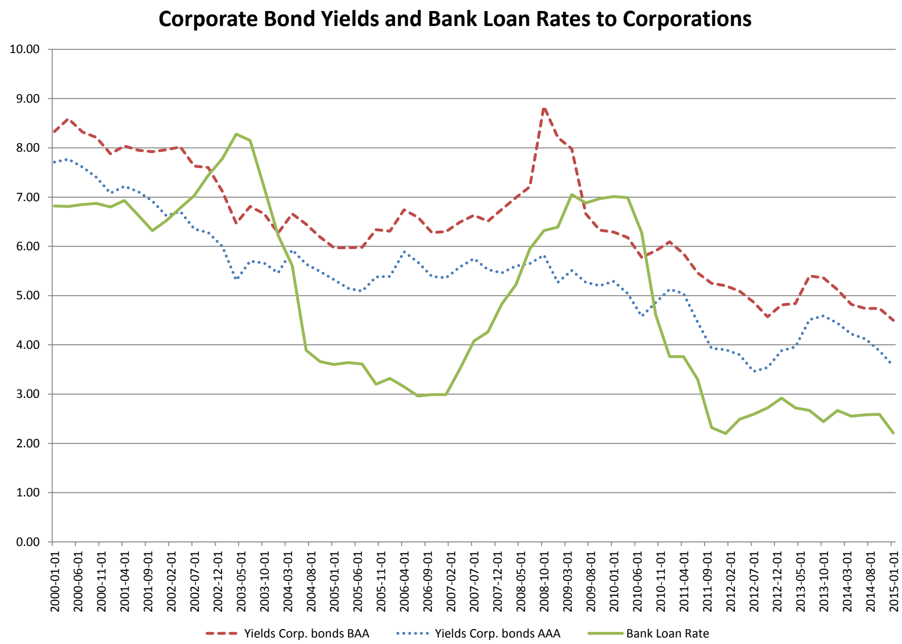


Figure 1: The yields on corporate bonds for Moody's Baa and Aaa are the red dashed line and blue dotted line respectively. The green solid line is the bank loan rates for commercial and industry loans.

paper that investigates the interaction between asset redistribution and capital investment, exposing the resulting inefficient allocation of resources along the business cycle. In addition, this work can provide an explanation for rising income inequality during recessions and also an explanation to why rising inequality can be harmful to the economy.

The rest of the paper is organized as follows: Section II presents some stylized facts to motivate this exercise. In section III a few VARs on US data are estimated to support the main argument of the study. Section IV presents all the details to the benchmark DSGE model, while section V demonstrates the main mechanism of the benchmark model in a simple partial equilibrium model framework. Section VI presents simulations from the DSGE model and section VII the policy recommendations for tackling the weak recovery after a crisis.

# 2 Motivation and Related Work

Recently, besides the efforts of the fed and the rest of the world's central banks to ease financial conditions and boost liquidity, corporate investment remains surprisingly low. Figure 1

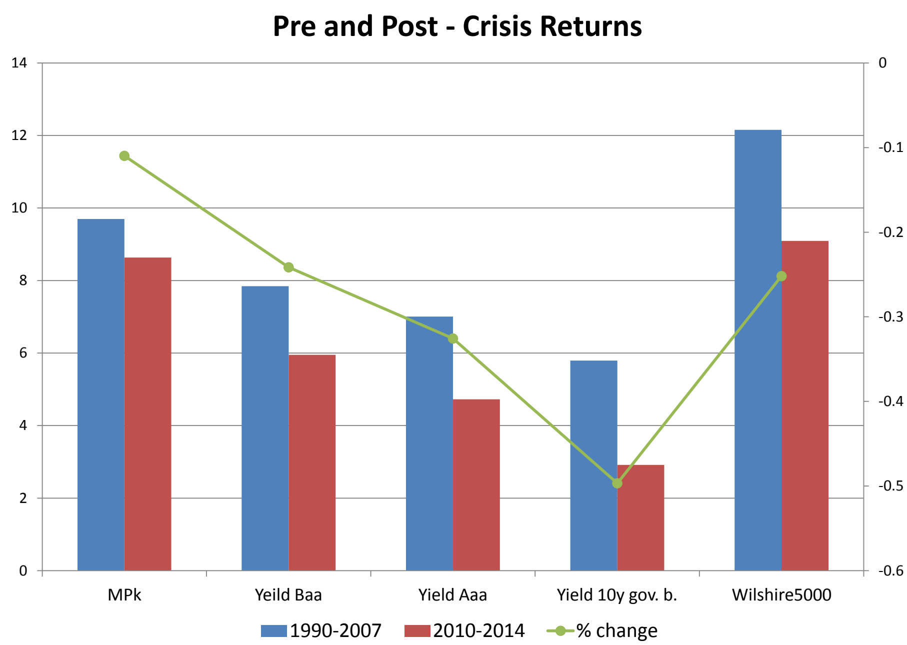


Figure 2: Those are the returns for various types of investments in the US market for the period before the crisis 1990 - 2007 (blue bars) and the period after the crisis 2010 - 2014 (red bars), along with the percent change in the return for the two periods (green line).

shows the evolution of corporate bond yields and bank loan rates. Specifically, the red dashed line and the blue dotted line corresponds to Moody's Aaa and Moody's Baa rated corporate bonds respectively. The green solid line corresponds to the weighted-average effective loan rate for commercial and industry loans for all US commercial banks. It is evident that the cost of borrowing is in nearly record lows for large companies and also for the small and medium sized ones that are more depended on bank lending. However, investment recovery has been very weak which is counter-intuitive.

The most common explanation provided to the above is that the return on investment in capital formation is too low due to the recent crisis. To shed some light into this, figure 2 provides a useful interpretation. The blue and red bars correspond to the yields for pre and post-crisis periods covering 1990 - 2007 and 2010 - 2014 respectively, for various investments in the US. As they appear in the figure those investments are the return to capital (marginal product of capital), the yields of Baa and Aaa bonds, the yield on government bonds and the yield on the stock market. The green line that takes negative values on the left axis is the percentage change in the yield from the two sub-periods. All assets have lower yields

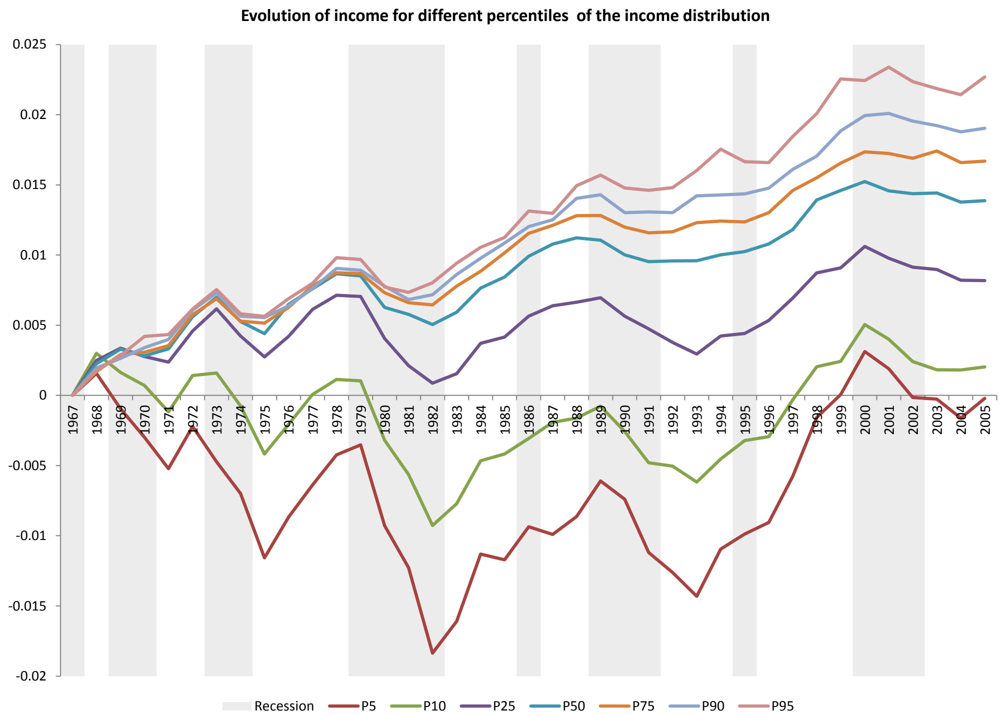


Figure 3: This figure shows the evolution of income for different percentiles of the income distribution. It is evident that in recessions the drop in income is more pronounced for the less well-off

compared to the pre-crisis period but it is evident that the return to capital has not been deteriorating as much, providing still a high return. As also argued by Banerjee, Kearns and Lombardi (2015), the low investment experienced cannot be attributed to low returns on capital.

Banerjee, *et. al* (2005), Guiso and Parigi (1999) and Bloom, Bond and Van Reenen (2007) propose the increase in risk as the main driving force of the phenomenon using a panel of 7 OECD countries. Our theoretical model builds on similar premises as risk and the need to diversify is what makes asset redistribution desirable. However, we claim that risk by itself is not the only obstacle for capital investment. Higher risk given returns gives the incentive for income redistribution and financial firms manage to attract more funds than the entrepreneurs, which prolongs the recession and leads to a jobless recovery. Therefore, we show that it is not only the risk per se that hinders growth but also the ability of some financial firm to capitalize on the increase in risk that diverts funds to their side. Therefore, in our model, when return over risk for an investment becomes lower, the ability of some agents to redistribute assets creates a barrier to economic growth, hindering capital investment.

In addition this study can implicitly provide an alternative explanation for the rise in income inequality in downturns as the relatively rich profit from income redistribution in downturns while the rest of the economy experiences a decrease in their revenues and well-being. Figure 3, plots different percentiles of the income distribution in logs setting the value of 1967 to zero for all series. We use the same data as in Heathcote *et al.* (2009), coming from the Current Population Survey (CPS) from 1967 to 2005. The lower series (red line) is the evolution of income for the $5^{th}$ percentile of the income distribution (relatively poor), going up to the $95^{th}$ percentile (relatively rich). The shaded areas represent recession periods. Besides the fact that in the figure income inequality increases in general as also documented by Saez and Zucman (2014) and Piketty (2010), It is evident that it tends to increase during recessions too. The observation that inequality is countercyclical is also reported by other studies using different datasets: Krueger *et al.* (2009), Heathcote *et al.* (2009) and Coibion *et al.* (2012).

# 3 Empirical Methodology

A structural VAR with a linear trend is estimated using US data collected covering the period from 1960:Q1 to 2015:Q4. For the purposes of investigating the effects on inequality another VAR is estimated using annual data from 1967 to 2012. A detailed description and the sourses of each data series employed in this exercise are presented in Table 1.

## 3.1 The VARs

This section presents an empirical estimation to further underline the main focus of this study, namely that income redistribution rises during recessions. The structural VAR representation is similar to the one in Killian (2009). We use a Choelesky decomposition to identify the impulse responses such that changes in ordering of variables does not have a major effect on the VAR responses, especially for shocks other than monetary where the identification is less straight forward. For monetary shocks, the exclusion restriction employed in the structure means that a recessionary interest rate shock will not feed through the economy instantaneously but will have a lag of at least one period.

The responses from the first VAR are presented in figure 4. The sample period ranges from 1960:Q2 to 2015:Q4 and the lag structure is set to 4 even though the results are un-

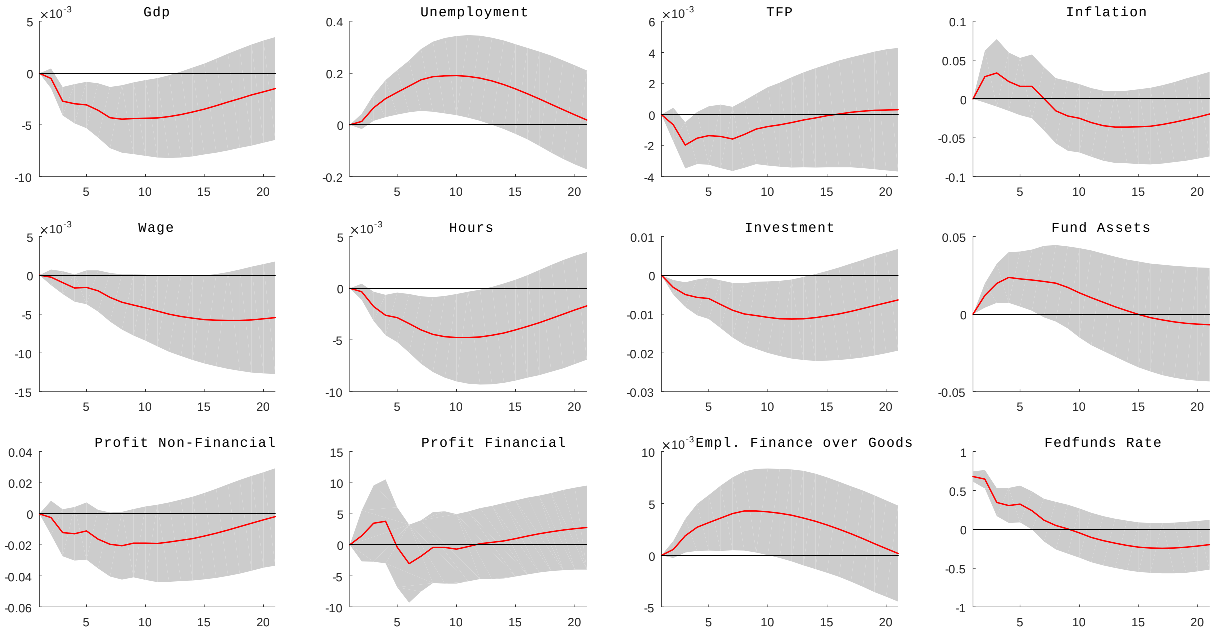


Figure 4: Those are the impulse responses from a structural VAR on US data from 1960:Q2 to 2015:Q4. The red solid lines are the impulse responses after a 1 standard deviation shock that increases the federal funds rate. All variables except for the federal funds rate respond with a lag. Shaded areas represent 95% confidence intervals.

changed if fewer lags are employed. An increase in the federal funds rate creates a recession in the economy. The real Gdp decreases along with wages and hours while unemployment increases. Inflation initially increases above the steady state level before turning below which is due to the inclusion of pre-Volcker data. Investment in capital goods (fixed capital formation) also decreases significantly. On the other hand, fund shares increase even though the economy is deteriorating which implies that the funds whose sole purpose is to redistribute existing assets increase their investment activities. Moreover, the profits of non-financial firms deteriorate while the profits of financial firms are initially increasing albeit insignificantly. The employment in finance compared to the employment in the goods producing industries increases indicating that the financial sector is relatively more profitable than the goods producing sector during downturns.

