Market Power, Inequality, and Financial Instability*

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Abstract

Over the last four decades, the U.S. economy has experienced a few secular trends: declining labor share, increasing profit share, widening income and wealth inequalities, rising household sector leverage and associated financial instability, manifested in an increase in the probability of financial crises. This paper provides a unifying framework for explaining these trends based on a rise in firm market power in both product and labor markets. We develop a general equilibrium model and show that the rise in firm market power over the last few decades can generate all of these secular trends. We derive macroprudential policy implications for financial stability.

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"*The long-run changes in the relative share of wages ... are determined by long-run trends in the degree of monopoly ... The degree of monopoly has a general tendency to increase in the long run and thus to depress the relative share of wages in income ... although this tendency is much stronger in some periods than in others.*" (Kalecki (1971), p. 65)

1 Introduction

A few secular trends have emerged in the United States over the last four decades, each of which may not be consistent with the implications of neoclassical balanced growth model with stable parameters. First, the labor income share has steadily declined while, as a flip side, the profit share has steadily increased.[1] Second, income and wealth inequality have been exacerbated.[2] Third, the widening of income/wealth inequality has happened concurrently with the rise in household sector leverage.[3] Finally, rising household sector leverage has been coupled with rising financial instability manifested in an increase in the probability of financial crises, as measured by Schularick and Taylor (2012).[4]

This paper argues that all these secular trends are interconnected with each other and driven by a single macroeconomic factor: the rising market power of firms both in product and labor markets over the last four decades. To the extent that profits and labor earnings are major income sources for wealthy and working class households, respectively, the rising market power of firms in product and labor markets has a potential to explain growing income inequality and wealth inequality through increased profits and capital gains (due to increased present value of future profits). If there is a positive correlation between income level and marginal propensity to save (MPS), as shown by Dynan et al. (2004) and Jappelli and Pistaferri (2014), growing income inequality driven by rising market power can also explain why household leverage has increased concurrently with income inequality. The fact that growing indebtedness of households is associated with increasing financial instability is hardly surprising.

The main contribution of this paper is to provide a unifying framework to quantitatively investigate the role of rising firm market power in explaining the aforementioned secular trends.[5] To

[1] Appendix A provides a description of all data series used in the paper. The labor share declined from about 68 percent in the early 1980s to around 0.60 since 2010.

[2] The income share of the top 5 percent of households (ranked by income) has been steadily rising from 21 percent in the early 1980s to 34 percent on the eve of the Global Financial Crisis (GFC) in 2008. In turn, the net worth of the top 5 percent households (ranked by net worth) has increased about 160 percent between 1983 and 2016 (see Wolff (2017)).

[3] The household sector credit-to-GDP ratio was 45 percent at the beginning of the 1980s. Since then, the ratio steadily increased and reached almost 100 percent on the eve of the GFC.

[4] Schularick and Taylor (2012) define financial crises as "events during which a country's banking sector experiences bank runs, sharp increases in default rates accompanied by large losses of capital that result in public intervention, bankruptcy, or forced merger of financial institutions." The probability of financial crisis in the United States, computed using the estimates of the multi-country logit model of financial crisis by Schularick and Taylor (2012), has steadily risen from 2.1 percent in 1980 to a level close to 3.5 percent on the eve of the GFC.

[5] This paper studies the consequences of rising firm market power. It is beyond the scope of this paper to provide a theory as to why firm market power has risen over the last four decades.

that end, we build a stylized general equilibrium model with two types of agents. The first type, agents K, whose population share is calibrated at 5 percent, own monopolistically competitive firms, accumulate capital and lend money through the credit market. Agents K are assigned so-called wealth-in-the-utility preferences so that they earn direct utility from accumulating financial assets. As will be detailed below, this assumption is crucial in calibrating a MPS consistent with the micro-level estimates. The second type, agents W, whose population share is calibrated at 95 percent, work for labor earnings and do not participate in capital markets. However, agents W can issue bonds to agents K in order to smooth out their consumption. We adopt the endogenous financial crisis mechanism from Kumhof et al. (2015) so that the notion of financial instability is well defined by the probability of financial crisis in the sense of Schularick and Taylor (2012). Borrowers compare the present values of expected utility under a default scenario with those in a non-default scenario in each period. A financial crisis occurs when the gains from default surpass the costs of default.

We posit that the market power of firms steadily increases in both product and labor markets over the period 1980–2010 and study the transitional dynamics of the model economy. On the one hand, we calibrate the range of the elasticity of substitution of monopolistically competitive firms to match the rise in markup reported by Hall (2018) and De Loecker et al. (2020) over this period. On the other hand, we calibrate the range of firm bargaining power in wage setting to match the change in the natural rate of unemployment (NRU) over the 30-year period. We then ask if such institutional changes could generate the secular trends we point out, and the answer is yes. The model generates the following quantitative results, which are broadly in line with the data over the 1980–2010 period (in parenthesis):[6]

R1. Decline of labor share: 13 ppts (7 ppts)

R2. Rise of profit share: 15 ppts (13 ppts)

R3. Rise of income share of top 5% in income distribution: 16 ppts (13 ppts)

R4. Cumulative growth of wealth of top 5% in wealth distribution: 104% (160%)

R5. Rise of credit-to-GDP ratio: 31 ppts (40 ppts)

R6. Rise of the probability of financial crisis: 0.8 ppts (1.3 ppts)[7]

Our modeling approach brings together two separate strands of recent literature that analyze secular trends in the U.S. economy. On the one hand, Gutiérrez and Philippon (2017), Eggertsson et al. (2018), Farhi and Gourio (2018), Bergholt et al. (2019), Barkai (2020), and De Loecker et al. (2020) explain the decline of the labor share and the capital share, and/or the rise in the profit

[6]We also explore the implications of our model for additional non-targeted variables with clear trends in the data. We find that, through the lens of our model, the increase in markup power can also explain a large part of the increase in the Tobin's Q and the decline in the investment-to-output ratio observed in the data from 1980 to 2010.

[7]We simulate our model and apply the same empirical model used by Schularick and Taylor (2012) to our simulated data to estimate the model's probability of financial crises.

share, via increases in firm market power in product markets.[8] However, these papers do not study how changes in factor shares are linked to the rise in income inequality, household sector leverage, and financial instability. On the other hand, Iacoviello (2008) and Kumhof et al. (2015) study the link between income inequality and household sector leverage. However, both papers remain agnostic about the origin of changes in the income distribution, as income inequality is assumed to follow an exogenous process in their endowment economy models. In our model, the income distribution is endogenously determined by firm market power in both product and labor markets.

Another feature that distinguishes our paper from the existing literature is that we model the labor market via search and matching frictions, endogenizing the unemployment rate. We view this as an important factor because, if one tries to explain the entire decline of the labor share (or rise in the profit share) through an increase in market power, an important counterfactual implication arises: a considerable increase in the NRU, which is not in line with the data.[9] This is one of the main reasons to believe that the firm market power in product markets needs to be combined with firm bargaining power in labor markets to explain the secular rise of the profit share or the secular decline of labor/capital share. The former increases the NRU while the latter lowers it, such that the two offset each other, while both contribute to the rise in profits. Importantly, Levy and Temin (2007) and Stansbury and Summers (2020) provide empirical evidence of a decline in worker's bargaining power over the last few decades.[10]

There are two crucial modeling assumptions behind our results. First, the concentration of stock ownership, and second, the assumption of wealth-in-the-utility function for agents K. Starting with the first, that the stock ownership is concentrated to agents K in the model implies that capital gains emanating from greater market power accrue to only one type of agent: the top 5 percent households. Also, the concentration of stock ownership implies that the decline of the labor share due to the rise in firm market power leads directly to a rise in income inequality against the bottom 95 percent households. If the income of agents W was diversified between labor income and dividend income, such a direct link would not exist. The degree of wealth inequality in our two-agent model economy is admittedly extreme, for the sake of simplicity. However, the reality of wealth inequality in the United States is also quite stark. In particular, the top 10 percent of households own 70 percent of total wealth according to the Survey of Consumer Finance (SCF), or 77 percent according to the capitalization methods of Saez and Zucman (2016). In turn, the top 10 percent of households account for about 85 to 90 percent of stock shares, bonds, trusts, and business equity (Wolff, 2017).

[8] Gutiérrez and Philippon (2019) and Gutiérrez et al. (2019) are different from this group of literature in that they are more explicit about the cause of the rise in market failure: the failure of free entry condition due to weak enforcement of antitrust laws.

[9] Labor market monopsony is another way of creating a wedge between the real wage and labor productivity, thereby contributing to the decline of the labor share. However, this has also a counterfactual implication: as the monopsony power of the firms in the labor market is strengthened, the NRU has to rise.

[10] Without the simultaneous decline of worker's bargaining power, one could prevent the rise in the NRU in the model by introducing an increase in matching efficiency, a decline of the separation rate, and/or a rise in employment subsidy. However, the implications of these alternative hypothesis for income inequality are not straightforward. In addition, some of these alternative explanations might not be consistent with the decline in the labor share.