The story is unchanged when technology shocks are considered. In figure 5, TFP corresponds to productivity shocks identified as output per hour which is what is commonly used

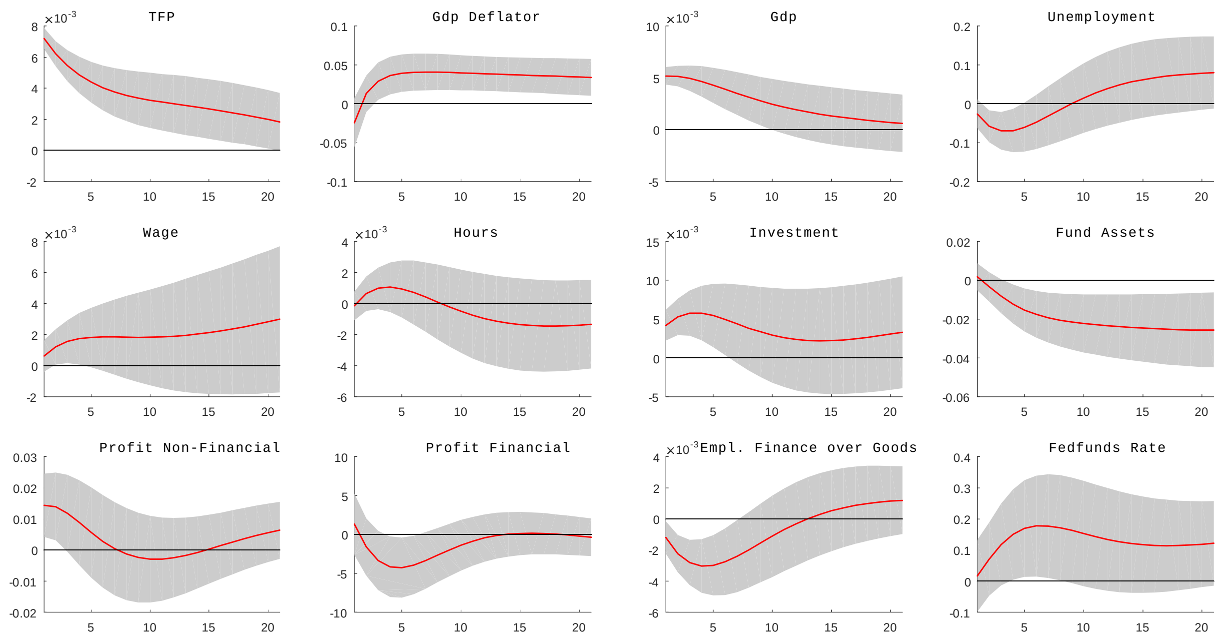


Figure 5: Those are the impulse responses from a structural VAR on US data from 1960:Q2 to 2015:Q4. The red solid lines are the impulse responses after a 1 standard deviation productivity shock (output over hours). Shaded areas represent 95% confidence intervals.

in the literature. The Cholesky ordering is one where the increase in productivity increases creates an expansion and the responses are mostly invariant to changes in their order. The lag length is set to 1 according to Akaike, Schwarz and Hannan-Quinn ctiteria. It is still evident that fund assets, profits to financial firms and the relative change in employment between finance and goods production are all countercyclical. They decrease in an expansion and increase in a downturn as the previous VAR depicts. Those phenomena are explained using a theoretical model is the following sections.

Another interesting exercise is investigating the responses obtained after a shock that increases the amount of loans to the financial sector summarized in figure 6. It seems that such a shock puts the economy into a recession. Other things constant, more loans to the financial sector produces a downturn, a result that is robust even if the sample excludes the recent financial crisis. In the theoretical model in this study it is also demonstrated that such a shock is recessionary because the incentive to redistribute existing assets becomes more prominent and absorbs a larger share of credit implying that the goods producing sector is

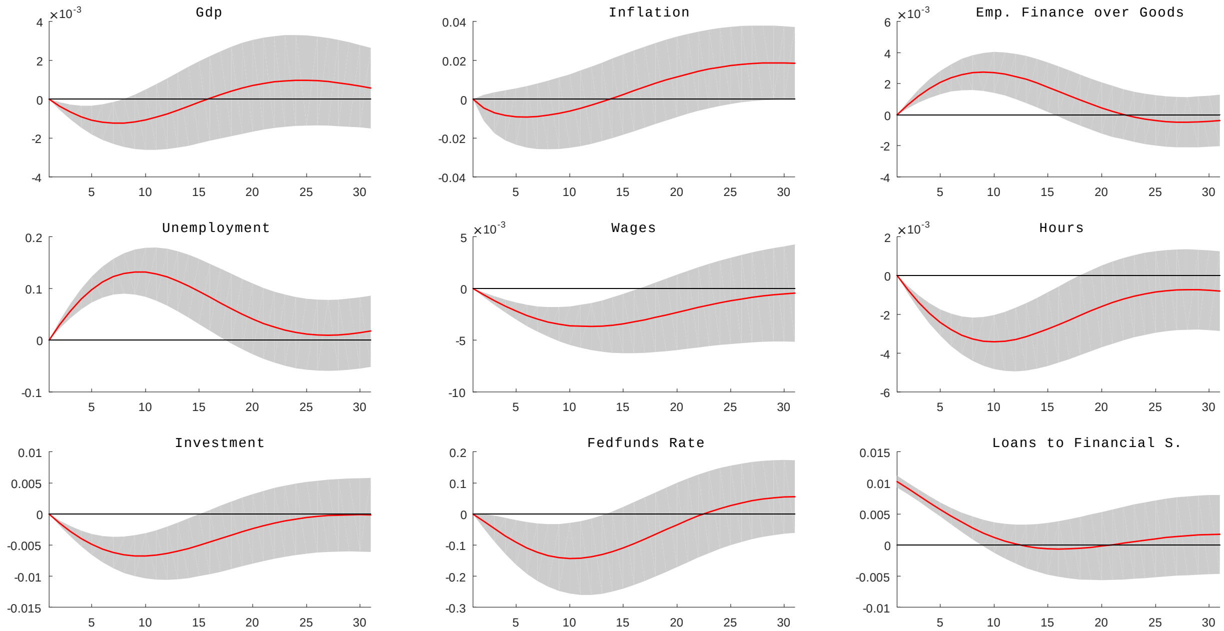


Figure 6: Those are the impulse responses from a structural VAR on US data from 1960:Q2 to 2015:Q4. The red solid lines are the impulse responses after a 1 standard deviation increase on loans to the financial sector. Shaded areas represent 95% confidence intervals. The shock induces a recession in the economy.

starved from funding.

The last VAR estimated in this study takes annual data from 1961 to 2006. The task is to explore how inequality is affected along the business cycle as well. After an increase in the federal funds rate gdp drops along with investment in capital. The household income gini coefficient increases showing that inequality is on the rise. In addition the total amount of assets held by the top 1% of the income distribution increases during a downturn. This implies that there might be a reason that inequality increases during a recession that relates to the accumulation of assets towards the rich.

# 4 The Model

We develop a DSGE model with three different types of households: 1) the common households that earn their wage income by selling their labor to intermediate firms: 2) the entre-

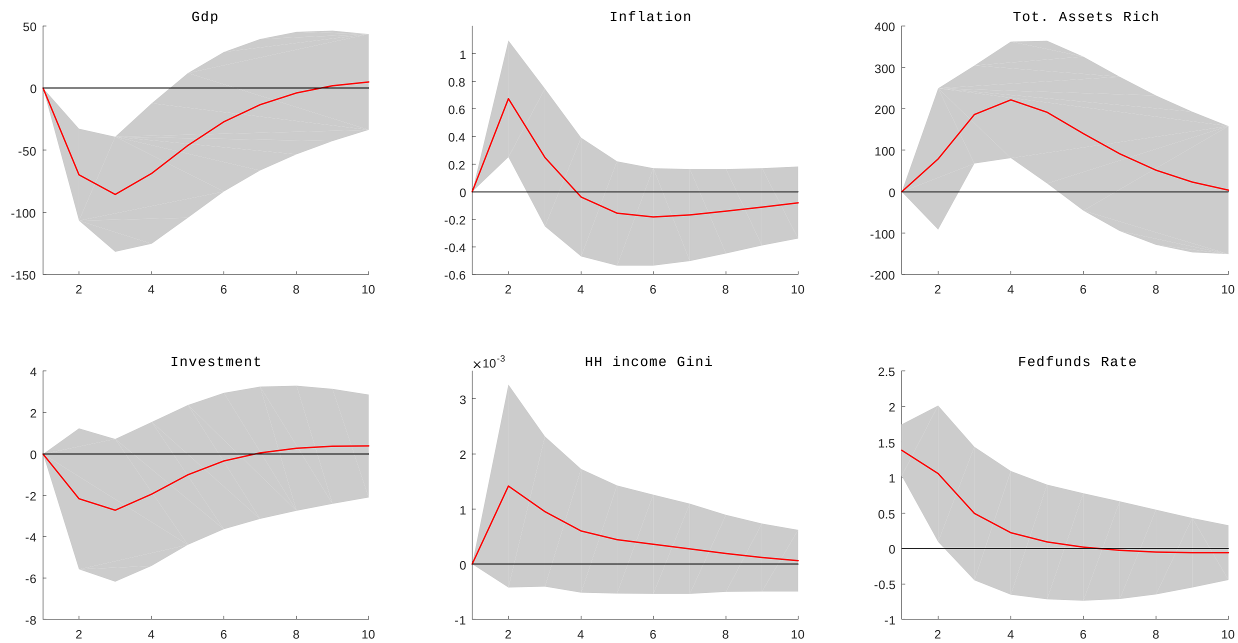


Figure 7: Those are the impulse responses from a structural VAR on US data from 1961 to 2006, annual data. The red solid lines are the impulse responses after a 1 standard deviation shock that increases the federal funds rate. All variables except for the federal funds rate respond with a lag. Shaded areas represent 95% confidence intervals.

preneurs that make a living by creating intermediate firms and 3) the Hedge Fund Clients, earning their income by purchasing firms from the entrepreneurs, providing them the means to diversify. All parameters or variables associated with each of those groups have a subscript $C$, $E$ and $R$ respectively.

The intermediate firms live for at most a period[2], thus the only asset in the economy that can be accumulated by each household is bank deposits. Deposits can also be used as collateral to secure loans from the banks. Only the entrepreneurs and the HFC compete for loans and their relative stock of collateral affects the number of loans they can acquire. In addition, the relative probabilities of default on their investments also play a vital role in the distribution of loanable funds to either the entrepreneurs or the HFC. Final good firms purchase the product of intermediate firms to produce the consumption good. There are

[2] We attempt this way to avoid a state space that depends on the whole history of asset creation, destruction, purchases and sales.

nominal rigidities in this sector.

## 4.1 Common Households

The common households are the workers in the economy. They sell their labor to entrepreneurs and they consume and deposit part of their income to banks each period. They supply their labor service to the entrepreneurs and they deposit their savings to the banks[3]. Common households get utility[4] indicated by $U(.)$ from consumption and disutility from labor indicated by $G(.)$. They also get utility from holding deposits as in Begenau (2016). Common households maximize the following objective function:

$$\max_{\left\{C_t^C, L_t, D_t^C\right\}_{t=0}^{\infty}} E_t \sum_{t=0}^{\infty} \beta_C^t \left\{ U\left(C_t^C\right) - N_t G\left(L_t\right) + \frac{z_c}{1-\alpha_C}\left(\frac{D_t}{C_t^C}\right)^{1-\alpha_C} \right\}$$

where the last term in the objective corresponds to the utility from deposits[5]. Households maximize the above objective adjusting consumption $C_t^C$ and labor effort $L_t$, subject to the following budget constraint:

$$C_t^C + D_t = N_t w_t L_t + R_{t-1}^d D_{t-1} + T_t \tag{1}$$

The budget constraint indicates that current expenditures involve consumption $C_t^C$ and new deposits $D_t$. Household income includes last period's deposits $D_{t-1}^C$ that earn a gross return of $R_{t-1}^d$, wage income $w_t L_t$ for the $N_t$ employed workers and dividends $T_t$ from final good firm profits and banks.

Denote with $\lambda_t^C$ the Lagrange multiplier for the constraint (1), the first order condition with respect to $C_t^C$ is:

$$U'\left(C_t^C\right) - z_c\left(\frac{D_t}{C_t^C}\right)^{1-\alpha_C}\frac{1}{C_t^C} = \lambda_t^C$$

[3] Common households cannot get loans as we assume loans are only for investments and not for consumption purposes even though this can be easily reformulated

[4] We assume external habit formation for the utility function i.e. $U\left(C_t^C\right) = \log\left(C_t^C - a_c C_{t-1}^C\right)$. The past consumption is assumed to be the consumption of other common households.

[5] This assumption is necessary for determinacy in the case deposits are determined by the household.

and the first order condition with respect to deposits is:

$$\lambda_t^C = \beta_C E_t \left(\lambda_{t+1}^C R_t^d\right) + \lambda_t^C z_c \left(\frac{D_t}{C_t^C}\right)^{1-\alpha_C} \frac{1}{D_t}$$

The Euler equation for deposits is

$$1 = \beta_C E_t \left(\frac{U_c\left(C_{t+1}^C\right)}{U_c\left(C_t^C\right)} R_t^d\right) + z_c \left(\frac{D_t}{C_t^C}\right)^{1-\alpha_C} \frac{1}{D_t} \tag{2}$$

where $R_t^d$ is the real deposit rate. The first order condition with respect to labor hours $L_t$ is:

$$\frac{G'\left(L_t\right)}{U\left(C_t^C\right)} = w_t$$

which implies that the real wage compensates the workers for the disutility of labor.