The assumption of wealth-in-the-utility is crucial in creating a direct link between rising income inequality and rising indebtedness, and eventually, rising financial instability.[11] The wealth-in-the utility is a form of non-homothetic preferences. If the preferences are homothetic, a permanent increase in income leads to a one-to-one increase in consumption. Such preferences cannot create a strictly positive MPS out of permanent income change. Even when income inequality were to increase to a substantial degree, there would be no unused income that would be lent out to the bottom 95 percent agents, hence no increase in financial instability. The non-homothetic preferences ensure that the MPS out of permanent income change is strictly positive, creating the necessary link between widening income/wealth inequality and increased financial instability. Note that we adopt this assumption only for the creditors of the model, not for the borrowers. From the viewpoint of the borrowers, if the preferences of the creditors were homothetic, the borrowers would have to cut their consumption rather than increase borrowing as their income share declined. It is in this sense that the preferences of the creditors are a causal driver of rising indebtedness of the borrowers in our model economy. Importantly, Mian et al. (2021) show that a substantial fraction of household debt in the United States reflects the top 10 percent of the wealth distribution lending to the bottom 90 percent, offering empirical support for our modeling assumptions.[12]

We run three validity checks against our modeling choices. First, we consider alternative preferences that generate utility not only from holding financial assets but also from holding physical capital. This alternative generates a few counterfactual consequences including overaccumulation of capital, an increase in the investment-to-output ratio and a decline of the unemployment rate in the order of 10 percentage points. Second, we consider borrowers' own incentives to increase debt. In particular we consider "keeping-up-with-the-Joneses" preferences such that the references point of external habit of agents W is the consumption level of agents K. This alternative posits that borrowers' desire to catch up with the lifestyle of wealthy households explains the rise in the household sector leverage ratio.[13] We find that if keeping-up-with-the-Joneses preferences had been the main driver of the credit expansion, the credit-to-GDP ratio would have risen 50 percentage points in 30 years, a substantially higher increase than the one observed in the baseline and also larger than in the data. However, such overshooting helps match the rise in the probability of financial crises. For this reason, we cannot preclude the possibility that the demand factor known as

[11] Our wealth-in-the utility specification is assumed to capture the fact that people accumulate wealth to achieve social status, for which there is ample empirical evidence (see, for example, Weiss and Fershtman (1998); Fiske (2010); Heffetz and Frank (2011); Cheng and Tracy (2013); Ridgeway (2014); Anderson et al. (2015); Mattan et al. (2017)). The wealth-in-the-utility assumption has also been useful in answering other economic questions, providing further support for it (see Michaillat and Saez (2021) and the references therein).

[12] A popular narrative regarding the rise in household leverage is that the savings glut lowered real interest rates, which then created incentives for low income households to increase leverage. Such a narrative is not inconsistent with our modeling approach. However, this narrative does not explain why saving glut exists to begin with, while our modeling approach can provide an answer to that question. On a related note, in our model, the saving glut of agents K and the greater indebtedness of agents W do not necessarily result in lower interest rates. While a greater credit supply lowers the interest rate on bonds, a greater indebtedness of borrowers results in higher default premium. There is no reason, a priori, to conclude that one is dominating the other.

[13] See Barba and Pivetti (2009). Such a theory dates back, at least, to Duesenberry (1949), and more recent applications can be found in Frank (1985) and Schor (1998).

keeping-up-with-the-Joneses is another reason behind the rise in household leverage and financial instability. Finally, we introduce nominal rigidities and non-zero trend inflation into the model to study whether the disinflation process observed during the 1980s and 1990s had any independent contribution to the secular trends on labor/capital/profit shares, income inequality, and financial instability.[14] We find that the additional contribution of monetary policy to the secular trends is not materially important.

We finish our analysis by deriving some macroprudential policy implications. To this end, we introduce a redistribution policy to our baseline model that consists of a dividend income tax for agents K and social security spending for agents W. This taxation is non-distortionary in our economy, as the tax rate does not interfere with production decisions. Our results show that a policy of gradually increasing the tax rate from zero to 30 percent over the last 30 years might have been effective in preventing almost 50 percent of buildup in income inequality, credit growth and the increase in the endogenous probability of financial crisis. Since the taxation leaves production efficiency intact, the secular decline in the labor share is left intact while the increase in income inequality is substantially subdued. This suggests that carefully designed redistribution policies can be quite effective *macroprudential* policy tools and more research is warranted in this area.

2 Model

There are two types of agents in the economy and each type is formed by a continuum of members. The first type, agents K, whose population share is $\chi \in (0,1)$, own the firms and accumulate physical capital. The members of the second type, agents W, work for a wage when employed and search for a job and receive unemployment benefits when unemployed. The two types interact with each other in the labor market and the credit market. The product market is monopolistically competitive, in which a continuum of firms produce a variety of consumption goods using capital and labor. The labor market is subject to search and matching frictions. Agents K play the role of employers and creditors, while agents W play the role of workers and debtors.

2.1 Technology

2.1.1 Profit Maximization

There exists a continuum of monopolistically competitive firms indexed by $i \in [0,1]$. A firm i uses a Cobb-Douglas technology to produce output $y_t(i) = zk_{t-1}(i)^{\alpha} n_t(i)^{1-\alpha}$, where z is aggregate productivity, taken as a constant throughout the analysis, and $k_{t-1}(i)$ and $n_t(i)$ are capital and labor inputs, respectively. Since the variety of consumption goods is combined by a CES aggregator with elasticity of substitution $\gamma \in (1,\infty)$, the product demand is given by $y_t(i) = p_t(i)^{-\gamma} y_t$, where $p_t(i) \equiv P_t(i)/P_t$ is the relative price of firm i, $P_t \equiv \left[\int_0^1 P_t(i)^{1-\gamma} di\right]^{1/(1-\gamma)}$ is the aggregate price

[14] This is a valid concern to the extent that the disinflation was not anticipated, and thus could tilt the wealth distribution toward the creditors.

index, and y_t is aggregate demand. We assume complete flexibility in product prices. Hence, the profit maximization problem of the firm is static:

$$\max_{p_t(i)} \left\{ p_t(i)^{1-\gamma} y_t - \mu_t(i) p_t(i)^{-\gamma} y_t \right\},$$

where $\mu_t(i)$ is the real marginal cost. The solution to the static optimization problem takes a well-known markup pricing rule:

$$p_t(i) = \frac{\gamma}{\gamma - 1} \mu_t(i). \tag{1}$$

2.1.2 Matching Technology

The matching process is governed by a CRS aggregate matching function given by $m(v_t, u_t) = \zeta v_t^{\epsilon} u_t^{1-\epsilon}$, where v_t and u_t denote aggregate vacancy posting and unemployed workers at the beginning of the period, respectively. ζ is the matching efficiency, and ϵ is the elasticity of the matching function. The job finding rate, the probability of an unemployed worker to meet a vacancy, is given by $p_t = m(v_t, u_t)/u_t = \zeta \theta_t^{\epsilon}$, where $\theta_t \equiv v_t/u_t$ is labor market tightness. The job filling rate, the probability of a vacancy to meet with an unemployed worker, is given by $q_t = m(v_t, u_t)/v_t = \zeta \theta_t^{\epsilon - 1}$. We assume exogenous separations so that in each period a fraction ρ of existing employment separates and enters unemployment. The unemployment rate at the beginning of the period is given by $u_t = 1 - \chi - (1 - \rho) n_{t-1}$.

2.1.3 Cost Minimization

A firm i posts vacancies $v_t(i)$, which cost ξ per period and vacancy, to replenish the employment stock exogeneously destroyed. The law of motion for the employment stock at firm i is given by $n_t(i) = (1 - \rho) n_{t-1}(i) + q_t v_t(i)$. Given the optimal relative price (1), the firm minimizes its production costs by choosing vacancies, employment, and capital rental. The efficiency conditions require:

$$J_t(i) = \frac{\xi}{q_t}, \tag{2}$$

$$J_t(i) = \mathbb{E}_t \sum_{s=1}^{\infty} m_{t,s}^K (1 - \rho)^{s-1} \left[\mu_s(i)(1 - \alpha) \frac{y_s(i)}{n_s(i)} - w_t(i) \right], \tag{3}$$

$$0 = \mu_t(i) \alpha \frac{y_t(i)}{k_{t-1}(i)} - r_t, \tag{4}$$

where $m_{t,t+1}^K$ is the stochastic discount factor of the owners of the firms, that is, agents K. In turn, $J_t(i)$ is the Lagrange multiplier of the cost minimization problem associated with the law of motion for employment stock, measuring the marginal value of a job for the firm. $w_t(i)$ is the wage rate, and r_t is the rental rate of capital.

Equation (2) shows that the marginal value of a job is equated with the present value of the vacancy costs expected over the duration of the vacancy, i.e., ξ/q_t. Equation (3) then shows the economic content of the marginal value of a job: the present value of the gap between the marginal productivity of labor and the real wage. In contrast with labor, firms do not face search frictions in capital markets and the efficiency condition (4) is static: the marginal cost of renting capital is equated with the marginal benefit of renting capital (i.e., the marginal productivity of capital evaluated at the real marginal cost).

2.1.4 Wage Bargaining

We assume that the equilibrium wage is determined through Nash bargaining between a firm and a matched worker: $w_t(i) = \arg\max W_t(i)^\eta J_t(i)^{1-\eta}$, where $W_t(i)$ is the worker's surplus value and η is the worker's bargaining power. The surplus value satisfies the following condition:

$$W_t(i) = \mathbb{E}_t \sum_{s=1}^{\infty} m^W_{t,s}(1-\rho)^{s-1}[w_s(i) - \underline{w}_s], \tag{5}$$

where $m^W_{t,t+1}$ is the worker's stochastic discount factor and $\underline{w}_t$ the worker's outside option given by

$$\underline{w}_t = b^U + (1-\rho)\mathbb{E}_t \left[m^W_{t,t+1} p_{t+1} \int_0^1 \frac{v_{t+1}(j)}{v_{t+1}} W_{t+1}(j) dj \right], \tag{6}$$

where b^U is unemployment insurance (UI) benefits and $p_{t+1}v_{t+1}(j)/v_{t+1}$ is the job finding probability at firm j at time $t+1$.

The Nash bargaining solution takes the well-known form of a rent sharing condition: $\eta J_t(i) = (1-\eta)W_t(i)$. It is straightforward to show that by combining the rent sharing condition with equations (2), (3), (5) and (6), we can derive the equilibrium wage as[15]

$$\begin{aligned} w_t(i) = {} & \eta\mu_t(i)(1-\alpha)\frac{y_t(i)}{n_t(i)} + (1-\eta)b^U \\ & + \eta(1-\rho)\mathbb{E}_t \left[\left(m^K_{t,t+1} - (1-\eta) m^W_{t,t+1}(1-p_{t+1}) \right) \frac{\xi}{q_{t+1}} \right]. \end{aligned} \tag{7}$$

2.2 Preferences

2.2.1 Agents W

The preferences of agents W are specified as a standard form of consumption utility:

$$U^W_t = \mathbb{E}_t \sum_{t=0}^{\infty} (\beta^W)^t \left\{ \frac{(c^W_t)^{1-1/\sigma_c}}{1-1/\sigma_c} \right\}, \tag{8}$$

where $c^W_t = \left[\int_0^1 c^W_t(i)^{1-1/\gamma} di \right]^{1/(1-1/\gamma)}$ is per-capita consumption of agents W, $\beta^W \in (0,1)$ is the time discount factor, and $\sigma_c \in (0,\infty)$ is the intertemporal elasticity of substitution.