## 4.2 Entrepreneurs

The entrepreneurs are the ones that create wealth for the whole economy by implementing ideas and producing goods and services as well as jobs. There is a continuum of ideas that can be put in production, although, in order to implement an idea, the entrepreneurs rely on banks for credit to pay the cost of labor $w_t L_t$. They search for a bank to obtain a line of credit and when this connection is established the newly created firm gets a loan every period of whatever amount is needed at the gross interest rate $R_t^E$. The line of credit is permanently interrupted in the case the firm defaults on its obligations and the entrepreneur must search for another bank to fund its operation next period. To secure loans the entrepreneurs need to provide collateral and the only asset eligible for that is housing, which also provides utility to the owners.

The problem of the entrepreneur is to maximize current and future consumption

$$\max_{\left\{C_t^E, H_t^E, \tilde{N}_t\right\}_{t=0}^{\infty}} E_t \sum_{t=0}^{\infty} \beta^t \left\{U\left(C_t^E\right) + G_H\left(H_t^E\right)\right\}$$

where $C_t^E$ denotes consumption of the entrepreneurs and $H_t^E$ the utility from housing consumption. The budget constraint for the entrepreneur is

$$C_t^E + P_t^h \left(H_t^E - H_{t-1}^E\right) = N_t \Psi_t^E \tag{3}$$

Entrepreneurs receive cash flows $\Psi_t^E$ from the $N_t$ firms they create. The price of housing is $P_t^h$ and the household enters the period with $H_{t-1}^E$ units of housing. The ideas from the entrepreneurs are unlimited, albeit $\tilde{N}_t$ is the maximum number of firms they can apply for a credit line given the collateral of the household. This gives rise to another constraint:

$$\tilde{N}_t R_t^E w_t L_t \leq m_t^E E_t P_{t+1}^h H_t^E \tag{4}$$

denoting that the maximum number of firms that can be financed $\tilde{N}_t$ is such that the total amount that can be owed to the bank next period $\tilde{N}_t R_t^E w_t L_t$ must be no greater than the loan to value ratio $m_t^E$ times the value of housing next period.

Each period the entrepreneurs have $N_t$ credit lines open and thus $N_t$ operating firms. The law of motion for the amount of credit lines or firms next period is:

$$N_{t+1} = \left(1 - \psi_t^E\right) N_t + \left(\tilde{N}_t - N_t\right) q_t^E \tag{5}$$

With a probability $\psi_t^E$ the firm defaults on its obligations with the bank and the credit line is broken and thus, the following period $\psi_t^E N_t$ firms disappear. The entrepreneurs can search for $\tilde{N}_t - N_t$ new credit lines, each one having a probability of $q_t^E$ to find a match with the bank.

Denoting with $\lambda_t^E$ and $\mu_t^E$ the Lagrange multipliers of constraints (3) and (4) respectively, the first order condition for housing is:

$$G'_H \left(H_t^E\right) + \beta E_t \lambda_{t+1}^E P_{t+1}^h + \mu_t^E E_t P_{t+1}^h = \lambda_t^E P_t^h \tag{6}$$

The first order condition for $\tilde{N}_t$ is

$$\beta q_t^E E_t \lambda_{t+1}^E \Psi_{t+1}^E = \mu_t^E R_t^E w_t L_t \tag{7}$$

The first order condition (foc) for consumption is:

$$\lambda_t^E = U_c\left(C_t^E\right) \tag{8}$$

and therefore, use (6), (7) to get

$$G'_H\left(H_t^E\right)+\beta E_t\lambda_{t+1}^E P_{t+1}^h+\frac{\beta m_t^E q_t^E}{R_t^E w_t L_t}E_t\lambda_{t+1}^E P_{t+1}^h\Psi_{t+1}^E=\lambda_t^E P_t^h \tag{9}$$

The above equation states that the entrepreneurs accumulate housing up to the point the marginal cost of housing which is the RHS of (9) is equal to its marginal benefit which involves 3 terms: the marginal utility from housing, the value of the housing next period and the value of the additional credit lines that can be opened next period by increasing the amount of collateral today.

## 4.3 Banks

The bank searches for lines of credit among entrepreneurs and hedge funds. If the total amount of lines of credit is $\Gamma_t$, the bank opens $s_t^E$ for the entrepreneurs and $s_t^R = 1 - s_t^E$ share for the hedge funds HF. There are two matching functions, one for the entrepreneurial lines of credit and one for the hedge funds. The matching function that determines the number of credit lines opened for entrepreneurs is:

$$M_t^E = A_\Gamma\left(\tilde{N}_t - N_t\right)^{\alpha_\Gamma}\left(s_t^E\Gamma_t\right)^{1-\alpha_\Gamma} \tag{10}$$

where $\tilde{N}_t - N_t$ is the number of credit lines the entrepreneurs can apply for and $s_t^E\Gamma_t$ the number of lines of credit the bank is offering to entrepreneurs. The matching function, equation (10) is a constant return to scale one and determines the amount of new credit lines to entrepreneurs each period. The matching function for loans to the hedge funds takes a similar form

$$M_t^R = A_\Gamma\left(\tilde{N}_t^R - N_t^R\right)^{\alpha_\Gamma}\left(\left(1-s_t^E\right)\Gamma_t\right)^{1-\alpha_\Gamma} \tag{11}$$

where $\tilde{N}_t^R - N_t^R$ is the maximum number of credit lines the hedge fund can apply for and $\left(1-s_t^E\right)\Gamma_t$ the corresponding number the bank assigns to them. The probability a line of credit assigned to entrepreneurs to find a match is

$$\rho_t^E = A_\Gamma\left(\frac{\tilde{N}_t - N_t}{s_t^E\Gamma_t}\right)^{\alpha_\Gamma} \tag{12}$$

Similarly the probability a line of credit for the HFC to find a match is

$$\rho_t^R = A_\Gamma \left( \frac{\tilde{N}_t^R - N_t^R}{s_t^R \Gamma_t} \right)^{\alpha_\Gamma} \tag{13}$$

The probability an entrepreneur to successfully establish a credit line with the bank is

$$q_t^E = A_\Gamma \left( \frac{s_t^E \Gamma_t}{\tilde{N}_t - N_t} \right)^{1-\alpha_\Gamma} \tag{14}$$

and the probability the hedge fund to open a credit line with the bank is

$$q_t^R = A_\Gamma \left( \frac{s_t^R \Gamma_t}{\tilde{N}_t^R - N_t^R} \right)^{1-\alpha_\Gamma} \tag{15}$$

The bank borrows from common households (deposits) and opens credit entrepreneurs and hedge funds. For the credit lines that find a match, the bank lends whatever amount asked and charges gross interest rates $R_t^E$ and $R_t^R$ on entrepreneurs and hedge funds respectively. To open credit lines the bank must bear a cost $\kappa_t^E$ and $\kappa_t^R$ (entrepreneurs and hedge funds respectively) which is the resources necessary to search for worthy opportunities within the pool of potential borrowers. Upon default it is assumed that the entrepreneurs pool their incomes and cover all the losses. However, the bank suffers a penalty with each default which corresponds to legal or monitoring costs that decrease return by $R_L^E$ and $R_L^R$ for entrepreneurs and hedge funds respectively.

Since the deposit rate is set by the central bank via a Taylor rule, the total amount of deposits and thus the amount of loans can be set either by the common household or by the bank through its demand for loans. From the bank balance sheet constraint, loans must equal deposits (bank profits are usually small). The central bank fixes the deposit rate and thus two different scenarios arise: The first scenario is when the households optimally choose their deposits which implies that the bank has no room to independently set its loans, as the deposit rate is set by the central bank. Alternatively, the second scenario is when the bank can freely choose its optimal loan portfolio which creates deposits of an equal amount. This implies that there is no room for the households to optimally choose their deposits. The two scenarios and the underlying equations are presented below.

### 4.3.1 Case 1: Banks Set Loan Portfolio

In this section the bank decides on the optimal amount of credit lines to open while the common household simply deposits the amount necessary for the market to clear. The bank seeks to maximize the following objective:

$$JB_t = \max_{\Gamma_t, s_t^E} N_t \left(R_t^E - \psi_t^E R_L^E\right) w_t L_t + N_t^R \left(R_t^R - \psi_t^R R_L^R\right) Q_t^R P_t^I - R_t^d D_t + E_t \Lambda_{t,t+1} JB_{t+1} \quad (16)$$

where the bank earns $R_t^E$ minus the losses from default $R_L^E$ that occur to a share $\psi_t^E$ of all firms. The bank earns this return for the $N_t$ credit lines maintained with entrepreneurs. The loan amount to each firm is $w_t L_t$ and the firm is free to ask for any amount as long as a credit line is open. Similarly it earns $R_t^R - \psi_t^R R_L^R$ from the $N_t^R$ credit lines maintained with the hedge funds. The hedge funds borrow $Q_t^R P_t^I$ amount to purchase firms, where $P_t^I$ is the price offered for the firm and $Q_t^R$ the share of the firm the hedge fund seeks to acquire.

At the start of the period the bank is committed to fund the operations of the firms and hedge funds with an existing line of credit from the past. Its decision is on the amount of new lines of credit to offer $\Gamma_t$ and the way those lines are going to be allocated to entrepreneurs $s_t^E$ and hedge funds $1 - s$. The maximization is subject to the law of motion for the number of credit lines to entrepreneurs:

$$N_{t+1} = \left(1 - \psi_t^E\right) N_t + \rho_t^E s_t^E \Gamma_t \quad (17)$$

The credit lines next period include the ones with firms that have not defaulted in the previous period and the newly created ones. New credit lines depend on the amount of lines the bank allocates for entrepreneurs $s_t^E \Gamma_t$ and the corresponding probability each line to match, $\rho_t^E$. Similarly the law of motion for the lines of credit to hedge funds is:

$$N_{t+1}^R = \left(1 - \psi_t^R\right) N_t^R + \rho_t^R \left(1 - s_t^E\right) \Gamma_t \quad (18)$$

The last constraint is the balance sheet constraint of the bank. That is:

$$N_t r_t K_t + N_t^R Q_t^R P_t^I + \kappa_t^E s_t^E \Gamma_t + \kappa_t^R s_t^R \Gamma_t = D_t + \Omega_t \quad (19)$$

The amount of lending and the cost to post new potential credit lines $\kappa_t^E s_t^E \Gamma_t$ and $\kappa_t^R s_t^R \Gamma_t$ are financed from deposits $D_t$ and initial reserves $\Omega_t$.

The first order condition with respect to $\Gamma_t$ is:

$$R_t^\Gamma\left(\kappa_t^E s_t^E+\kappa_t^R s_t^R\right)=s_t^R\rho_t^R E_t\Lambda_{t,t+1}\frac{dJB_{t+1}}{dN_{t+1}^R}+s_t^E\rho_t^E E_t\Lambda_{t,t+1}\frac{dJB_{t+1}}{dN_{t+1}} \tag{20}$$

The first order condition for $s_t^E$ is

$$R_t^\Gamma\left(\kappa_t^E-\kappa_t^R\right)=\rho_t^E E_t\Lambda_{t,t+1}\frac{dJB_{t+1}}{dN_{t+1}}-\rho_t^R E_t\Lambda_{t,t+1}\frac{dJB_{t+1}}{dN_{t+1}^R} \tag{21}$$

To interpret the way the allocation of credit lines between entrepreneurs and hedge funds works, without loss of generality assume that the cost of opening credit lines is equal for each type of borrower and $\kappa_t^E=\kappa_t^R$. From equation (21) this implies that

$$\rho_t^E E_t\Lambda_{t,t+1}\frac{dJB_{t+1}}{dN_{t+1}}=\rho_t^R E_t\Lambda_{t,t+1}\frac{dJB_{t+1}}{dN_{t+1}^R} \tag{22}$$

Note that $\rho_t^E$ and $\rho_t^R$ are decreasing functions of $s_t^E$ and $s_t^R$ respectively (check equations (12) and (13)). If one sector promises higher return on the marginal credit line than the other, (for example if $\frac{dJB_{t+1}}{dN_{t+1}}>\frac{dJB_{t+1}}{dN_{t+1}^R}$), then the portion of the vacant credit lines $s_t^E$ assigned to entrepreneurs increases while the portion $s_t^R$ going to hedge funds decreases. As more vacant credit lines are assigned to entrepreneurs, the probability of each one to find a match drops which pushes $\rho_t^E$ downwards ($\rho_t^R$ upwards) until equation (22) is satisfied.

To get the credit line posting conditions, find the two envelope conditions by taking derivatives of objective (16) with respect to $N_t$ and $N_t^R$. That is

$$\frac{dJB_t}{dN_t}=\left(R_t^E-\psi_t^E R_L^E-R_t^d\right)r_tK_t+\left(1-\psi_t^E\right)E_t\Lambda_{t,t+1}\frac{dJB_{t+1}}{dN_{t+1}^E} \tag{23}$$

and

$$\frac{dJB_t}{dN_t^R}=\left(R_t^R-\psi_t^R R_L^R-R_t^d\right)Q_t^R P_t^I+\left(1-\psi_t^R\right)E_t\Lambda_{t,t+1}\frac{dJB_{t+1}}{dN_{t+1}^R} \tag{24}$$

Use (21) to eliminate $\rho_t^R E_t\Lambda_{t,t+1}\frac{dJB_{t+1}}{dN_{t+1}^R}$ from (20). This implies that:

$$\kappa_t^R R_t^d=\rho_t^R E_t\Lambda_{t,t+1}\frac{dJB_{t+1}}{dN_{t+1}^R} \tag{25}$$

Equation (25) signifies that at the optimal level the cost to search for a credit line must be equal to the expected benefit from opening it, which depends on the probability $\rho_t^R$. Similarly, use (21) to eliminate $\rho_t^E E_t \Lambda_{t,t+1} \frac{dJB_{t+1}}{dN_{t+1}}$ from (20) to get

$$\kappa_t^E R_t^d = \rho_t^E E_t \Lambda_{t,t+1} \frac{dJB_{t+1}}{dN_{t+1}} \tag{26}$$

Lead (23) a period in advance and substitute (25) and (25) a period in advance to get the line of credit creation condition for the entrepreneurs

$$\frac{\kappa_t^E R_t^d}{\rho_t^E} = E_t \Lambda_{t,t+1} \left( R_{t+1}^E - \psi_{t+1}^E R_L^E - R_{t+1}^d \right) r_{t+1} K_{t+1} + E_t \Lambda_{t,t+1} \left( 1 - \psi_{t+1}^E \right) E_t \frac{\kappa_{t+1}^E R_{t+1}^d}{\rho_{t+1}^E}$$

In the same fashion the line of credit creation condition for the hedge fund credit lines is derived:

$$\frac{\kappa_t^R R_t^d}{\rho_t^R} = E_t \Lambda_{t,t+1} \left( R_{t+1}^R - \psi_{t+1}^R R_L^R - R_{t+1}^d \right) r_{t+1} K_{t+1} + E_t \Lambda_{t,t+1} \left( 1 - \psi_{t+1}^R \right) E_t \frac{\kappa_{t+1}^R R_{t+1}^d}{\rho_{t+1}^R}$$

The profit of the bank the current period is then

$$\tilde{\Omega}_t = N_t \left( R_t^E - \psi_t^E R_L^E \right) r_t K_t + N_t^R \left( R_t^R - \psi_t^R R_L^R \right) Q_t^R P_t^I - R_t^d D_t$$

The reserves and thus the initial capital next period is

$$\Omega_{t+1} = (1 - \omega) \tilde{\Omega}_t + (1 - \delta_B) \Omega_t$$

The banks pays $\omega$ fraction of the current earnings as dividends to the owners. There is also a cost to maintain the bank capital and thus a fraction $\delta_B$ of capital/reserves is lost.