[15] Note that equation (2) implies $J_t(i) = J_t$ for all firms, which, together with the rent sharing condition, implies $W_t(i) = W_t$ for all workers. Equation (5) then implies $w_t(i) = w_t$ for all workers. Substituting $w_t(i) = w_t$ and $\mu_t(i) = (r_t/\alpha)(k_{t-1}(i)/y_t(i))$ in equation (3) shows that $k_{t-1}(i)/n_t(i) = k_{t-1}/n_t$, which then implies $\mu_t(i) = \mu_t$ for all firms.

Agents W work for wage incomes when employed and search for new jobs and collect UI benefits when unemployed. Agents W do not accumulate physical capital or shares of firms. However, they can issue defaultable private bonds (b_t per capita) for consumption smoothing. The market price of the discount bond is denoted by q_t^B. If borrowers do not default, the bond delivers one unit of consumption good to lenders in the next period. If borrowers default, lenders recover only $1-h$, where h is the haircut associated with the default. Thus, the actual payment can be expressed as:

$$l_t = (1 - h\delta_t^B)b_{t-1},$$

where $\delta_t^B \in \{0, 1\}$ is a default indicator that takes 1 upon default and 0 otherwise.

While defaulting releases the budget constraint of agents W by hb_{t-1}, it also involves pecuniary and non-pecuniary costs, the latter taking the form of a direct utility cost, something that can be considered as "default stigma."We explain the former here and the latter when discussing the default decision in Section 2.3. The size of the pecuniary default cost is assumed to be a fraction ν_t of aggregate output, which follows:

$$\nu_t = \rho_\nu \nu_{t-1} + \gamma_\nu \delta_t^B. \tag{9}$$

Since the pecuniary cost of default comes down to zero only gradually, it generates a sequence of negative income flows. Hence, while defaulting immediately releases the budget constraint for agents W, it generates a sequence of default-related payments as well. The pecuniary cost of default is assumed to reduce aggregate income:

$$y_t = zk_{t-1}^\alpha n_t^{1-\alpha} - \nu_t y_t.$$

Finally, we assume that there are two types of transfer payments to agents W: UI benefits $(1 - \chi - n_t)b^U/(1 - \chi)$ and lump-sum tax T_t, which funds UI benefits. The budget constraint of agents W can then be expressed as

$$c_t^W = q_t^B b_t - l_t + \frac{1}{1-\chi}\left[\int_0^1 w_t(i)n_t(i)di - \nu_t y_t\right].$$

Note that UI benefits are canceled out by the lump-sum transfer. However, this does not imply that UI benefits do not play any role in our model. UI benefits are an important determinant of the bargained wage as shown by equation (7).

The efficiency condition for bond issuance is given by

$$q_t^B = \mathbb{E}_t\left[m_{t,t+1}^W(1 - hp_{t+1}^\delta)\right], \tag{10}$$

where $m_{t,t+1}^W = \beta^W(c_{t+1}^W/c_t^W)^{-1/\sigma_c}$ and $p_{t+1}^\delta \equiv \text{prob}(\delta_{t+1}^B = 1)$. Equation (10) plays the role of credit demand in the private bond market. To show how the bond market clears, we need to describe how credit supply is determined by type-K agents' bond investment decision.

2.2.2 Agents K

The preferences of agents K are specified as

$$U_t^K = \mathbb{E}_t \sum_{t=0}^{\infty} (\beta^K)^t \left\{ \frac{(c_t^K)^{1-1/\sigma_c}}{1-1/\sigma_c} + \psi^B \frac{[1+b_t(1-\chi)/\chi]^{1-1/\sigma_b}}{1-1/\sigma_b} \right\}, \tag{11}$$

where $c_t^K = \left[\int_0^1 c_t^K(i)^{1-1/\gamma} di\right]^{1/(1-1/\gamma)}$ is per-capita consumption of agents K, $\beta^K \in (0,1)$ is the time discount factor, and $b_t(1-\chi)/\chi$ is per-capita holdings of private bonds by agents K.

The budget constraint of agents K is given by

$$c_t^K = (l_t - q_t^B b_t)\frac{1-\chi}{\chi} + \frac{1}{\chi}\left\{r_t k_{t-1} + \Pi_t - q_t^K \left[k_t - (1-\delta)k_{t-1}\right]\right\}, \tag{12}$$

where $r_t k_{t-1}$ is aggregate rental income, Π_t is aggregate dividend income, and $q_t^K \left[k_t - (1-\delta)k_{t-1}\right]$ is new investment in physical capital, with q_t^K denoting the price of capital and δ the capital depreciation rate.[16]

The departure from the standard consumption utility model is that $\psi^B > 0$ and agents K earn utility not only from consuming goods but also from holding financial bonds in (11). Financial wealth in this class of models represents absolute social status, and economic agents earn direct utility from increases in their social status (Bakshi and Chen, 1996) represented by financial wealth. The specific functional form is taken from Kumhof et al. (2015). Similar specifications are recently used by Ono (2015) and Michau (2018) to study secular stagnation.[17]

The efficiency conditions of maximizing (11) subject to (12) are given by

$$q_t^B = \mathbb{E}_t \left[m_{t,t+1}^K (1 - hp_{t+1}^\delta)\right] + \frac{\psi^B}{(c_t^K)^{-1/\sigma_c}} \left[1 + b_t\left(\frac{1-\chi}{\chi}\right)\right]^{-1/\sigma_b} \tag{13}$$

and

$$1 = \mathbb{E}_t \left[m_{t,t+1}^K \left(\frac{r_{t+1} + (1-\delta)q_{t+1}^K}{q_t^K}\right)\right]. \tag{14}$$

Equation (13) plays the role of credit supply. The credit market equilibrium $\{b_t, q_t^B\}$ is determined by the intersection of equations (10) and (13). In this equilibrium, the second term on the right side of equation (13), the marginal utility of bond holding, creates a liquidity premium for bond holders, who are willing to accept a higher market value of debt (a lower interest rate). Equation (14) is a standard Lucas-tree equation.

To see the importance of non-homothetic preferences such as (11) for the nexus between income

[16] To endogenize the price of capital, we assume the presence of a representative firm that transforms consumption goods into investment goods using a CRS technology. Since the structure of this industry is well known in the literature, we omit the description for brevity.

[17] We assume that these agents, however, do not earn direct utility either from capital accumulation or from shares of production firms. This is because we want to assign a certain "moneyness" feature to private and public bonds, and in this interpretation, equation (11) can be viewed as an application of a money-in-utility specification. However, in Section 4.1, we show the effects of introducing physical capital into the utility function of agents K.

inequality and excess supply of credit (and its resulting implication for financial instability), consider the homothetic preferences, i.e., $\psi^B = 0$. With this type of preferences, the goal of the agent is to make the marginal utilities of consumption similar across different time periods. In response to a temporary increase in income, the agent has to spread out the increased income over consumption expenditures across different time periods, implying that the saving must be positive today. However, in response to a permanent increase in income, the only way to achieve the same goal is to increase consumption expenditures by an equal amount across all different periods, implying that the MPS out of permanent income change is zero. This is why such homothetic preferences cannot create a direct link between income inequality and excess credit supply. However, with the non-homothetic preferences such as (11) in which agents earn direct utility out of the act of saving, the MPS can be made positive even in response to a permanent change in income distribution.

2.3 Default Decision and Financial Instability

We define financial instability as the likelihood of an event in which a significant portion of debt obligations is reneged at least partially. In our model, the likelihood is measured by $p_t^\delta \equiv \text{prob}(\delta_t^B = 1)$. We borrow the endogenous default decision from the endowment economy of Kumhof et al. (2015) and adapt it into our production economy. In our framework, the default probability is a function of all state variables. For a given set of macroeconomic fundamentals, borrowers' default decision depends on the random draw of the utility cost of default denoted by ϵ_t^δ. In particular, ϵ_t^δ is i.i.d and follows a modified logistic distribution with cdf $\Xi(\cdot)$:

$$\Xi(\epsilon_t^\delta) = \left\{ \begin{array}{ll} \dfrac{\varrho}{1+\exp(-\varsigma\epsilon_t^\delta)} & \text{if } \epsilon_t^\delta < \infty \\ 1 & \text{if } \epsilon_t^\delta = \infty \end{array} \right\},$$

where $0 < \varrho < 1$. The parameters ϱ and ς, together with γ_ν and ρ_ν from equation (9), are calibrated to match the empirical evidence on financial crises.

We define the values of default U_t^D and non-default U_t^N as

$$U_t^D((1-h)b_{t-1}, \nu_{t-1}) = \frac{(c_t^D)^{1-1/\sigma_c}}{1-1/\sigma_c} + \beta^W \mathbb{E}_t[U_{t+1}^W(l_{t+1}, \rho_\nu \nu_{t-1} + \gamma_\nu)],$$

and

$$U_t^N(b_{t-1}, \nu_{t-1}) = \frac{(c_t^N)^{1-1/\sigma_c}}{1-1/\sigma_c} + \beta^W \mathbb{E}_t[U_{t+1}^W(l_{t+1}, \rho_\nu \nu_{t-1})],$$

where U_{t+1}^W corresponds to equation (8). $c_t^D \equiv c_t^W(\delta_t^B = 1)$ and $c_t^N \equiv c_t^W(\delta_t^B = 0)$ are consumption values conditional on default and non-default decisions, respectively. Note that a default decision today creates a persistent difference in the flow of future utility due to the assumption $0 < \rho_\nu < 1$. The probability of default is then given by

$$p_t^\delta \equiv \text{prob}(\delta_t^B = 1) = \Xi(U_t^D((1-h)b_{t-1}, \nu_{t-1}) - U_t^N(b_{t-1}, \nu_{t-1})). \tag{15}$$

Note that individuals take macroeconomic variables as given while making their individual default decision. The bond market is characterized as a competitive equilibrium with a continuum of agents and "the actions of a single individual are negligible" (Aumann, 1975). In our symmetric default or non-default equilibrium, each individual makes an identical choice, believing that her actions will not affect macroeconomic outcomes. However, with everyone making the same choice, default decisions impact the economy in equilibrium. It is for the same reason that neither the borrower's nor the lender's efficiency condition (equations (10) and (13), respectively) incorporate the effect of increasing debt on the probability of default or on bond prices. In other words, both agents behave as if $\partial p_{t+1}^{\delta}/\partial b_t = \partial q_t^B/\partial b_t = 0$ because they view their individual actions as inconsequential for the competitive equilibrium in the debt market.[18]

3 Results

The main results of the paper are presented in this section. We first calibrate the model economy to be consistent with relevant macroeconomic moments of the U.S. economy in 1980. We then keep all parameters fixed at this 1980 initial steady state and implement exogenous increases in firm market power both in product and labor markets. We do so via changes in the elasticity of substitution between goods and via changes in the worker's bargaining power, respectively. The main finding of the paper is to show that the increase in market power can go a long way in explaining secular trends on labor/capital/profit shares, income inequality, and financial instability by performing an analysis of transitional dynamics. Finally, we analyze the marginal contributions of changes in market power in the product market vs. changes in market power in the labor market in explaining the secular trends.