**The Bellman Equations** Given the maximization problem above, the value of a vacant credit line to the bank is

$$V_t^E = -R_t^d \kappa_t^B + \rho_t^E E_t \Lambda_{t,t+1} J_{t+1}^E + \left( 1 - \rho_t^E \right) E_t \Lambda_{t,t+1} V_{t+1}^E \tag{27}$$

where $V_t^E = 0$ for every $t$; and the value of an active credit line to the bank is

$$J_t^E = \left( R_t^E - \psi_t^E R_L^E - R_t^\Gamma \right) w_t L_t + \left( 1 - \psi_t^E \right) E_t \Lambda_{t,t+1} J_{t+1}^E \tag{28}$$

where $\psi_t^E$ is the probability the loan to be repaid which depends on the state of the economy and is explicitly determined in a following section. Upon default, (an event with probability $1-\psi_t^E$), the bank is still covered (gets $R_t^E$) but forces the borrower to liquidate the collateral, a move that affects the bank's reputation (or suffers legal costs) and results to a constant loss[6] of $R_L^E$.

The value of a vacant credit line to the bank is

$$V_t^R = -R_t^d \kappa_t^B + E_t \Lambda_{t,t+1} \rho_{t+1}^R J_{t+1}^R + \left(1 - \rho_t^R\right) E_t \Lambda_{t,t+1} V_{t+1}^R \tag{29}$$

where $V_t^R = 0$ for every $t$. The value of an active credit line with a hedge fund to the bank is

$$J_t^R = \left(R_t^R - \psi_t^R R_L^R - R_t^d\right) Q_t^R P_t^I + \left(1 - \psi_t^R\right) E_t \Lambda_{t,t+1} J_{t+1}^R \tag{30}$$

The expression $1 - \psi_t^R$ is the probability of default for the hedge fund. The probabilities of default for both projects are obviously correlated but the bank cannot account for the correlation of defaults of every pair of assets in the economy and thus does not react to that.

$$\Xi_t^E = R_t^V - R_t^E w_t L_t + \left(1 - \psi_t^E\right) E_t \Lambda_{t,t+1} \Xi_{t+1}^E + \psi_t^E E_t \Lambda_{t,t+1} \tilde{\Xi}_{t+1}^E \tag{31}$$

The value of an entrepreneur's idea seeking a credit line is

$$\tilde{\Xi}_t^E = q_t^E E_t \Lambda_{t,t+1} \Xi_{t+1}^E + \left(1 - q_t^E\right) E_t \Lambda_{t,t+1} \tilde{\Xi}_{t+1}^E \tag{32}$$

The value of a credit line to the hedge fund is

$$\Xi_t^R = Q_t^R \bar{V}_t - R_t^R Q_t^R P_t^I + \left(1 - \psi_t^R\right) E_t \Lambda_{t,t+1} \Xi_{t+1}^R + \psi_t^E E_t \Lambda_{t,t+1} \tilde{\Xi}_{t+1}^R \tag{33}$$

and the value of searching for a credit line to the hedge fund is

$$\tilde{\Xi}_t^R = q_t^R E_t \Lambda_{t,t+1} \Xi_{t+1}^R + \left(1 - q_t^R\right) E_t \Lambda_{t,t+1} \tilde{\Xi}_{t+1}^R \tag{34}$$

[6]The possibility of a bank failure is out of the scope of this study and this is why we assume the bank is always covered when it lends up to a "utility" or reputation loss. As far as the probability of default varies with time, the results are unchanged.

**Surplus Maximization** This section determines the interest rates charged for loans to Entrepreneurs and hedge funds. The bank solves the usual bargaining problem that splits the surplus from an existing credit line allocating $\zeta$ portion to the entrepreneurs and $1-\zeta$ to the banks. That is the bank solves

$$\max_{R_t^E} \left(\Xi_t^E - \tilde{\Xi}_t^E\right)^{\zeta} \left(J_t^E\right)^{1-\zeta}$$

The first order condition is

$$\zeta J_t^E = (1-\zeta)\left(\Xi_t^E - \tilde{\Xi}_t^E\right)$$

Plug in the above equations (28), (31), (32) and (27) at the equilibrium to get the gross rate to Entrepreneurs

$$R_t^E = (1-\zeta)\frac{R_t^V}{w_t L_t} + \zeta\psi_t^E R_L^E + \zeta R_t^d - \zeta\frac{q_t^E}{\rho_t^E}\frac{R_t^d\kappa_t^E}{w_t L_t} \tag{35}$$

The interest rate charged to entrepreneurs is higher the larger the expected revenue from the firm relative to its cost $\frac{R_t^V}{w_t L_t}$. Also there is a risk premium captured by the risk of default $1-\psi_t^E$ and the loss given default $R_L$. Higher yield from government bonds $R_t^G$ implies higher rate charged to entrepreneurs as $R_t^G$ is the outside option for the bank. Higher borrowing cost $R_t^\Gamma$ grants more bargaining power to the borrower that manages to negotiate a lower interest rate. Similarly higher probability a loan application by entrepreneurs to be funded $1-\rho_t^E$ gives bargaining power to the loan applicant and lowers the rate $R_t^E$. The last term depends on the market tightness for credit lines. If there are relatively more applications for credit lines than the banks are offering to entrepreneurs, there is a lower chance a credit line not to match for the bank and thus less chance for the bank to repay the cost $\kappa_t^E$ next period. Therefore, the bank charges a lower rate.

For the derivation of the interest rate charged to hedge funds use the first order condition for the Nash-bargaining problem between the bank and the hedge fund

$$\zeta J_t^R = (1-\zeta)\left(\Xi_t^R - \tilde{\Xi}_t^R\right)$$

and plug in (30), (33), (34) and (29) to get the gross rate for the hedge funds

$$R_t^R = (1-\zeta)\frac{V_t}{P_t^I} + \zeta\psi_t^R R_L^R + \zeta R_t^d - \zeta\frac{q_t^R}{\rho_t^R}\frac{R_t^d\kappa_t^R}{Q_t^R P_t^I} \tag{36}$$

Equation (36) has a similar interpretation as (35).

#### 4.3.2 Case 2: Depositors Set Loan Portfolio

In the case the loans are set by deposits, the bank still solves the same optimization problem in (16) with the same constraints, however it only optimally chooses $s_t^E$ and not the aggregate amount of credit lines. In other words, the depositors set the amount of deposits and through equation (19), the bank simply splits this amount to entrepreneurs and deposits. Therefore, for this solution the necessary condition is only

$$R_t^\Gamma \left(\kappa_t^E - \kappa_t^R\right) = \rho_t^E E_t \Lambda_{t,t+1} d\frac{JB_{t+1}}{dN_{t+1}} - \rho_t^R E_t \Lambda_{t,t+1} d\frac{JB_{t+1}}{dN_{t+1}^R}$$

along with the two envelope conditions

$$\frac{dJB_t}{dN_t} = \left(R_t^E - \psi_t^E R_L^E - R_t^\Gamma\right) r_t K_t + \left(1 - \psi_t^E\right) E_t \Lambda_{t,t+1} \frac{dJB_{t+1}}{dN_{t+1}}$$

and

$$\frac{dJB_t}{dN_t^R} = \left(R_t^R - \psi_t^R R_L^R - R_t^\Gamma\right) Q_t^R P_t^I + \left(1 - \psi_t^R\right) E_t \Lambda_{t,t+1} \frac{dJB_{t+1}}{dN_{t+1}^R}$$

Following the same procedure as the previous section, the interest rate to entrepreneurs is

$$R_t^E = (1-\zeta)\frac{R_t^V}{r_t K_t} + \zeta \psi_t^E R_L^E + \zeta R_t^\Gamma - \zeta \frac{q_t^E}{r_t K_t} E_t \Lambda_{t,t+1} \frac{dJB_{t+1}}{dN_{t+1}}$$

while the interest rate to hedge funds is

$$R_t^R = (1-\zeta)\frac{V_t}{P_t^I} + \zeta \psi_t^R R_L^R + \zeta R_t^\Gamma - \zeta \frac{q_t^R}{Q_t^R P_t^I} E_t \Lambda_{t,t+1} \frac{dJB_{t+1}}{dN_{t+1}^R}$$

### 4.4 Government and Monetary Authority

The government consumes according to the following exogenous process

$$\frac{G_t}{\bar{G}} = \left(\frac{G_{t-1}}{\bar{G}}\right)^{\rho_g} e^{\varepsilon_g}$$

where $G_t$ is the government consumption of the real good, $\varepsilon_g$ a normally distributed IId shock and $\bar{G}$ the long run value of $G_t$. The government budget constraint is

$$G_t + R^G_{t-1} B_{t-1} = T_t + B_t$$

where $T_t = T^H_t + T^E_t + T^R_t + T^C_t$ are the tax receipts from hedge funds, the entrepreneurs, the HFC and the common households respectively. The government owns the banks and final good firms and receives $\Pi^G_t$ as dividends. The amount of government bonds held by the public is

$$b^G_t = B^G_t + \Gamma_t - M^E_t - M^R_t$$

The first term is the amount of bonds that are directly purchased by the ALM department of the bank. The rest of the bonds are purchased by the loan department and they are the funds that failed to match with a project.

The central bank uses a common Taylor rule to adjust the federal funds rate $i^{ff}_t$

$$\frac{i^{ff}_t}{i^{ff}} = \left(\frac{i^{ff}_{t-1}}{i^{ff}}\right)^{\rho_m} \left[\left(\frac{P_t}{P_{t-1}}\right)^{g_\pi} \left(\frac{Y_t}{Y}\right)^{g_y}\right]^{1-\rho_m}$$

where $i^{ff}_t = R^d_t$ in equilibrium.

## 4.5 Intermediate good firms

There are $N_t$ intermediate firms producing each a differentiated product $x_{it}$ and thus the aggregate intermediate good $X_t$ is:

$$X_t = A^x_t \left[\int_{N_t} (x_{it})^{\frac{\theta_x - 1}{\theta_x}} \, di\right]^{\frac{\theta_x}{\theta_x - 1}} \tag{37}$$

The elasticity of substitution is $\theta_x$ and $A^x_t = N_t^{\xi - \frac{1}{\theta_x - 1}}$ is a variety effect[7]. The usual cost minimization problem determines the demand for each good:

$$x_{it} = (A^x_t)^{\theta_x - 1} \left(\frac{p^x_{it}}{\tilde{P}^x_t}\right)^{-\theta_x} X_t \tag{38}$$

[7]When $\xi = \frac{1}{\theta_x - 1}$ the aggregator, equation (37) takes the standard Dixit-Stiglitz form.

where $p_{it}^x$ is the price of each intermediate firm. The price of the aggregate good is

$$\tilde{P}_t^x = \frac{1}{A_t^x}\left[\int_{N_t} (p_{it}^x)^{1-\theta_x}\, di\right]^{\frac{1}{1-\theta_x}} \tag{39}$$

The firms producing the intermediate good are generated and managed by the entrepreneurs. Each firm produces using the labor effort of a single worker according to the following production function

$$x_{it} = z_t K_{it} \tag{40}$$

The cost to create a firm which can only be funded by loans is $w_t L_{it}$, the wage to the worker. There is idiosyncratic uncertainty associated with intermediate firms, captured by a random cost $\varphi_i$. The entrepreneur maximizes the expected profit

$$V_{it} = \max_{p_{it}^x}\left\{\frac{p_{it}^x}{P_t} x_{it} - R_t^E r_t K_{it} - \bar{\varphi}\right\}$$

where $\varphi_i$ is an IID random variable and $\varphi_i \sim N\left(\bar{\varphi}, S_t^2\right)$. The maximization is subject to the demand, equation (38) and the production function, equation (40). The foc is

$$P_t^x \frac{p_{it}^x}{\tilde{P}_t^x} = \frac{\theta_x}{\theta_x - 1}\frac{R_t^E r_t}{z_t}$$

Define the relative price of the aggregator as

$$P_t^x \equiv \frac{\tilde{P}_t^x}{P_t}$$

Since all firms are the same, then from (39) we get $\frac{p_{it}^x}{\tilde{P}_t^x} = N_t^{\xi}$ therefore the aggregate relative price is

$$P_t^x = \frac{\theta_x}{\theta_x - 1}\frac{R_t^E r_t}{z_t N_t^{\xi}} \tag{41}$$

Equation (41) shows that the relative price is a markup over marginal cost.