3.1 Calibration

The model is calibrated at a quarterly frequency to match relevant macroeconomic moments of the U.S. economy in 1980 (i.e., our initial steady state). Table 1 summarizes the parameter values.

Preferences and default: The calibration strategy for default-related parameters follows closely the one in Kumhof et al. (2015). In particular, we use the same default haircut ($h = 0.1$) and the persistence of the default cost ($\rho_\nu = 0.65^{0.25}$). The output loss upon default is set to $\gamma_\nu = 0.028$, which implies a 3.5 percent loss in aggregate output on impact and a cumulative output loss of around 11 percent of annual output. Regarding the parameters of the modified logistic distribution of the utility cost of default, we calibrate $\varrho = 0.0086$ and set ς =18 to match an annual default probability of 2.1 percent, consistent with its empirical counterpart in 1980 computed by Schularick and Taylor (2012). We set the wealth elasticity σ_b= 1.09 as in Kumhof et al. (2015) and set $\psi^B = 0.29$ to generate a MPS out of permanent income of 0.43 for agents K, which is very close to the empirical estimate of MPS of the top 5 percent income earners computed

[18]This differs from models of sovereign debt default, where a country is a monopolistic provider of sovereign bonds and internalizes the effects of issued quantities on the price of bonds when optimizing bond issuance.

Table 1: Parameters Values

Parameter	Value
Population share of agents K	$\chi = 0.05$
Haircut	$h = 0.1$
Persistence of default cost	$\rho_\nu = 0.65^{0.25}$
Size default cost	$\gamma_\nu = 0.028$
Default cost parameter	$\varrho = 0.0086$
Default cost parameter	$\varsigma = 18$
Wealth elasticity private bond	$\sigma_b = 1.09$
Utility weight on private bond	$\psi^B = 0.29$
Discount factor of agents W	$\beta^W = 0.99$
Discount factor of agents K	$\beta^K = 0.88$
Elasticity of intertemporal substitution	$\sigma_c = 1$
Capital share of production	$\alpha = 0.16$
Investment adjustment cost	$\kappa = 0.5$
Depreciation rate of capital	$\delta = 0.05$
Elasticity of substitution between goods	$\gamma = 7.5$
Aggregate productivity	$z = 1$
Matching efficiency	$\zeta = 0.948$
Separation rate	$\rho = 0.21$
Matching function elasticity	$\epsilon = 0.5$
Worker's bargaining power	$\eta = 0.75$
Unemployment insurance benefits	$b^U = 0.47$ ($b^U/w = 0.71$)
Vacancy posting cost	$\xi = 0.11$

by Kumhof et al. (2015) using data from the SCF.[19] Figure 12 in the Appendix shows that our baseline simulation results are robust to alternative calibrations of the parameters ψ^B and σ_b that imply the same MPS of top income earners as in the baseline. In other words, what matters for our results is the resulting MPS of top income earners, that might result from different combinations of the parameters ψ^B and σ_b. We set the discount factor of agents W to a standard value in the literature ($\beta^W = 0.99$) and the discount factor of agents K to match a private credit-to-GDP ratio of 0.45 in the initial steady state ($\beta^K = 0.88$), consistent with its empirical counterpart in 1980.[20] Finally, we specify a log utility ($\sigma_c = 1$).

Production: The capital share of production equals $\alpha = 0.16$ to match a labor income share of 0.69 in the initial steady state. We set the investment adjustment cost coefficient κ and the capital

[19] Since the empirical estimates of MPS are available only in annual frequency, we recalibrate the model in annual frequency to compute the MPS. We also simplify the model such that the income of agents K follows a random walk and the only vehicle for saving is the private bond (to simplify the portfolio optimization problem since the focus is about how much of the permanent income change leads to total saving). Following Kumhof et al. (2015), we solve for a linearized difference equation for debt using the budget constraint of agents K and the first order condition for bond investment of agents K in partial equilibrium, with no changes to market prices, consistent with the empirical micro-level estimates. We compute the MPS using 6-year cumulative changes in bond holdings due to a marginal increase in permanent income, to be consistent with the empirical estimates of Dynan et al. (2004) and Kumhof et al. (2015). Our baseline calibration of $\psi^B = 0.29$ yields a MPS = 0.43. Figure 4 studies two alternatives values of ψ^B, which are consistent with alternative MPS estimates for top income earners provided by Dynan et al. (2004).

[20] $\beta^K < \beta^W$ may seem contradictory to the fact that agents K are the creditors from the perspective of a modeling technique that assigns 'patience' to creditors and 'impatience' to debtors. However, in our framework, it is not the patience that generates the desire to save, but the wealth-in-the utility preferences. A mechanical comparison of equations (10) and (13), the FOCs for bond issuance of agents W and bond investment of agents K, respectively, reveals that $\beta^K < \beta^W$ must be the case.

depreciation rate δ to standard values in the literature ($\kappa = 0.5$ and $\delta = 0.05$). The elasticity of substitution between goods is set to $\gamma = 7.5$ in the initial steady state, consistent with a 15 percent markup (Hall, 2018). Since the focus of this paper is to match secular trends in the data, we omit analysis of business cycle fluctuations and thus keep aggregate productivity fixed at $z = 1$.

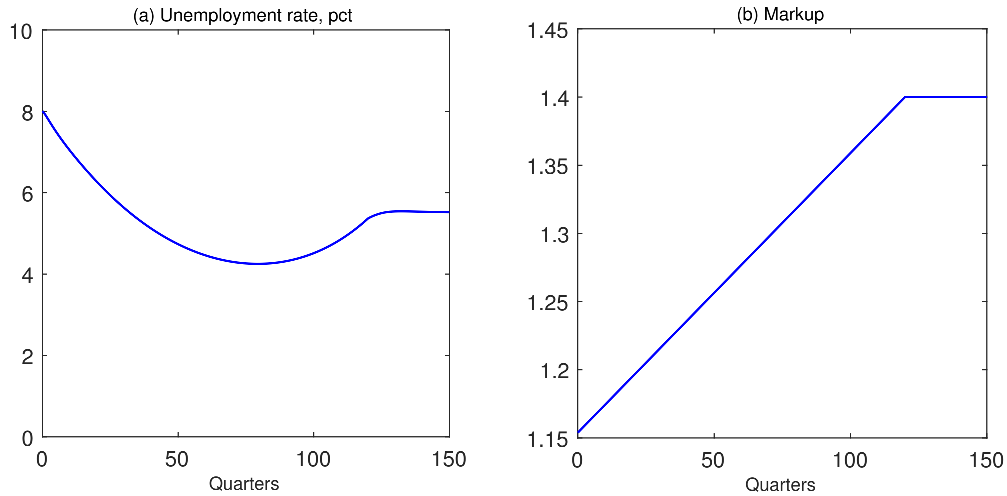
Labor markets: The efficiency of the matching function is set to $\zeta = 0.948$ to hit a quarterly job finding rate of 70 percent in the initial steady state as in the Current Population Survey (CPS). The exogenous gross separation rate is calibrated to $\rho = 0.21$ so that the quarterly net separation rate equals 6.2 percent as in the CPS. We follow the evidence reported in Petrongolo and Pissarides (2001) to calibrate the elasticity of the Cobb-Douglas matching function to $\epsilon = 0.5$. We set the worker's bargaining power to $\eta = 0.75$ in the initial steady state, resulting in an initial steady state unemployment rate of 8 percent. UI benefits equal $b^U = 0.47$, which represent 71 percent of the equilibrium wage in the initial steady state. The literature considers this a plausible value (Hall and Milgrom, 2008). Finally, we set the vacancy posting cost equal to $\xi = 0.11$, about 11 percent of labor productivity, essentially the same as in Hagedorn and Manovskii (2008) and very similar to other values used in the literature.

Secular trends in market power: We implement the rise of firm market power in product markets via decreases in the elasticity of substitution between goods, γ, and the rise of firm market power in labor markets via decreases in worker's bargaining power, η. In particular, we assume that both γ and η follow random walk processes: $\gamma_t = \gamma_{t-1} + \epsilon_t^\gamma$, and $\eta_t = \eta_{t-1} + \epsilon_t^\eta$. We then jointly calibrate $\{\epsilon_t^\gamma, \epsilon_t^\eta\}_{t=1}^{T=120}$ such that the markup rises from 15 percent to 40 percent and the unemployment rate falls from 8 percent to 5.5 percent over a 30-year period.[21] The calibrated change in markup over the 30-year period corresponds to the same range estimated by Hall (2018) and is somewhat lower than the rise estimated by De Loecker et al. (2020). The change in the unemployment rate is consistent with the downward trend in the unemployment rate that is observed in the data since the late 1970s. There is large uncertainty surrounding estimates of the NRU. However, the magnitude of decline is similar to other analysis. For instance, the Congressional Budget Office estimates that the NRU has fallen about 2 percentage points since 1980s. Our assumption is moderate in that the linear time trend from 1976 (to avoid the high unemployment rates during early 1980s) to 2007 would imply a decline of the unemployment rate from 8 percent to 4.7 percent over this time period.

Figure 1 shows that the markup and the unemployment rate reach their final steady state after 120 quarters and remain constant at those levels afterward. Importantly, agents do not have perfect foresight over $\{\epsilon_t^\gamma, \epsilon_t^\eta\}_{t=1}^{T=120}$ at the beginning of the simulation, which means that they are surprised every period by the innovations, ϵ_t^γ and ϵ_t^η. An alternative assumption regarding the information structure is to assume that the entire paths of $\{\epsilon_t^\gamma, \epsilon_t^\eta\}_{t=1}^{T=120}$ are known to the agents at the beginning of the simulation. However, we do not adopt this assumption because it seems unrealistic to believe that, at the beginning of the 1980s, agents were able to perfectly foresee the

[21] This requires the elasticity of substitution to fall from 7.5 to 3.5 and worker's bargaining power to fall from 0.75 to 0.384.

Figure 1: Calibration Targets



structural changes in market power that the economy would undergo over the following 30 years.

Note that the path of the unemployment rate shown in Figure 1 is U-shaped as the unemployment rate slightly undershoots the terminal level of 5.5 percent. This path is because the decline of worker's bargaining power initially dominates the rise in product market power in its effects on the unemployment rate. The former improves the job creation condition for firms. The latter works in the opposite direction: As firms increase markups, product and labor demands are reduced.

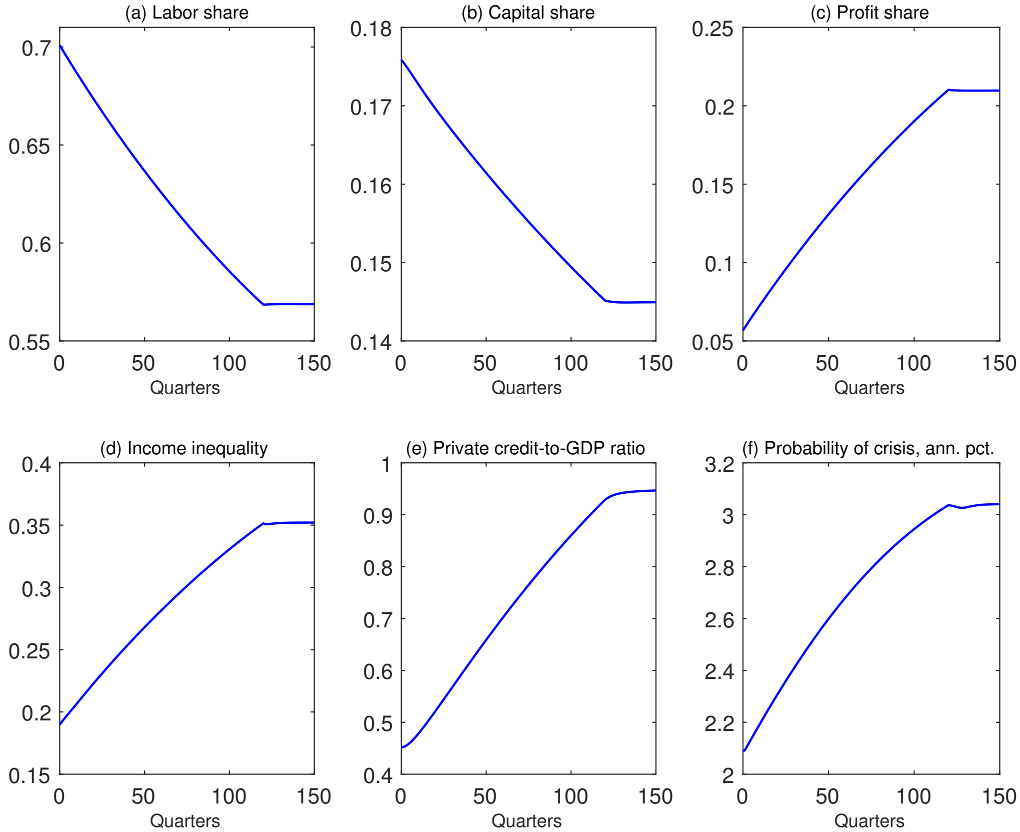
3.2 Main Results

Figure 2 shows the macroeconomic implications of rising firm market power in both product and labor markets in our model. In particular, we plot the dynamic transition paths of factor shares and profit shares in the top panels and the corresponding paths for income inequality (measured by the top 5 percent income share), private credit-to-GDP ratio, and default probability in the bottom panels.

A rise in firm market power in both product and labor markets generates a fall in the labor share of about 13 percentage points. Capital share, given by $(r_t + \delta)k_{t-1}/y_t$, also declines but by much less. The declines of labor and capital shares are a direct consequence of the decline of real marginal cost, which itself is due to the rising market power. Since the production efficiency requires $\alpha\mu_t = r_t k_{t-1}/y_t$, the capital share has to decline. In turn, the labor share has to decline more than the real marginal cost because of the firms' rising bargaining power in the labor market, which increases the value of a filled job, something not feasible without the real wage declining much faster than the real marginal cost given equation (3). The decline of both capital and labor shares can only mean that the profit share must rise as shown in panel (c).

In our environment, profits and capital incomes are earned by agents K. Given that the increase in the profit share is larger than the decline of the capital share, the income share of agents K secularly rises as a consequence of firms' greater market power, as shown in panel (d). In our calibrated model and consistent with the data, agents K exhibit relatively high MPS out of

Figure 2: The Rise of Market Power: Macroeconomic Implications



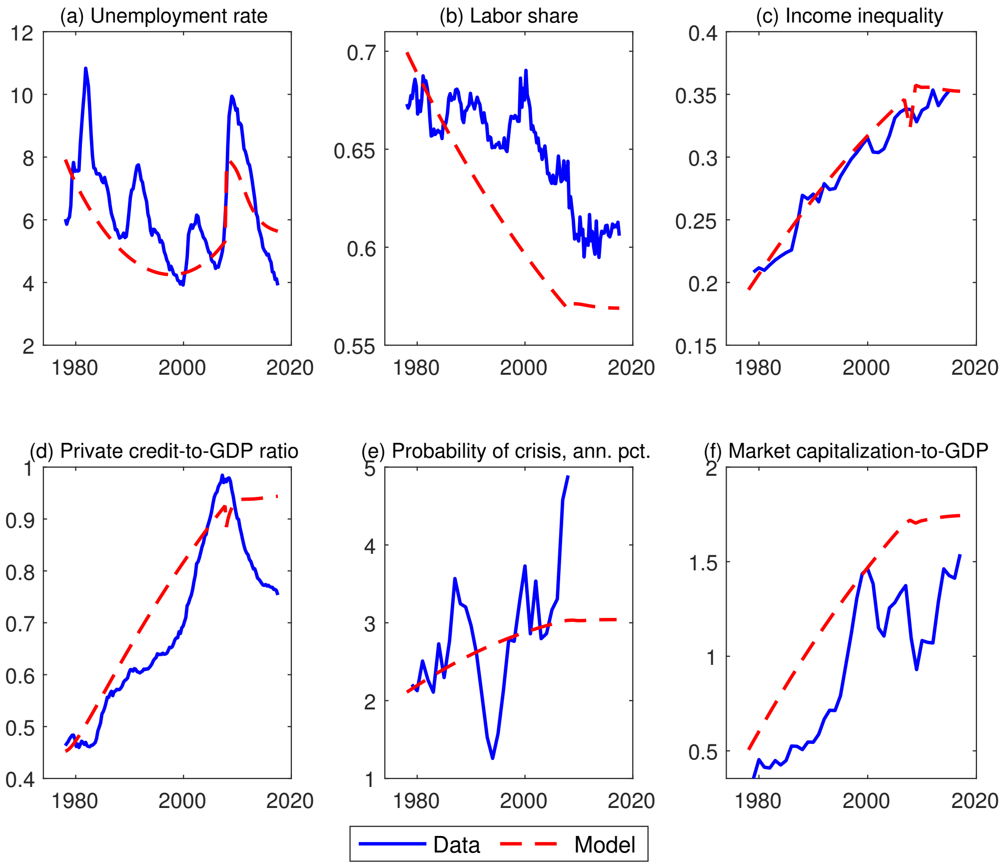
permanent income due to the wealth-in-the-utility preferences. This feature is crucial to induce agents K to accumulate financial wealth. As shown in panel (e), a substantial part of increased income of agents K is invested in private bonds, and the credit-to-GDP ratio rises secularly. As the indebtedness of the economy grows, the probability of financial crisis also rises by about 1 percentage point (see panel (f)).[22]

Figure 3 compares the results of the model (red dashed lines) with data (blue solid lines) for six relevant variables. Since the focus of this paper is to match the secular trends in the data using the transition dynamics of the model, we abstract from analyzing business cycle fluctuations. However, we do incorporate the fact that a financial crisis occurred in 2008. Accordingly, at the end of the 30-year simulation, the economy is given a particularly low realization of the random draw for the utility cost of default, and a financial crisis occurs. Consequently, as shown in panel (a), the unemployment rate jumps about 2.5 percentage points, around half of the observed surge during the GFC.

When comparing the secular trends generated by the model with the data, we see that the decline of the labor share predicted by the model is slightly greater than in the data (see panel (b)). However, given that there is no distinction between the median and average labor earnings

[22]For the empirical definition of the probability of financial crises see footnotes 4 and 7. For the formal definition of the probability of financial crises in the model, see equation (15), which is the probability of a random draw of utility cost of default being less than the utility gain from defaulting.