The reservation cost $\hat{\varphi}_t$ is the value of $\varphi_i$ such that the profit of the firm is zero, which is (after using 41)

$$\hat{\varphi}_t = \frac{P_t^x X_t}{\theta_x N_t} \tag{42}$$

Any draw from the distribution of $\varphi_i$ greater than $\hat{\varphi}_t$ means the firm makes a loss. The above states that the no default cost $\hat{\varphi}_t$ is higher (i.e. lower chance of default) when the price $P_t^x$ is higher, the demand $X_t$ is higher, the competition $N_t$ lower, and there is a low degree of substitutability $\theta_x$ between the goods. The probability of a default $1 - \psi_t^E$ used in (28) is thus

$$1 - \psi_t^E = \Pr\left(\varphi_i > \hat{\varphi}_t\right) = 1 - F\left(\hat{\varphi}_t\right)$$

Given the distribution of $\varphi_i$, The conditional valuation of the firm given that all period $t$ variables are observed apart from the idiosyncratic shock, is distributed[8] as $V_{it} \sim N\left(\bar{V}_t, S_t^2\right)$, where the mean $\bar{V}_t$ (after some algebra) is

$$\bar{V}_t = \frac{1 - \tau_t^E}{\theta_x} \frac{P_t^x X_t}{N_t} - \bar{\varphi}$$

The variance could be constant $S_t^2$ or countercyclical as evidence suggests (Mele 2007).

### 4.6 Final Good Firms

There are nominal rigidities in this sector ala Calvo. The Aggregate output is

$$Y_t = \left[\int_0^1 \left(y_{jt}\right)^{\frac{\theta-1}{\theta}} dj\right]^{\frac{\theta}{\theta-1}}$$

where $\theta$ is the elasticity of substitution. The demand for each firm derived from a cost minimization problem of the household is:

$$y_{jt} = \left(\frac{p_{jt}}{P_t}\right)^{-\theta} Y_t$$

where the aggregate price level is

$$P_t = \left[\int_0^1 \left(p_{jt}\right)^{1-\theta} dj\right]^{\frac{1}{1-\theta}} \tag{43}$$

[8] The reason we inserted the idiosyncratic uncertainty $\varphi_i$ as additive in the profit of the firm is to be able to secure normality for the valuation of the firms as well. Deviating from this assumption does not alter the results even though it complicates the derivations.

The production function is $y_{jt} = z_t^f X_{it}$ where $z_t^f$ is productivity and $X_{it}$ the amount of the aggregate intermediate good used by the firm. The firm faces probability $\gamma$ not to be able to adjust its price every period. The objective of the firm is

$$\max_{p_t} \sum_{k=0}^{\infty} \gamma^k E_t Q_{t,t+k} \left[ \frac{p_t}{P_{t+k}} y_{t+k}(p_t) - \frac{P_{t+k}^x}{z_t^f} y_{t+k}(p_t) \right]$$

The first order condition is

$$(\theta - 1) \Lambda_t^1 = \theta \Lambda_t^2$$

where

$$\Lambda_t^1 = \left( \frac{p_t}{P_t} \right) \sum_{k=0}^{\infty} \beta^k \gamma^k E_t \lambda_{t+k} \left[ \left( \frac{P_t}{P_{t+k}} \right)^{1-\theta} Y_{t+k} \right]$$

and

$$\Lambda_t^2 = \sum_{k=0}^{\infty} \beta^k \gamma^k E_t \lambda_{t+k} \left[ \frac{P_{t+k}^x}{z_{t+k}^f} \left( \frac{P_t}{P_{t+k}} \right)^{-\theta} Y_{t+k} \right]$$

Recursively, the two expressions become

$$\Lambda_t^1 = \left( \frac{p_t^*}{P_t} \right) \lambda_t Y_t + \beta\gamma \left( \frac{p_t^*}{P_t} \right) E_t \left( \frac{P_{t+1}}{p_{t+1}^*} \right) \left( \frac{P_t}{P_{t+1}} \right)^{1-\theta} \Lambda_{t+1}^1$$

and

$$\Lambda_t^2 = \lambda_t \frac{P_t^x}{z_t^f} Y_t + \beta\gamma E_t \left( \frac{P_t}{P_{t+1}} \right)^{-\theta} \Lambda_{t+1}^2$$

The relative price $\frac{p_t^*}{P_t}$ of the price adjusting firms is

$$1 = (1-\gamma) \left( \frac{p_t^*}{P_t} \right)^{1-\theta} + \gamma \left( \frac{P_{t-1}}{P_t} \right)^{1-\theta}$$

## 4.7 Wealth Redistribution

The following sections describe the process of redistributing assets from the entrepreneurs to the hedge funds. In this model, firms are created by entrepreneurs who eventually choose to share the risk of their project by selling shares of the firm to hedge funds. Hedge funds affect the real economy by providing diversification to the entrepreneurs, because they fend off firm idiosyncratic risk by holding a portfolio of such assets. The HFC may also redistribute wealth from each other but this does not necessarily affect the real economy unless a significant amount of agents is unable to repay their obligations. Therefore, we explicitly concentrate on the redistribution between entrepreneurs and hedge funds. The following sections determine the share of each firm that changes hands along with the underlying price.

### 4.7.1 Entrepreneur Portfolio Management

The model in this section is close to Emmons and Schmid (2002) with the introduction of uncertainty. The portfolio of stocks the entrepreneur holds is managed by a financial analyst. Before the firm produces and the idiosyncratic shock is revealed, the analyst, on behalf of entrepreneurs, decides upon $Q_t^E$, the share of the firm to keep ($Q_t^E \in [0,1]$). Given that the market price of the firm is $P_t^I$, the analyst sells $1 - Q_t^E$ share of it to the hedge funds. The individual firm valuation is normally distributed $V_{it} \sim N\left(\bar{V}_t, S_t^2\right)$. Firms are exante identical thus the $i$ subscript is dropped henceforth. The problem of the analyst is to maximize the utility of wealth as follows:

$$\max_{Q_t} \left\{U^A\left(Q_t^E V_t + \left(1 - Q_t^E\right) P_t^I\right)\right\} \tag{44}$$

We assume that the utility function $U^A(x)$ of the analyst is CARA: $-e^{-\phi x}$. This implies that given $x \sim N(\mu, \sigma^2)$ is normally distributed and $U^A(x)$ is a CARA utility function, the expected utility is $U^A(x) \simeq \mu - \frac{\phi}{2}\sigma^2$. The problem of the analyst, equation (44) becomes

$$\max_{Q_t} \left\{Q_t^E \bar{V}_t + \left(1 - Q_t^E\right) P_t^I - \frac{\phi}{2}\left(Q_t^E S_t\right)^2\right\}$$

the foc solved for $Q_t^E$ is

$$Q_t^E = \frac{\bar{V}_t - P_t^I}{\phi S_t^2} \tag{45}$$

and shows the demand for the share of the firm, given valuation, prices, uncertainty and that the entrepreneur initially owns the asset. As the shares of the firm held by the entrepreneurs and hedge funds sums to one, $Q_t^E + Q_t^R = 1$. Substitute this in the demand for the asset by entrepreneurs, equation (45) and solve for the price of the asset, that is

$$P_t^I = \bar{V}_t + \phi S_t^2 Q_t^R - \phi S_t^2 \tag{46}$$

This is the inverse demand for the hedge fund. The price of the firm is higher the higher the expected valuation $\bar{V}_t$. The price is also higher the more risky the project is (high $S_t^2$) or the more risk averse the financial analyst is (high $\phi$), because in such cases the need for diversification is greater for the entrepreneurs.

### 4.7.2 Hedge Funds

The hedge funds simply create a portfolio of selected stocks from all those available. Every period the hedge funds that have an active credit line with a bank purchase a share of the current period's earnings of a firm[9]. Entrepreneurs need to diversify, a need that is exploited by the hedge funds. This provides hedge funds with the option of getting a share of the wealth created by the entrepreneurs simply because they have access to funding. The hedge fund has access to $N_t$ assets that are traded each period. The large portfolio of assets held, gives the opportunity for the fund to fully hedge against idiosyncratic risk, which is the reason entrepreneurs sell part of their share in the first place. The hedge fund does not worry about the probability of a loss from a single transaction even though the risk of such event concerns banks because it imposes legal and reputation costs. As entrepreneurs hold initially the whole share of each firm and firms securing funding survive for a period, there are no opportunities for the hedge fund to sell assets. The hedge fund is big enough to be able to influence prices and decides upon how much of the stock to hold. The hedge fund purchases a $Q_t^R$ share of the firm at price $P_t^I$ to maximize

$$\Pi_t^R = \max_{Q_t^R} Q_t^R \left( \bar{V}_t - R_t^R P_t^I \right) \tag{47}$$

where $Q_t^R R_t^R P_t$ is the cost of borrowed funds. The price of the stock is (46), which is the constraint attached to objective (47). This implies that the higher the stake the fund seeks to obtain in the firm, the more expensive each share becomes. The foc is

$$Q_t^R = \frac{\left(1 - R_t^R\right) \bar{V}_t + R_t^R \phi S_t^2}{2 R_t^R \phi S_t^2} \tag{48}$$

[9]The hedge funds do not buy the whole firm as this would entail the need to track the whole history of transactions which makes the model intractable.

Plug equation (48) in (46) to get the price of the firm

$$P_t^I = \frac{\left(1 + R_t^R\right)\bar{V}_t - R_t^R \phi S_t^2}{2R_t^R} \tag{49}$$

In the following sections we show the effect on the economy from those transactions between the entrepreneurs and the hedge funds. For example, consider the maximum profit $\Pi_t^R$ given (48) and (49) and take the derivative with respect to $\bar{V}_t$. That is

$$\frac{d\left(Q_t^R\left(\bar{V}_t - R_t^R P_t^I\right)\right)}{d\bar{V}_t} = Q_t^R\left(1 - R_t^R\right) < 0$$

which is negative as $R_t^R > 1$. This implies that is a recession where each firm's valuation deteriorates, the profit opportunity for the hedge fund increases since the firm owners are more desperate to diversify. This closely relates to Warren Buffet's strategy of buying assets with a low price-to-book value shares. The hedge fund is better off when dealing with firms in distress which happens more often during recessions.

On the other side of the transaction, differentiating the average cash flow to entrepreneurs with respect to the expected value of the firm $\bar{V}_t$ implies:

$$\frac{d\left(\left(1 - Q_t^R\right)\bar{V}_t + Q_t^R P_t^I\right)}{d\bar{V}_t} = 1 - \frac{\left(R_t^R - 1\right)^2}{2\left(R_t^R\right)^2 \phi S_t^2}\bar{V}_t$$

splitting the second term of the right hand side as below

$$\frac{d\left(\left(1 - Q_t^R\right)\bar{V}_t + Q_t^R P_t^I\right)}{d\bar{V}_t} = 1 - \frac{R_t^R - 1}{R_t^R}\frac{\left(R_t^R - 1\right)\bar{V}_t}{2R_t^R \phi S_t^2} > 0$$

because for both terms $\frac{R_t^R - 1}{R_t^R} < 1$ and $\frac{\left(R_t^R - 1\right)\bar{V}_t}{2R_t^R \phi S_t^2} < 1$. The last term must be less than 1 because it is a sufficient condition for $Q_t^R$ to be positive according to equation (48). This implies that the cash flow from all investments to entrepreneurs is lower in a recession (as $\bar{V}_t$ decreases).

## 4.8 The Hedge Fund Clients

The HFC are the households that can make a living because of their ability to attract funds. The HFC do not contribute in the creation of the firms, but they provide a way for entrepreneurs to diversify[10]. The hedge funds and the HFC can be merged to a single entity; however breaking the decision problem to two separate ones makes the model simpler without loss of generality. The HFC household is very similar to the entrepreneur's. They consume, buy housing and search for credit lines for hedge funds to borrow and invest in assets. Defaults in investment are covered by the household even though the bank looses reputation or spends in efforts to monitor the loan or legal costs. The HFC household's problem becomes:

$$\max_{C_t, D_t^R} E_t \sum_{t=0}^{\infty} \beta_R^t \left\{ U\left(C_t^R\right) + G_H\left(H_t^R\right) \right\} \tag{50}$$

subject to the following constraints: The first is the law of motion for the lines of credit that indicate the number of firms the hedge fund can partially purchase (for 1 period) which is

$$N_{t+1}^R = \left(1 - \psi_t^R\right) N_t^R + \left(\tilde{N}_t^R - N_t^R\right) q_t^R$$

The number of lines of credit next period depends on the number of credit lines in the previous period with no default as troubles in repayment of a period's loan is the ultimate reason for the credit line to permanently break. Defaults occur with probability $\psi_t^R$. In addition, new credit line can increase the following period's amount. The household can apply at most for $\tilde{N}_t^R$ credit lines given its housing collateral. Each of the available credit line applications $(\tilde{N}_t^R - N_t^R)$ have a probability of $q_t^R$ to match.

The second is the budget constraint

$$C_t^R + P_t^h \left(H_t^R - H_{t-1}^R\right) = N_t^R \Psi_t^R \tag{51}$$

The household here consumes $C_t^R$ buys housing $H_t^R$ and gets a profit of $\Psi_t^R$ for each of the $N_t^R$ firms purchased.

The other constraint is the one that signifies the maximum amount of credit lines to apply for, that depends on the available collateral next period (housing) and also on the amount owed to the bank next period. That is

$$\tilde{N}_t^R R_t^R Q_t^R P_t^I \leq m_t^R E_t P_{t+1}^h H_t^R \tag{52}$$

[10] In reality many of such transactions do not even have a service to provide in the economy. Here we assume that all such transactions provide diversification even though lots of them are triggered by overconfidence.

Define the Lagrange multiplier for the budget constraint as $\lambda_t^R$ and for the maximum credit lines amount as $\mu_t^R$. The first order condition for housing is

$$G'_H\left(H_t^R\right) + \beta E_t \lambda_{t+1}^R P_{t+1}^h + \mu_t^R m_t^R E_t P_{t+1}^h = \lambda_t^R P_t^h \tag{53}$$

and for $\tilde{N}_t^R$ is

$$\beta E_t \lambda_{t+1}^R q_t^R \Psi_{t+1}^R = \mu_t^R R_t^R Q_t^R P_t^I \tag{54}$$

while for consumption is

$$U'\left(C_t^R\right) = \lambda_t^R \tag{55}$$

Eliminate $\mu_t^R$ by plugging (54) into (53) to get

$$G'_H\left(H_t^R\right) + \beta E_t \lambda_{t+1}^R P_{t+1}^h + \beta \frac{m_t^R q_t^R}{R_t^R Q_t^R P_t^I} E_t P_{t+1}^h \lambda_{t+1}^R \Psi_{t+1}^R = \lambda_t^R P_t^h$$

This equation has a similar interpretation as equation (9) since both households are more or less symmetric.

## 4.9 Equilibrium

**Entrepreneurs**: The net cash flow to the entrepreneurs $\Psi_t^E$ from each firm created is

$$\Psi_t^E = \frac{N_t^R}{N_t}\left[Q_t^E \bar{V}_t + \left(1 - Q_t^E\right) P_t^I\right] + \left(1 - \frac{N_t^R}{N_t}\right) \bar{V}_t$$

The first term of the above is the return from selling part of the firm to the hedge funds. As hedge funds secure $N_t^R$ credit lines, the randomly choose $N_t^R$ firms each period. Therefore, the probability a firm is partly purchased by hedge funds is $\frac{N_t^R}{N_t}$. The second term is the return from the business they fully own.

Bank capital evolves as follows: The profit of the bank the current period is

$$\tilde{\Omega}_t = N_t\left(R_t^E - \psi_t^E R_L^E\right) r_t K_t + N_t^R\left(R_t^R - \psi_t^R R_L^R\right) Q_t^R P_t^I - R_t^d D_t$$

The reserves and thus the initial capital next period is

$$\Omega_{t+1} = (1-\omega)\,\tilde{\Omega}_t + (1-\delta_B)\,\Omega_t$$

where $1-\omega$ is the percent of profits paid as dividends and $\delta_B$ the cost to maintain bank capital.

**Hedge Funds**: The value of the investment to the HFC is:

$$\Psi_t^R = Q_t^R \left(\bar{V}_t - R_t^R P_t^I\right)$$

and the number of firms the hedge funds hold a stake at is $N_t^R \leq N_t$.

**Market Clearing:** The aggregate resource constraint is

$$\begin{aligned} & C^R + C^E + C^C + G + N\bar{\varphi} + \delta_B \Omega + \left(s_t^E \kappa_t^E + s_t^R \kappa_t^R\right) \Gamma_t \\ = \ & Y - \left(1-\psi^E\right) R_L^E N_t w_t L_t - \left(1-\psi^R\right) R_L^R N_t^R Q_t^R P_t^I \end{aligned} \tag{56}$$

The amount of housing is fixed and therefore

$$H_t^E + H_t^R = \bar{H}$$

## 4.10 The Default Probabilities

If $V_{it}$ is the valuation of the $i$ project, then the breakeven point considered by hedge funds is $V_{it} = R_t^R P_t^I$. Substitute in the price, equation (49) to get

$$V_{it} = \frac{\bar{V}_t + R_t^R \bar{V}_t - R_t^R \phi S_t^2}{2} \tag{57}$$

The valuation depends on the idiosyncratic shock (see the intermediate goods section)

$$V_{it} = \frac{1}{\theta_x - 1} \frac{R_t^E r_t}{N_t^{1+\xi} z_t} X_t - \varphi_i \tag{58}$$

Using (57) and (58) we get the cut-off point, above which a default occurs for the hedge fund

$$\hat{\varphi}_t^R = \frac{1}{\theta_x - 1} \frac{R_t^E r_t}{z_t N_t^{1+\xi}} X_t - \frac{\bar{V}_t + R_t^R \bar{V}_t - R_t^R \phi S_t^2}{2} \tag{59}$$

Use equation (42) in (59) the above, to get an expression relating the two reservation values,

$$\hat{\varphi}_t^R = \hat{\varphi}_t - \frac{\left(1 + R_t^R\right)\bar{V}_t - R_t^R S_t^2 \phi}{2} \tag{60}$$

As $\psi_t^i$ where $i \in \{E, R\}$ is the probability of default

$$\psi_t^R = \Pr\left(\varphi_i > \hat{\varphi}_t^R\right)$$

and

$$\psi_t^E = \Pr\left(\varphi_i > \hat{\varphi}_t\right)$$

From equation (60), the probability of default for the hedge fund is greater for the hedge fund as $\hat{\varphi}_t^R < \hat{\varphi}_t$ which is expected because it relates both the probability of default for the firm and the hedge fund. However, in a recession where the firm valuation $\bar{V}_t$ decreases, equation (60) states that the reservation pont $\hat{\varphi}_t^R$ becomes greater relative to $\hat{\varphi}_t$. Therefore, the probability of default $\Pr\left(\varphi_i > \hat{\varphi}_t^R\right)$ for the particular asset the hedge fund invests, decreases relative to the probability of the entrepreneur to default $\Pr\left(\varphi_i > \hat{\varphi}_t\right)$. This is going to direct more funds to the hedge funds by encouraging the bank to open relatively more credit lines to the hedge funds. To summarize, in a recession, relatively more funds are going to be allocated to the hedge funds and thus away from the production of goods and services. It seems more rewarding for investors to redistribute the existing wealth than bother produce more goods and services.

# 5 Partial Equilibrium Framework

This section provides some intuition on our results by using a partial equilibrium model to examine the basic mechanism in closed form. We provide two alternative scenarios in the sections that follow. The same mechanism is at work in our benchmark model specification. It is a single period model thus we ignore the time subscripts for all variables.

Suppose there is a much simpler economy consisting of only entrepreneurs, banks and hedge funds. The Entrepreneurs are endowed with a tree that produces the good $V$ and $V$ ˜ $N\left(\bar{V}, S^2\right)$. The entrepreneurs sell part of the trees to hedge funds as in the "Hedge Funds" section above. Banks charge the same interest rates to both entrepreneurs and hedge funds and it is fixed to $R^{\Gamma}$ while the deposit rate for the bank is $R^d$.

The return to the hedge fund is

$$R^R = \frac{\bar{V}}{R^\Gamma P^I} - 1 \tag{61}$$

where $R_t^\Gamma$ is the gross interest rate charged to borrow the funds and $P^I$ the price of the firm as in the benchmark model. Using the equilibrium price, equation (49) in equation (61), the latter becomes

$$R^R = \frac{-\left(R^\Gamma - 1\right)\bar{V} + R^\Gamma \phi S^2}{\bar{V} + R^\Gamma \bar{V} - R^\Gamma \phi S^2} \tag{62}$$

The derivative of the return to the hedge fund, equation (62) is

$$\frac{dR_t^R}{d\bar{V}} = \frac{-2R^\Gamma \phi S^2}{\left[\bar{V} + R^\Gamma \bar{V} - R^\Gamma \phi S^2\right]^2} < 0 \tag{63}$$

Equation (63) declares that when the average valuation increases (decreases) the return to the hedge fund decreases (increases). Stated differently, in recessions the return of the hedge fund rises and deteriorates in expansions, thus it is more profitable to redistribute wealth in recessions than in expansions. We do not wish to make the prediction that hedge funds make more money in recessions than in expansions. In this model hedge funds only purchase firms for a period. However, our claim is that in a recession, the marginal dollar generates a higher return if it is directed at a wealth redistribution opportunity rather than a wealth creating one. Thus new investment opportunities are more profitable for hedge funds even though the hedge fund may accumulate capital losses from its existing portfolio in reality. To avoid a growing state space in the model we do not consider this possibility.

It is not only profitable for the firm to redistribute wealth in a recession but also it seems safer for the bank to favor projects that redistribute wealth. Since $V \sim N\left(\bar{V}, S^2\right)$, the probability of a default is

$$\Pr\left(V \leq 0\right) = \Pr\left(\frac{V - \bar{V}}{S} \leq -\frac{\bar{V}}{S}\right) = \Phi\left(-\frac{\bar{V}}{S}\right) \tag{64}$$

On the other hand, the probability of a hedge fund investment to default as a function of the parameters and $\bar{V}$ is

$$\Pr\left(V \leq R^\Gamma P^I\right) = \Pr\left(\frac{V - \bar{V}}{S} \leq \frac{R^\Gamma P^I - \bar{V}}{S}\right) = \Phi\left(\frac{R^\Gamma P^I - \bar{V}}{S}\right)$$

Substitute (49) in (assume all loan rates equal $R^{\Gamma}$) and the above probability becomes

$$\Phi\left(\frac{R^{\Gamma}P^{I}-\bar{V}}{S}\right)=\Phi\left(\frac{\left(R^{\Gamma}-1\right)\bar{V}-R^{\Gamma}\phi S^{2}}{2S}\right) \tag{65}$$

The above probabilities of default define the share of loaned funds flowing to entrepreneurs and hedge funds. The single period version of (22) is:

$$\rho^{E}\left(R^{R}-R^{d}-\psi^{R}R_{L}^{R}\right)w_{t}L_{t}=\rho^{R}\left(R^{R}-R^{d}-\psi^{R}R_{L}^{R}\right)Q_{t}^{R}P_{t}^{I} \tag{66}$$

This implies that the right hand side is the value to the bank of opening a credit line with entrepreneurs. It involve the probability for the credit line to match and the reward which is the return above the borrowing rate $R^{R}-R^{d}$ minus the cases that are going to default. This value must equal the value of the marginal credit line assigned to hedge funds at the optimum.

Assume that the loan amounts are equal for simplicity i.e $w_{t}L_{t}=Q_{t}^{R}P_{t}^{I}$ and plug in (66) the probabilities of default (64) and (65) to get

$$\rho^{R}\left(R^{\Gamma}-R^{G}-\Phi\left(\frac{\left(R^{\Gamma}-1\right)\bar{V}_{t}-R^{\Gamma}\phi S^{2}}{2S}\right)R^{L}\right)=\rho^{E}\left(R^{\Gamma}-R^{G}-\Phi\left(-\frac{\bar{V}}{S}\right)R^{L}\right) \tag{67}$$

Now substitute for $\rho^{R}$ and $\rho^{E}$ using equations (13) and (12) respectively and use also $s^{E}+s^{R}=1$ to get

$$V^{R}=A_{\Gamma}\left(\frac{b^{R}}{\left(1-s^{E}\right)\Gamma}\right)^{\alpha_{\Gamma}}\left(R^{\Gamma}-R^{d}-\Phi\left(\frac{\left(R^{\Gamma}-1\right)\bar{V}-R^{\Gamma}\phi S^{2}}{2S}\right)R^{L}\right) \tag{68}$$

$$= A_{\Gamma}\left(\frac{b^{E}}{s^{E}\Gamma}\right)^{\alpha_{\Gamma}}\left(R^{\Gamma}-R^{d}-\Phi\left(-\frac{\bar{V}}{S}\right)R^{L}\right)=V^{E}$$

In equilibrium the value of an additional credit line to the entrepreneur $V^{E}$ must equal the value of the additional credit line to the hedge fund $V^{R}$. Figure **??** characterizes the equilibrium credit line allocation by the banks to entrepreneurs and hedge funds. Initially, the right hand side of equation (68) is graphed as the downward sloping curve $V_{1}^{E}$ as a function of the share of funds $s^{E}$ that go to entrepreneurs. The upward sloping curve $V_{1}^{R}$ is the left hand side of equation (68). The equilibrium is where the two curves intersect, which

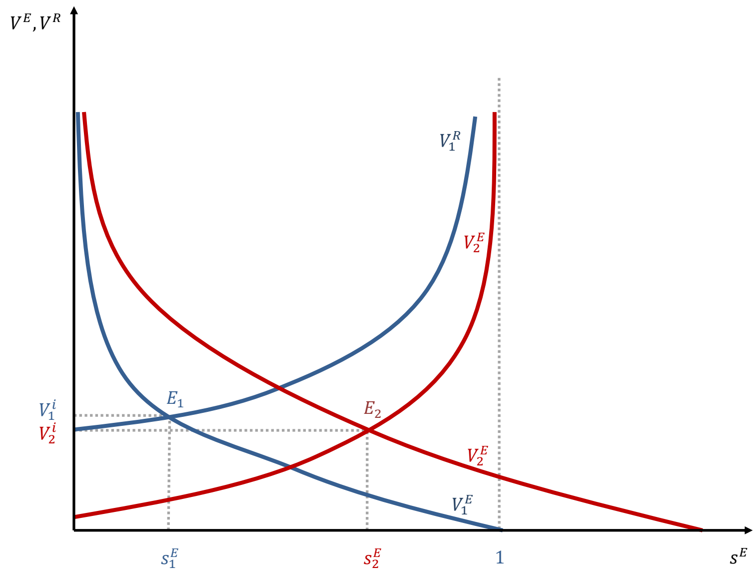


Figure 8: This represents the solution to the partial equilibrium model. The horizontal axis depicts the share of lines of credit the bank allocates to the entrepreneurs while the rest is allocated to hedge funds. The new equilibrium arises after an expansion in output, where a higher share of credit reaches the entrepreneurs at the expense of hedge funds.

is initially at $E_1$. In an expansion $\bar{V}$ increases and therefore the probability for entrepreneurs to default $\Phi\left(-\frac{\bar{V}}{S}\right)$ decreases as firms become more profitable. Thus the value of of the extra dollar loan to entrepreneurs becomes higher which shifts figure $V_1^E$ upwards to $V_2^E$ in figure **??**. On the other hand, as the need for diversification is less important to entrepreneurs (risk is unchanged), they sell their shares to hedge funds at a relatively higher price. For the bank, as redistribution becomes less rewarding, the probability of a hedge fund purchase of shares to default $\Phi\left(\frac{\left(R^{\Gamma}-1\right)\bar{V}-R^{\Gamma}\phi S^2}{2S}\right)$ increases as $R^{\Gamma} > 1$. This shifts figure $V_1^E$ downwards to $V_2^E$. The new equilibrium is at $E_1$ where more credit lines are allocated by the bank to entrepreneurs and less to hedge funds. Alternatively, in a recession more funds reach the hedge funds at the expense of entrepreneurs.

The incentives of the two competing for funds agents are opposite along the business cycle which is what the VAR model also documents. While the incentives of nearly all other investments coincide along the business cycle, capital investment and asset redistribution move in opposite directions. This observation can be exploited by policymakers to boost growth during a recession.