Figure 3: The Rise of Market Power: Matching Trends

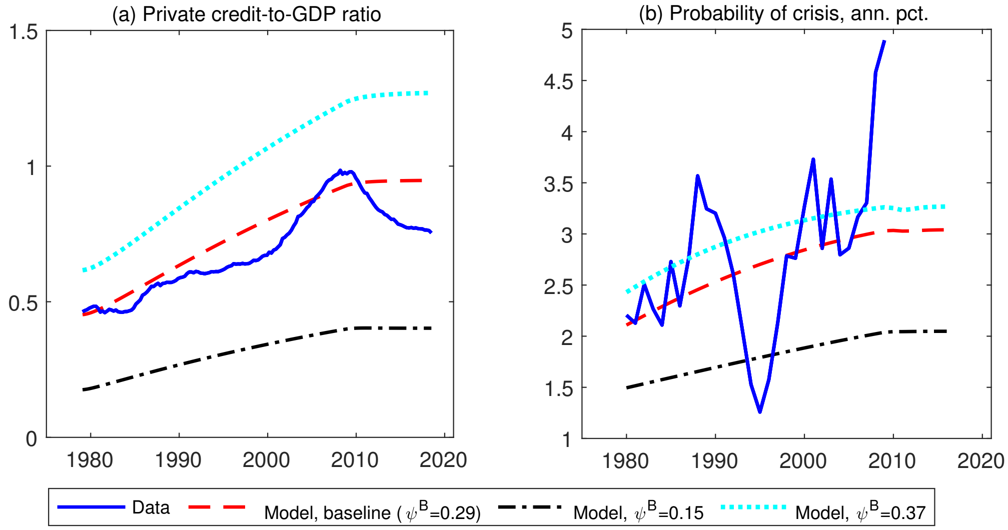


in our model and the median labor share has declined more than the average labor share in the data, the greater decline in labor share during our simulation can be considered more in line with the decline of median labor share in the data. Regarding the capital share and the profit share, the secular trends generated by the model are in line with their empirical counterparts estimated by Barkai (2020). In particular, the capital share falls by 18 percent in the model, from 0.176 to 0.145, close to the 22 percent decline observed in the data. In turn, the profit share increases 15.3 percentage points in the model, from 5.7 percent to 21 percent, also close to the 13.5 percentage point increase observed in the data.

Panel (c) shows that the model's income share of top 5 percent income earners (i.e., agents K in the model) tracks very closely the secular trend of its empirical counterpart. The combination of the top 5 percent's rising income share and the relatively high MPS of this income group due to the wealth-in-the-utility preferences makes the unused income be accumulated as financial wealth in the form of private credit. Importantly, as shown in panel (d), the model-generated credit-to-GDP ratio follows very closely the secular trend in the data.

Panel (e) then shows the secular rise of the probability of financial crisis both in the model and in the data. In the data, this probability reached almost 5 percent on the eve of GFC. However, the linear trend estimate, which we are trying to match with the transitional dynamics of the model, rose only to 3.5 percent. Thus, the model can account for about two thirds of the trend increase of

Figure 4: The Wealth-in-the-Utility Preferences and Financial Instability



the probability of financial crisis in the data.

Eggertsson et al. (2018) argue that savings did not contribute much to the rise of financial wealth accumulation because the nation-wide saving rate has been relatively low in the United States. Thus, capital gains must have played a more prominent role. However, it is important to notice that the low saving rate hides important financial flows among heterogeneous agents. In contrast with the accumulation of physical capital, the accumulation of private credit shown in panel (d) of Figure 3, does not contribute to the "wealth of the nation" as the assets of the creditors are offset by the liabilities of the debtors. However, credit accumulation is an important channel through which wealth inequality is created. Panel (f) shows the secular rise of stock market capitalization-to-GDP for both model and data. Comparing panels (d) and (f), we can see that credit accumulation accounts for roughly a third of total gains in wealth of agents K in the model and in the data. Therefore, in contrast with Eggertsson et al. (2018), our model assigns an important role for saving in creating wealth inequality. The rest of the increase in wealth inequality is due to capital gains driven by the rise in profits. Importantly, our results are consistent with Greenwald et al. (2019), who find that the most important driving force behind the sharply rising equity values in the United States over the last several decades has been a factor share shock that reallocates rents to shareholders and away from labor compensation. Greenwald et al. (2019) interpret this shock as changes in industry concentration and changes in the bargaining power of U.S. workers, which are also the driving forces in our model economy.

Figure 4 shows the crucial role played by the wealth-in-the-utility preferences in the model in matching the observed secular trends in the credit-to-GDP ratio and the probability of financial crisis. Recall that we calibrate the utility weight on private bond holdings, ψ^B, to equalize the MPS of agents K in the model to the MPS of wealthy agents in the data. This requires $\psi^B = 0.29$ in our baseline calibration. We study here two alternative values of ψ^B, based on two alternative MPS values of top income earners estimated by Dynan et al. (2004): (i) $\psi^B = 0.37$, equivalent to a MPS of 0.50, consistent with the SCF-based two-step instrumental-variable estimate for top 5 percent income earners; and (ii) $\psi^B = 0.15$, equivalent to a MPS of 0.25, consistent with the PSID-based one-step estimate for top 20 percent income earners.[23] The rest of the parameters are kept unchanged at their baseline values in Table 1.

Figure 4 shows that, in general, assigning higher (lower) values for ψ^B, that is, letting agents K earn higher (lower) utility from holding financial assets leads to larger (smaller) MPS and therefore larger (smaller) accumulation of credit relative to the size of the economy, and a higher (lower) probability of financial crisis. Similar results are obtained by changing σ_b instead of ψ^B (see Figure 13 in the Appendix).

Finally, we study the implications of our model for two non-targeted variables with clear trends in the data: Tobin's Q and the investment-to-output ratio. Gutiérrez and Philippon (2017) and Gutiérrez and Philippon (2019) show that the Tobin's Q of the U.S. stock market increased more than threefold since 1980 and that the investment-to-operating income ratio has fallen about 20 percentage points from 27 percent in 1980 to 7 percent in 2012. Both papers argue that these two phenomena are consistent with the rise in market power. The results in this paper are also in line with these secular trends: our model's Tobin's Q increases 4.3 times during our simulation period, slightly overshooting the increase of 3.5 times observed in the data.[24] At the same time, the model's investment-to-output ratio declines about 18 percent. This is called "decline of Q-sensitivity (-elasticity) of investment (and entry)"by Gutiérrez and Philippon (2019). Note that the decline of the investment-to-output ratio is unavoidable in the model if the driving force behind the rise in Tobin's Q is a rise in firm market power. The capital market efficiency requires $r_t = \mu_t \alpha y_t / k_{t-1}$. In the model, r_t is fixed by the time preference, and hence, the decline of real marginal costs due to rising firm market power requires a decline of capital-to-output ratio, which is consistent with the decline of the investment-to-output ratio over time.[25]

3.3 The Role of Rising Firm Market Power in the Labor Market

Our main results are based on the assumption that firm market power in both product and labor markets has increased simultaneously since 1980. In this section, we quantify the marginal contributions of the two.

Panel (a) of Figure 5 compares the paths of the unemployment rate in our baseline case (blue solid line), where firms' market power rises in both product and labor markets, with the alternative (red dashed line), where only firm market power in product markets rises. Panel (b) shows the paths of the markup in these two cases, which by construction is identical in both cases.

[23] Similar alternative values for the MPS are analyzed by Kumhof et al. (2015).

[24] In the model, Tobin's Q is computed as the ratio between the net present value of firms' profits and the value of capital. See panel (a) of Figure 14 in Appendix B.

[25] Note that the decline of the gross investment-to-output ratio both in the model and in the data underestimates the downward pressure on capital accumulation observed in reality since both the model and the data do not take into account the secular rise of the depreciation rate and the secular decline of the real interest rate. The net investment-to-output ratio ($(k' - k)/y$) has declined nearly 50 percent in the last four decades in the data. See panel (b) of Figure 14 in Appendix B.

Figure 5: The Rise of Market Power: Macroeconomic Implications

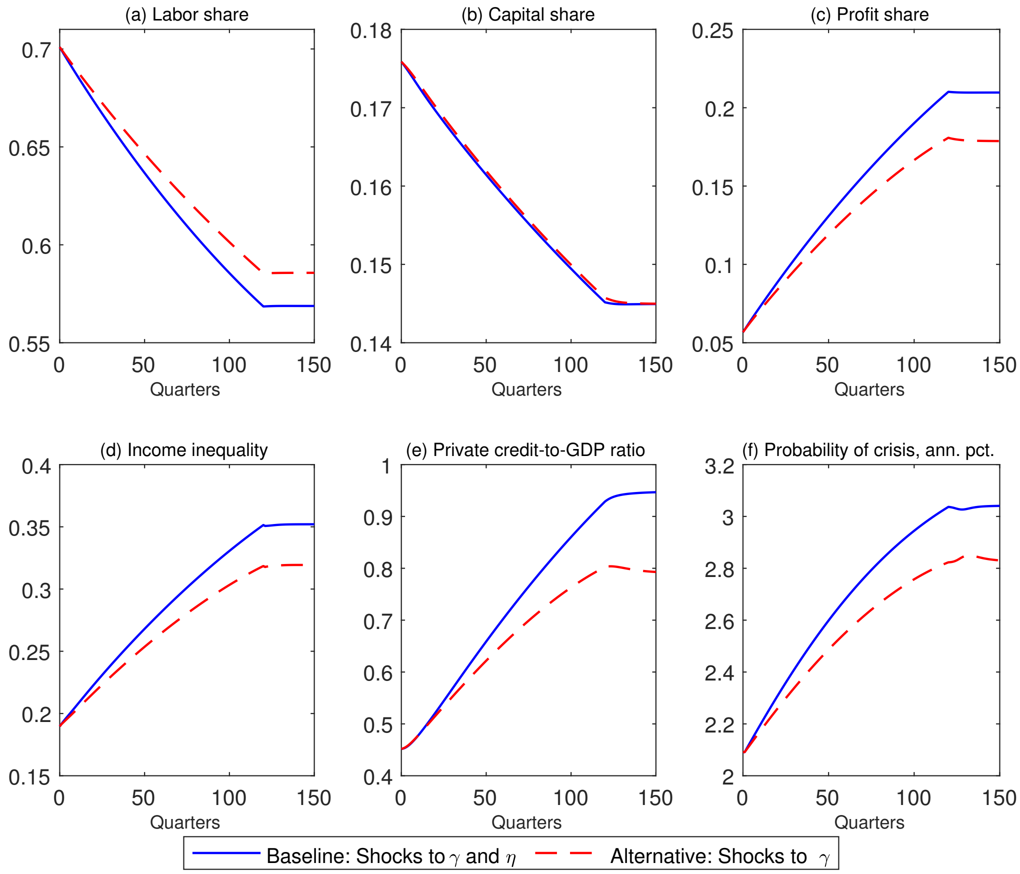
What is notable in panel (a) is that the rise in market power in product markets required to explain the increase in markups would imply an implausibly large increase in the unemployment rate without a concurrent change of firm bargaining power in the labor market. That would result in an unemployment rate of around 25 percent at the end of the simulation period, which is clearly inconsistent with the data. The assumption that firm bargaining power in the labor market has risen together with market power in product markets over the last three decades is thus essential to avoid a counterfactual prediction for the unemployment rate, an aspect often overlooked in the recent literature on market power (Gutiérrez and Philippon, 2017; Eggertsson et al., 2018; Farhi and Gourio, 2018; Bergholt et al., 2019; Barkai, 2020; De Loecker et al., 2020). Importantly, the decline in workers bargaining power is consistent with the empirical evidence provided by Levy and Temin (2007) and Stansbury and Summers (2020).