# 6 Simulations

We provide the impulse responses of the model after a negative productivity shock, a shock that eases borrowing conditions for hedge funds and a monetary shock. The negative productivity shock comes from a 1% decrease in the aggregate productivity $z_t^f$ of each of the final good firms which follows an AR(1) process. The borrowing conditions shock is a lowering in the cost of funding $\kappa_t^R$ that also follows an AR(1) process. The monetary shock is an unexpected 1% increase in the federal funds rate $i_t^{ff}$. For this exercise it is assumed that the constraints in (4) and (52) are not binding and thus $\mu_t^E = \mu_t^R = 0$.

## 6.1 Parameterization

We parameterize the model by using parameter values that are plausible. Table 2 presents the values for the model's parameters along with a description. We assume that the interest rate charged to entrepreneurs and the HF is $R^E = 1.1$ and $R^R = 1.12$. By definition, the probability of a firm to default is lower $(1 - \psi^E < 1 - \psi^R)$ than the probability of a hedge fund to default on an investment in the same firm. It is assumed that the loss given default for both entrepreneurs and hedge funds is the same $(R_L^E > R_L^R)$.

We set the number of firms $N$ to one in steady state and the number of those firms partially owned by entrepreneurs is $N^R = 0.4$. Usually the transactions classified as wealth redistribution can be much higher, but we ignore the redistribution of wealth from one HFC household to the other as we group all HFC households to one big household for simplicity. We impose no frictions in the redistribution of assets between the HFC.

## 6.2 Impulse Responses

In figure 9 the responses after a negative productivity shock that decreases $z^f$ are displayed where $z^f$ is considered to follow an AR(1) process. Since there are 20 subplots we are going to refer to each plot as plot($i$,$j$), corresponding to the plot on the $i^{th}$ row and $j^{th}$ column of figure 9. On the impact of the productivity shock, firm value in plot(4,4) decreases as each firm becomes less productive. A drop in firm valuation eventually reduces the cash flow to Entrepreneurs (cash flow after selling part of the firm to HF) in plot(5,2) and at the same time the cash flow to the hedge funds increases in plot (5,3), as low valuation gives the opportunity to hedge funds to step in and redistribute assets providing diversification to Entrepreneurs. This immediately increases the probability of default for entrepreneurs in plot(2,2) and decreases the probability of default for the hedge funds in plot(2,3) a situation that encourages banks to open more credit lines for the hedge funds in plot(3,1) taking away credit from Entrepreneurs in plot(2,4). Hence, the number of intermediate firms deteriorates in plot(1,4) while the number of hedge funds or the number of assets the hedge funds accumulate increases as plot(2,1) shows. Inevitably, output drops more than it would if credit did not favor the Hedge funds during the downturn.

In addition, inequality increases in the model in plot(5,4). This result is robust even if the Entrepreneurs are considered rich. This might be interesting because as inequality increases, the rich gain the opportunity to redistribute income that increases fluctuations from potential output making recessions more severe and prolonging the time for the economy to recover. Inequality is countercyclical as it surges in recessions and decreases in expansions according to the model and empirical evidence as in Coibion *et al.* (2012) and our VAR on annual US data in figure 7. As the rich are the ones that hold financial assets to a greater extend and they are the ones that can enjoy the capital gains from their purchases, they are the ones also that become relatively less affected by recessions due to their ability to capitalize on asset redistribution. This increases inequality with all its adverse effects documented by various authors such as Kumhof and Ranciere (2011).

The above responses are in line with the responses from the VAR on US data. After a recessionary shock, either productivity or monetary, both figures 4 and 5 show that in a recession the number of assets accumulated by the funds increases and also the relative profitabilty of the financial firms over goods producing firms increases. The employment also in the financial sector over the goods producing sector increases. In the model, a proxy for employment in the goods producing sector is the number of intermediate firms which equals employment (plot(1,4)). A proxy for employment in finance is the number of firms acquired, plot(2,1), which is also the number of hedge funds and the number of people working in hedge funds in the model. Clearly the movement of the two resembles the movement of the relative employment in the two sectors in the empirical VARs in figures 4 and 5.

In another exercise it is demonstrated that the standard deviatios $S$ of the idiosyncratic fixed cost of the firms $\phi$ is important for Gdp dynamics. Figure 10 depicts the effect of a change in uncertainty in the economy. The red solid responses is the effect of a 1% negative productivity shock when $S = 0.1$ which is the same exercise as figure 9. The blue dashed responses are the ones corresponding to a model with higher uncertainty, $S = 0.3$. More uncertainty makes the case for asset redistribution more prominent and there is a much larger benefit to the hedge funds than in a less uncertain environment. The favoring of the hedge funds by banks makes the starvation from credit for entrepreneurs more severe and the recession deeper.

The next VAR investigates the effect of easing the conditions for the Hedge funds to obtain credit. In the model this corresponds to a decrease in the cost to open credit lines with the Hedge funds for the bank $\kappa_t^R$ which follows an AR(1) for persistent effects. In line with the empirical exercise in figure 6 the easiness in accessing credit for the Hedge funds puts the economy in a recession that become relatively more credible and attract credit while the production sector finds credit relatively less easily and production deteriorates.

Running the model as in case 2 where the depositors set the equilibrium loanable funds in the economy and banks simply choose the allocation between Entrepreneurs and Hedge funds is not much different. In this case monetary shocks are employed. Figure 12 represents the responses in the model economy after a 1% increase in the federal funds rate. The dynamics are similar to the previous ones with a similar interpretation. An increase in the federal funds rate puts the economy in a recession with incomes deteriorating while the incomes of those that redistribute income are rising[11].

# 7 Policy Implications

In this section this study offers some insights into the ways the effect of income redistribution imposes on the volatility of the economic variables and on inequality can be tackled. As already documented in the previous sections, easing credit conditions for Entrepreneurs can decrease the deviations from potential output in the model. Suppose the Central bank imposes the following rule that determines the cost of opening credit lines to Entrepreneurs:

$$\frac{\kappa_t^E}{\bar{\kappa}^E} = \left(\frac{Y_t}{\bar{Y}}\right)^{a_m} \tag{69}$$

where $a_m > 0$. In a recession, as income $Y_t$ drops, the cost to open credit lines for the Entrepreneurs is boosted. Simulations from such a framework are reported in figure 13. The graph depicts the responses of a negative 1% productivity shock and the red responses

[11] More accurately, for the current deals, the hedge funds are profiting. They could e loosing on already existing assets though, a feature that is not captured in the mode due to tractability issues.

are the ones obtained earlier in the benchmark case. The blue solid lines correspond to the model where $\kappa_t^E$ evolves according to 69. Clearly the recession in this case is milder than in the benchmark model. A smaller share of loans is now reaching the Hedge funds and a larger portion reaches the Entrepreneurs and more intermediate firms are created and employment is boosted. Moreover the inequality problem is less severe according to the last two sub-plots[12].

There are other ways that can practically boost the recoveries in practice. Affecting $\kappa_t^E$ or $\kappa_t^R$ can represent various strategies in practice. The same effect can be triggered for example by making the LTV ratio for the entrepreneurs procyclical. This brings back a very old tool of monetary policy, the first tool ever used by central banks to influence the real economy. Before central banks discovered open market operations they used the discount window to inject liquidity in a very specific way. It handed loans to banks to fund "productive" investments, i.e. those which aimed in producing a good or service. Increasing the incentives of banks to fund projects for productive purposes can prevent inequality from distorting the flow of credit. Similar schemes have been promoted by the European Investment Bank recently[13], in order to promote access to finance (PAF), but only to a small extent. PAF can indeed prevent inequality from reallocating the funds to wealth redistribution, let the credit flow to the production of goods and services instead and consequently diminish the severity of the recession as in figure 13.

Therefore, the increasing PAF, perhaps through the discount window once again, to encourage loans for wealth creation is highly recommended. While this plan can also be relatively ineffective if there is a decrease in the incentive for entrepreneurship during recessions it can nevertheless support existing businesses and avoid further deterioration of the economic environment. In addition, it can diminish the incentive for the HFC to redistribute wealth which is an important factor that prolongs the downturns as we demonstrate in this paper.

[12] There are two inequality estimates because we classify Entrepreneurs as rich in the first case and not rich in the other. Nevertheless, the effect is the same.

[13] http://www.eib.org/infocentre/publications/all/jeremie-a-new-way-for-using-eu-structural-funds-to-promote-sme-access-to-finance-via-holding-funds.htm)

# 8 Conclusion

This paper aims at giving both an explanation and a way to confront the low response of investment after a crisis. In an economy, credit is not only used for investments that have the potential to create wealth but can also be used to redistribute the already existing wealth. Wealth redistribution is mostly a privilege of the few and the incentive to capitalize on it changes along the business cycle. We demonstrate that during a recession the incentive to redistribute wealth becomes stronger. As return per unit of risk is lower during the recession, entrepreneurs in their attempt to hedge their risk provide the opportunity for hedge funds to profit from getting a stake of their assets. Thus redistribution in a downturn becomes more profitable tor investors and also more attractive for the banks, resulting in funding these type of investments more heavily. Moreover, those that are able to profit from asset accumulation become richer which could enable them to absorb even more credit leading to a new round of asset redistribution. This leaves entrepreneurs with fewer credit options forcing them to cut firm creation and production further, deepening the recession.

Moreover, the ability of those with access to funding to profit from capital gains in a recession worsens the gap between the rich and the poor, for it is the rich that can have access to funding and can hold portfolios of assets. This provides an additional explanation to why inequality increases during downturns; an empirical observation documented in many studies and also provide an explanation to why rising inequality can be harmful. As rich become richer, the access to credit enables them to redistribute existing assets, an aspect that increases the fluctuations around the potential output. The higher the uncertainty in the economy income redistribution by the rich may deepen the recession even further. This observation gives the incentive to policy makers to intervene during recessions appropriately to boost growth and employment by discouraging asset redistribution, albeit it should encourage it during expansions.

Specifically we propose that central banks should ease access to credit for goods production and hinder it for asset redistribution in recessions doing the opposite in expansions. Practically they could manage this by using the discount window once again to offer liquidity to banks that fund productive investments, the first tool ever used by the Fed to conduct monetary policy. In addition, using macroprudential tools such as LTV ratios and promoting access to finance (PAF) in ways that the entrepreneurs can secure loans more easily, recessions can become less severe and recovery can be boosted.

This study aims to create a new strand of literature that ultimately aims in finding the optimal size of the financial sector that redistributes wealth. If asset redistribution congests productive investments, then regulating the financial sector appropriately might be rewarding in terms of growth.

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# A Appendix

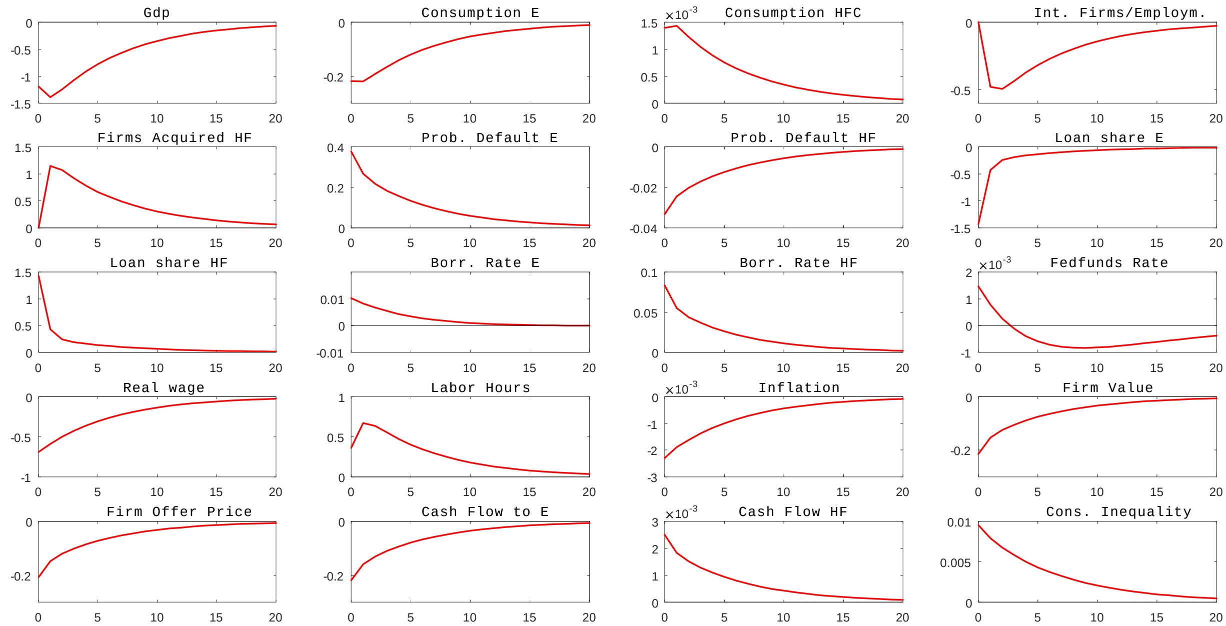


Figure 9: Those are the impulse responses of the benchmark model after a negative 1% technology shock that decreases the total factor productivity. The letter E corresponds to entrepreneurs, HFC to the hedge fund clients and HF to Hedge Funds.