Figure 6 compares the two transitional dynamics for the same variables plotted in Figure 2, with the blue solid line showing the baseline case and the red dashed line showing the alternative with only changes to market power in the product market. The difference between the two cases can be considered the marginal contribution of the rise in firm bargaining power in the labor market. Figure 6 makes it clear that the rise in firm's bargaining power does contribute to the decline of the labor share and the rise in the profit share. However, it is also clear that the contribution of changes in firms bargaining power in the labor market to rises in income inequality, credit-to-GDP ratio, and probability of financial crisis is much smaller than the effects of increased market power in the product market.

4 Alternative Hypotheses

This section runs three validity checks against our baseline specifications. First, we consider an alternative utility form: capital-in-the-utility function for agents K. Our baseline model treats fi-

Figure 6: The Rise in Market Power: Macroeconomic Implications



nancial wealth and physical assets asymmetrically in that only the former generates direct utilities for wealthy households. This alternative removes the asymmetry by assuming that wealthy households earn direct utilities from both assets. Second, we consider an alternative hypothesis behind the rise in credit accumulation. In particular, in addition to the wealth-in-the-utility preferences for creditors, we consider borrowers' motive to increase debt by incorporating keeping-up-with-the-Joneses preferences. Finally, we introduce nominal rigidities and non-zero trend inflation into the model to study whether the disinflation process observed during the 1980s and 1990s had any independent contribution to the secular trends on labor/capital/profit shares, income/wealth inequality, and financial instability. In all three exercises, we simulate the model and then confront the obtained results with empirical evidence. Results are summarized in Table 2.

4.1 Capital-In-The-Utility Function

We first investigate what happens if agents K earn direct utility not only from financial wealth but also from physical capital accumulation. In this case, the efficiency condition for capital accumulation (equation (14)), is modified into

$$1 = \mathbb{E}_t \left[m^K_{t,t+1} \left(\frac{r_{t+1} + (1-\delta) q^K_{t+1}}{q^K_t} \right) \right] + \frac{\psi^K}{(c^K_t)^{-1/\sigma_c}} \left[\left(1 + \frac{k_t}{\chi} \right) \right]^{-1/\sigma_k},$$

Table 2: Alternative Hypotheses

Variable	(a) Baseline	(b) Capital in the utility	(c) Keeping up with the Joneses	(d) Exogenous contract duration	(e) Endogenous contract duration
Unemployment rate	-2.5	-9.9	-2.5	-2.5	-3.5
Markup	24.6	24.6	24.6	26.7	23.4
Marginal costs	-17.6	-17.6	-17.6	-19.1	-16.9
Labor share	-13.2	-14.5	-13.2	-14.7	-12.9
Capital share	-3.1	-1.5	-3.1	-3.4	-3.0
Profit share	15.3	16.8	15.3	17.1	14.8
Income inequality	16.0	17.0	16.2	18.5	16.1
Private credit-to-GDP ratio	30.8	51.5	49.6	56.1	48.6
Probability of financial crisis	0.77	1.03	0.95	1.09	0.94
Tobin's Q	221	104	221	241	213
Investment-to-output ratio	-17.6	18.1	-17.6	-19.1	-16.9

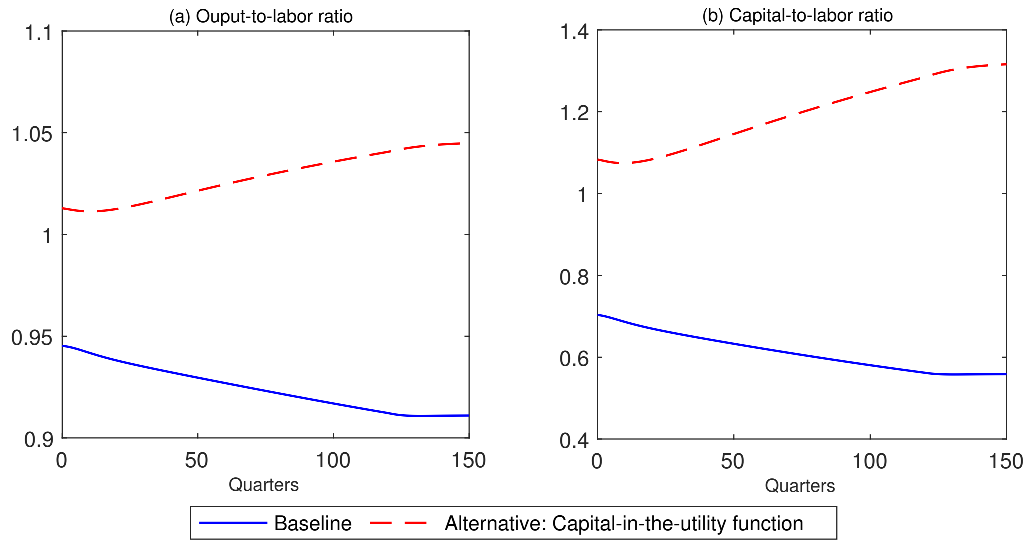
Note: All values report changes over 120 quarters. All values are expressed in percentage points except marginal costs and the investment to output ratio that are expressed as percent change.

where the additional second term captures the liquidity premium due to wealth-in-the-utility preferences. We set $\psi^K = \psi^B$ and $\sigma_k = \sigma_b$ such that the preferences are modeled symmetrically between bond holdings and capital accumulation. The rest of the parameter values remain unchanged to the baseline case, except for the matching efficieny that is set to $\zeta = 0.8$ to avoid a negative unemployment rate at the end of the simulation period. With $\psi^K > 0$, the new equilibrium requires the rental rate of capital, r_t, to decline below the level that prevails in the baseline case, which then leads to increases in firms' capital demand. As a result, we predict that capital accumulation will be larger than in the baseline. The relevant question is whether this prevents credit accumulation from reaching the level observed in our baseline case by diverting resources from credit accumulation to capital accumulation.

Column (b) of Table 2 shows the results, to be compared with our baseline case presented in column (a). Not surprisingly, allowing for the capital-in-the-utility reduces the decline of the capital share compared with the baseline. While capital accumulation is enhanced by the liquidity premium discussed above, the production efficiency also requires an increase in labor input as the increase in capital elevates the marginal productivity of labor. This explains why the unemployment rate falls as much as ten percentage points over the three decades under analysis. This is in stark contrast with our baseline results and is a counterfactual implication of the capital-in-the-utility preferences.

The labor share declines more in the alternative. This happens despite the fact that increased capital accumulation generates a large increase in labor demand. The reason is that capital-in-the-utility makes the production much more capital intensive as shown by Figure 7. Panel (a) compares the output/labor ratios and panel (b) the capital/labor ratios in the two economies. Both ratios decline over time in the baseline. This is because the output/labor ratio is equal to $y_t/n_t = z(k_{t-1}/n_t)^\alpha$ and the capital/labor ratio declines as the rise in market power reduces capital demand and the decline of worker's bargaining power increases labor demand. The exact opposite

Figure 7: Output/Labor and Capital/Labor Ratio



happens with the capital-in-the-utility specification: capital intensity, measured by k_t/n_t, almost doubles after the three decades of transition. In turn, income inequality rises slightly more than in the baseline economy, given the smaller decline in the capital share and the greater rise in the profit share, which are major components of income for agents K.

Our experiment with the capital-in-the-utility was motivated by the concern that such preferences may fail to generate the rise in the credit-to-GDP ratio observed in the data because the marginal utility of holding physical capital may restrain credit accumulation. However, it turns out that the rise of the credit-to-GDP ratio in this alternative economy is even greater than in our baseline. In particular, the credit-to-GDP ratio rises 51.5 percentage points, which is above the 30.8 percentage point increase of the baseline economy. The capital-in-the-utility preferences create additional incomes that can support additional capital accumulation and can even increase the income devoted to credit accumulation. Since the model with the alternative preferences generates a larger increase in the credit-to-GDP ratio than the baseline, it also generates a larger increase in the probability of financial crisis.

Importantly, the alternative specification for preferences has one important counterfactual implication: the investment-to-output ratio rises secularly, and the cumulative magnitude is on the order of 18 percent. This result is clearly at odds with the data, and this is the most important reason why we do not adopt the capital-in-the-utility preferences as our baseline case.

4.2 Keeping-Up-with-the-Joneses Preferences

One intuitive narrative behind the rise in household sector leverage is that as income inequality rises, lower-income households have tried to keep up with the consumption level of upper-class households by increasing debt (see, for example, Christen and Morgan (2005), Barba and Pivetti (2009), Fligstein et al. (2017)). This narrative implicitly posits that what matters for utility is not the absolute level of consumption, but the position of the agent's consumption relative to the consumption level of a reference group (Duesenberry, 1949; Frank, 1985; Abel, 1990; Galí, 1994). If the consumption gap between low-income households and high-income households increases as a result of a widening income gap and the former group is trying to emulate consumption patterns of the latter group, the borrowing demand of the former group increases.

One way to represent such preferences in our environment is to assign an external habit to the utility of agents W and have the reference consumption be the consumption level of agents K:

$$U_t^W = \mathbb{E}_t \sum_{t=0}^{\infty} (\beta^W)^t \frac{(c_t^W - \tilde{s} c_{t-1}^K)^{1-1/\sigma_c}}{1 - 1/\sigma_c},$$

where $\tilde{s} \equiv s \times (\bar{c}^W / \bar{c}^K)$, and s denotes the degree of external habit.[26] As the income inequality gap grows over time between the two agents, $c_t^W - \tilde{s} c_{t-1}^K$ declines because agents W's consumption declines and agents K's consumption increases. Hence the marginal utility $(c_t^W - \tilde{s} c_{t-1}^K)^{-1/\sigma_c}$ increases over time, which incentivizes more borrowing to increase consumption.