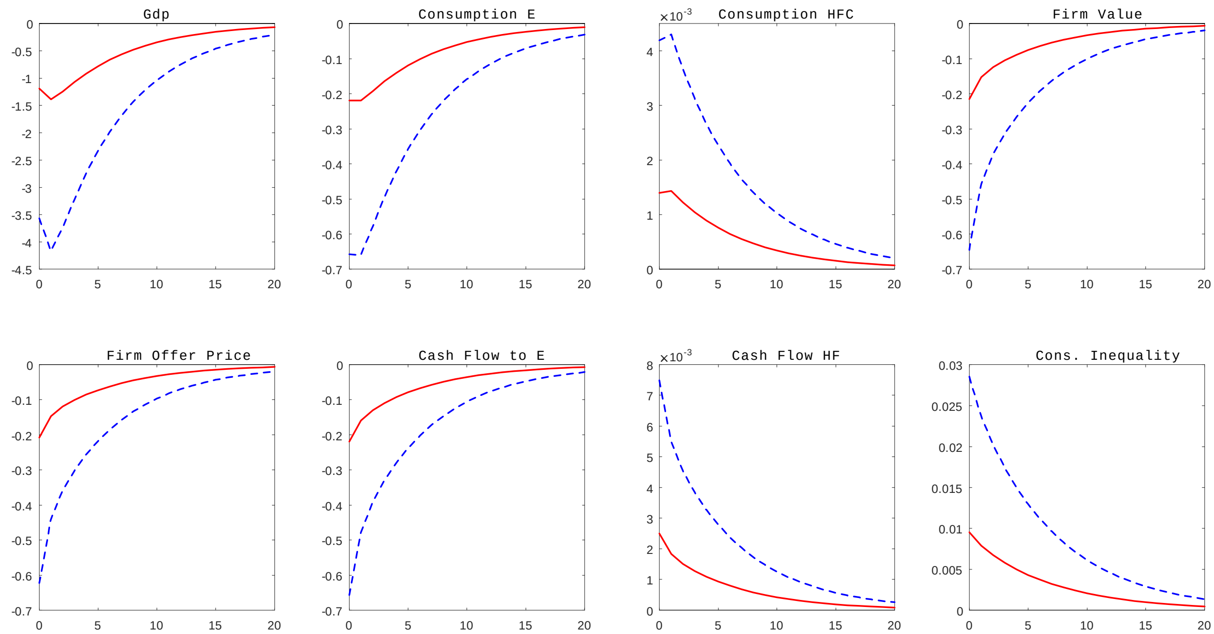


Figure 10: Those are selected responses after a 1% negative productivity shock. The red solid responses correspond to a standard deviation parameter for the idiosyncratic shock $\varphi$ equal to 0.1 and the blue dashed responses to a standard deviation of 0.3. Higher uncertainty in the economy makes the problems created by income redistribution more severe as the recession repercussions become more dire.

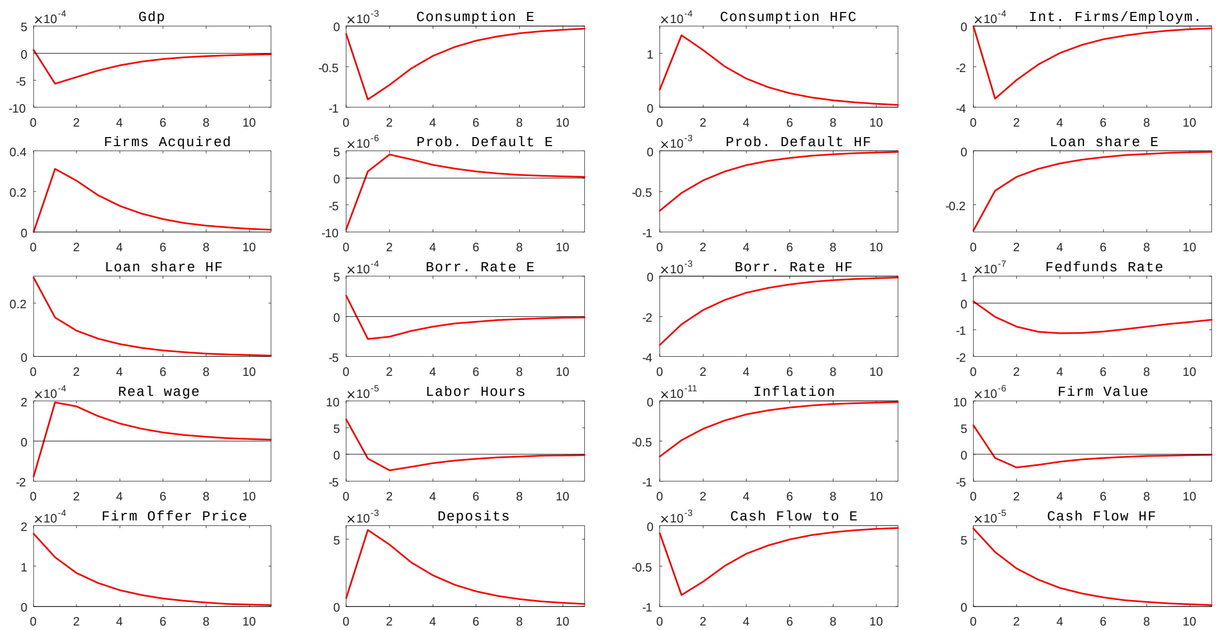


Figure 11: Those are the responses after a shock that makes the access to funding for the hedge funds easier. In the model this corresponding to a 1% decrease in $\kappa_R$. Similar to the empirical exercise, the model predicts that easing the access to credit for those that redistribute income produces a recession.

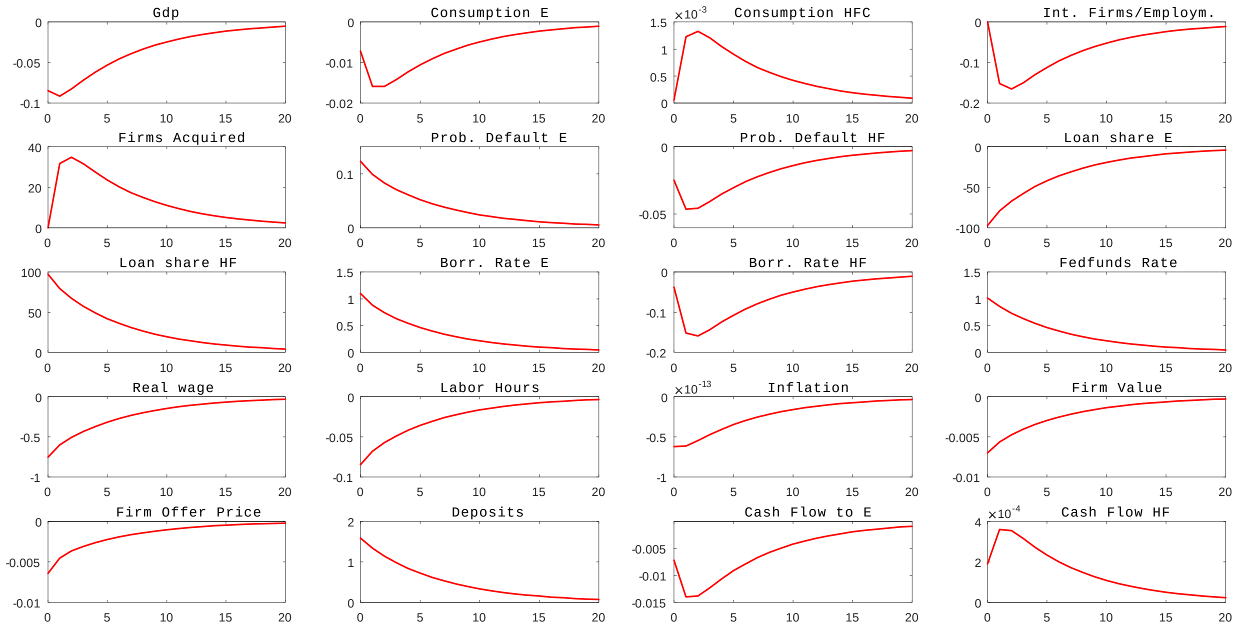


Figure 12: Those are the impulse responses of the benchmark model after a 1% shock that increases the federal funds rate. The letter E corresponds to entrepreneurs, HFC to the hedge fund clients and HF to Hedge Funds.

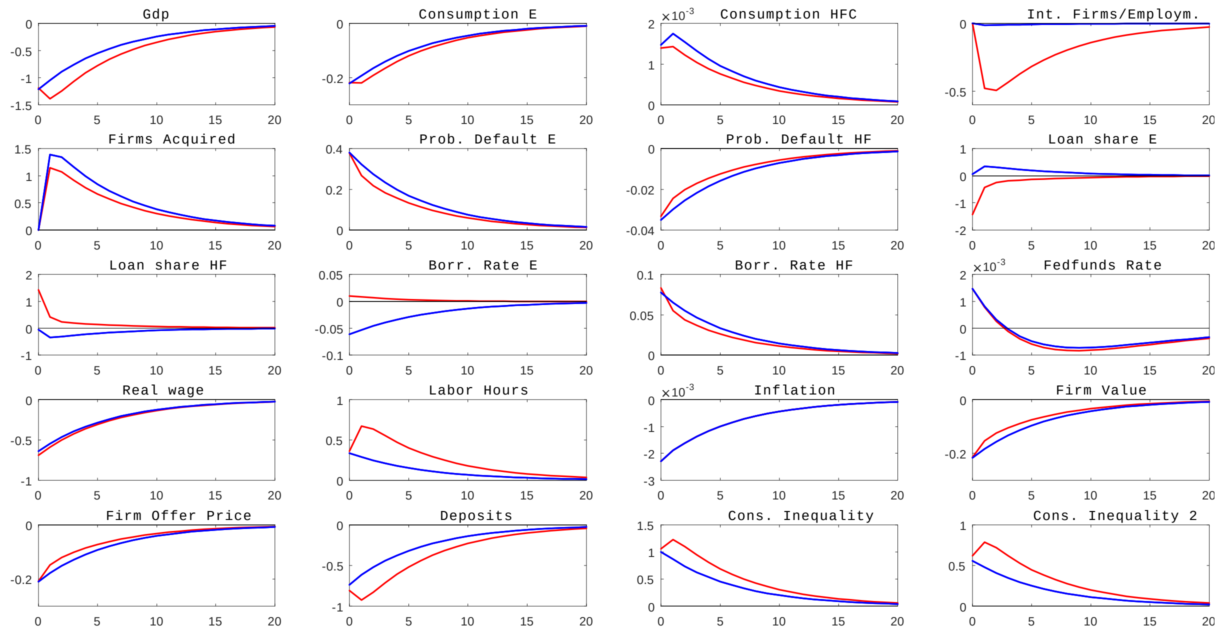


Figure 13: We present the responses after a 1% negative productivity shock. The red lines correspond to the responses of the benchmark model. The blue ones are the responses from the model with a lower relative cost of opening a credit line with Entrepreneurs instead of Hedge Funds. If funding to Entrepreneurs becomes relatively more easily accessible the recession becomes less severe and the recovery is stimulated.

| Variable | Code | Description |
|---|---|---|
| *Gdp* | GDPC1 | *Real Gross Domestic Product, Billions Chained* 2009 *Dollars, Seasonally Adjusted* |
| *Inflation* | GDPDEF_PCH | *Gross Domestic Product; Implicit Price Deflator, Change, Seasonally Adjusted* |
| *Fedfunds Rate* | FEDFUNDS | *Effective Federal Funds Rate, Percent, Quarterly, Not Seasonally Adjusted* |
| *Investment* | USAGFCFQDSMEI | *Gross Fixed Capital Formation Not Seasonally Adjusted* |
| *Loans Fin. S.* | FBLSRAQ027S | *Financial business; total loans liability, Level, Millions, Not Seasonally Adjusted* |
| *Unemployment* | UNRATE | *All Employees; Financial Activities, Thousands, Seasonally Adjusted* |
| *Empl. Goods* | USGOOD | *All Employees; Goods Producing Industries, Thousands, Seasonally Adjusted* |
| *Empl. Finace* | USFIRE | *All Employees; Financial Activities, Thousands, Seasonally Adjusted* |
| *TFP* | OPHNFB | *Nonfarm Business Sector; Real Output Per Hour Index* $2009 = 100$, *Seasonally Adjusted* |
| *Hours* | PRS85006022 | *Nonfarm Business Sector; Average Hours, Change, Annual Rate, Seasonally Adjusted* |
| *Profit Financial* | A392RC1Q027SBEA | *Corporate profits; Domestic industries; Financial, Billions, Seasonally Adjusted* |
| *Profit Non Financ.* | A464RC1Q027SBEA | *Nonfinancial corporate business; Profits bef. tax, Billions, Seasonally Adjusted* |
| *Fund Assets* | Z1/Z1/LM653164205.Q | *Mutual Fund Shares, Federal Reserve Board* |
| *HH Income Gini* | Gini Equiv HH Disp Inc | *Heathcote, Perri and Violante,* (2009) |
| *Tot. Assets Rich* | Top 1% fin. Assets | http://topincomes.g-mond.parisschoolofeconomics.eu/ |

Table 1: This is the table containing the descriptions and the sources of data for the series used in the VAR analysis. All data come from the st. Louis FRED dataset unless stated otherwise.

| *Variable* | *Value* | *Description* | *Variable* | *Value* | *Description* |
|---|---|---|---|---|---|
| $N$ | 1 | Number of firms | $\kappa^E$ | 0.05 | Cost credit line E |
| $N^R$ | 0.4 | Firms owned by HFC | $\kappa^R$ | 0.001 | Cost credit line HF |
| $1-\psi^E$ | 0.1 | Prob. default Entre. loan | $\rho_m$ | 0.85 | Interest rate inertia par. |
| $1-\psi^R$ | 0.48 | Prob default HFC loan | $\gamma$ | 0.85 | Calvo prob. |
| $R^d$ | 1.05 | Gross deposit rate | $R_L^E$ | 0.1 | Bank loss from Ent. |
| $R^E$ | 1.12 | Rate to Entrepreneurs | $R_L^R$ | 0.1 | Bank loss HF |
| $R^R$ | 1.05 | Rate to Hedge funds | $\beta^C$ | 0.98 | discount factor comm. |
| $\alpha_\Gamma$ | 0.5 | Matching function elast. | $\beta$ | 0.7 | disc factor Ent & HF |
| $A_\Gamma$ | 0.6 | Matching function const. | $\theta$ | 11 | Elast. of subst. firms |
| $\bar{\varphi}$ | 0 | firm fixed cost/revenue | $\rho^E$ | 0.6 | Prob. bank lends Ent. |
| $S_t$ | 0.1 | Standard deviation of $\varphi_i$ | $\rho^R$ | 0.75 | Prob. bank lends HF. |
| $l$ | 2 | Disutility of labor param. | $g_y$ | 0 | Taylor rule gdp resp. |
| $\theta_x$ | 11 | Elasticity of subst. int.firms | $g_\pi$ | 1.1 | Taylor rule infl. resp |
| $q^E$ | 0.6 | Prob. Entr. get loan | $\tilde{N}^E$ | 1.2 | Max credit lines E |
| $q^R$ | 0.4 | Prob. HF get loan | $\tilde{N}^R$ | 0.9 | Max credit lines R |

Table 2: The table presents the parameterization of the model