Column (c) of Table 2 summarizes the results with the keeping-up-with-the-Joneses preferences when $s = 0.50$. The alternative preferences for the borrowers do not affect the outcomes for product and labor markets: labor and profit shares, real marginal cost, the investment-to-output ratio, and Tobin's Q remain the same as in the baseline. However, the private credit-to-GDP ratio rises 50 percentage points, overshooting the increase observed in the data.

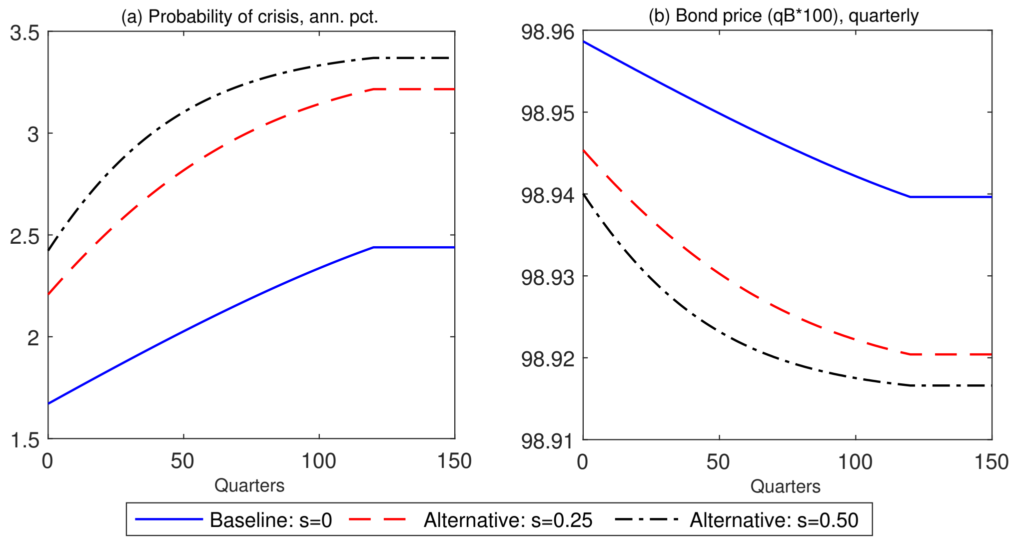
The higher credit demand and debt-to-income ratio result in a higher probability of financial crisis, which increases almost 1 percentage point over the 30-year period and gets closer to the estimate of Schularick and Taylor (2012). Panel (a) of Figure 8 compares three cases of different degrees of habits, $s = 0$ (baseline), $s = 0.25$, and $s = 0.50$. The panel shows that higher demand of credit increases the probability of crisis monotonically during the entire transitional period. Panel (b) of Figure 8 shows the effects of increases in the probability of default on the bond price. The lower the bond price, the more expensive financing becomes.

Our baseline results suggest a "demand-driven" credit boom is not necessary to generate the bulk of the rise in the credit-to-GDP ratio, as the baseline explains 30 percentage points out of 40 percentage points increase in the data. However, the alternative results indicate that a mild degree of demand factors such as keeping-up-with-the-Joneses preferences can help match the full degree of credit expansion and higher probability of financial crisis.[27]

[26] We scale the level of consumption of agents K by the steady state consumption ratio between the two agents $\bar{c}^W / \bar{c}^K$ because the per capita consumption level is much larger for agents K and $c_t^W - s c_{t-1}^K$ could be negative for a conventional value of habit parameter s.

[27] Coibion et al. (2020) argue that keeping-up-with-the-Joneses preferences did not play an important role in credit expansion during mid-2000s based on the finding that "low-income households in high-inequality regions accumulated less debt relative to income than their counterparts in lower-inequality regions." In contrast, the findings of Christen and Morgan (2005), Barba and Pivetti (2009), and Fligstein et al. (2017) are more consistent with the keeping-up-with-the-Joneses preferences. We do not take a stance between the two findings. However, we note that the version of keeping-up-with-the-Joneses of Coibion et al. (2020) is a particular one in that the reference point of consumption of the low-income households is the consumption level of the high-income households in their local area rather than the national average.

Figure 8: Keeping Up With Joneses and Probability of Default



4.3 The Role of Disinflation Policy

This paper evaluates whether the observed rise of firm market power both in product and labor markets in the last decades explains the secular trends in the labor/capital/profit share, income/wealth inequality, and financial instability in an economy without nominal rigidities. Our analysis has assumed that the disinflation policy, which was implemented concurrently over the time period of analysis, has not played any relevant role in this process and hence can be set aside in the analysis of the secular trends. This section tests the validity of this assumption by introducing nominal rigidities and non-zero trend inflation into our model described in Section 2.[28]

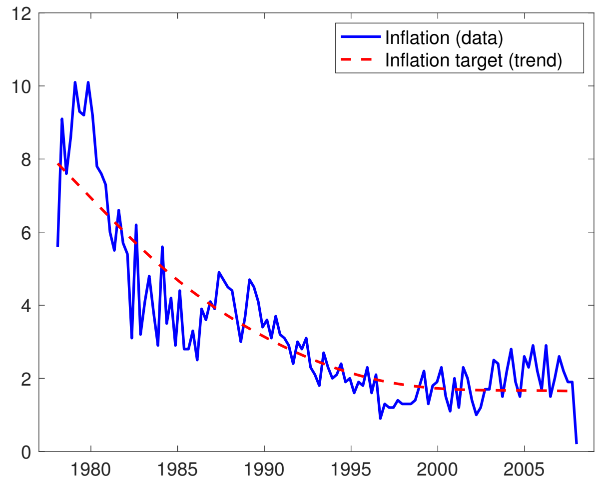
From the viewpoint of standard New Keynesian theory, there is a natural link between disinflation policy and factor shares. According to the theory, the current inflation rate is the present value of future real marginal cost, the inverse of which is the gross markup. Hence, if a central bank wants to implement a disinflation policy, it has to engineer a decline of future real marginal costs, which requires a decline of the labor and capital share since $\mu = (wn + rk)/y$.[29] In a standard New Keynesian model, disinflation policy can achieve the reduction of real marginal cost by reducing the dispersion of relative prices, which then leads to increase in productivity and reduction in real marginal cost (see Yun (2005)). Hence, there is a theoretical linkage between disinflation policy and factor shares. The question is how quantitatively important this linkage is.

We consider two types of staggered pricing models, one in which the duration of price contract is exogenously fixed (i.e., standard staggered Calvo pricing model) and the other in which firms can optimally readjust the duration of the contract in response to changes in trend inflation. Our exercise consists of adding an exogenous process for trend inflation to the secular trend in firm market power in both product and labor markets and seeing whether the model results differ from

[28] Details on the extended model and its calibration are relegated to Appendix C for brevity.

[29] $\mu = (wn + rk)/y$ implies that the profit share of the economy is given by $1 - \mu$. This discussion ignores search frictions in the labor market for the sake of simplicity.

Figure 9: Disinflation Policy



our baseline results. We think that this test is important because the disinflation policy may have important real effects and if so, who the disinflation policy has benefited the most is an important macroeconomic question to analyze.

4.3.1 Calibration of the Disinflation Policy

We assume that the central bank is in perfect control of the trend inflation rate, defined as the inflation rate in the nonstochastic steady state. In particular, we consider that the central bank announces a new inflation target π^* in each quarter. This announcement is perfectly credible to the agents. The perfect credibility assumption is represented by a random walk process, $\pi_t^* = \pi_{t-1}^* + \epsilon_t^{\pi^*}$, such that $\mathbb{E}_t[\pi_{t+s}^*] = \pi_t^*, \mathbb{E}_{t+1}[\pi_{t+1+s}^*] = \pi_{t+1}^*, ..., \mathbb{E}_T[\pi_{T+s}^*] = \pi_T^*$ for any $s \geq 0$. The sequence of shocks $\epsilon_t^{\pi^*}$ is chosen such that the path of the inflation target over 120 quarters follows the observed trend of the core PCE inflation rate in the United States from 1979 to 2008 shown in Figure 9.[30] Agents do not have perfect foresight of $\{\epsilon_t^{\pi^*}\}_{t=1}^{T=120}$ at the beginning of the simulation, which means that they are surprised by the changes in the inflation target that occur in each quarter.[31]

4.3.2 Exogenous Contract Duration Model

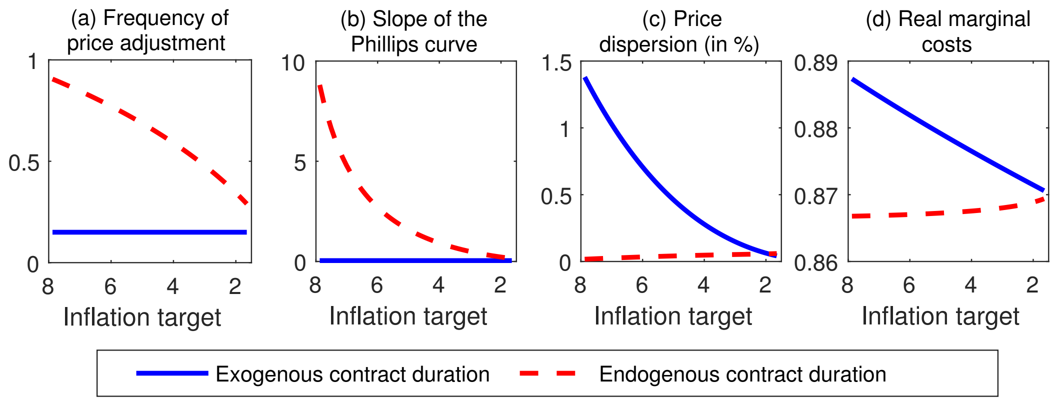
The staggered price contract model formalized by Calvo (1983) assumes that regardless of the history of pricing, all firms have a probability $1 - \varphi$ of resetting their prices. We additionally assume that the fraction of firms φ with no opportunity to optimally reset their prices set their prices with indexation, i.e., $P_t(i) = P_{t-1}(i)\pi_{t-1}^{\varepsilon}$, where $\varepsilon \in [0, 1)$ is the degree of indexation.[32]

[30] We apply the Hodrick-Prescott filter using data from 1979 to 2018 to obtain the trend inflation rate with a smoothing parameter equal to 10^5.

[31] We assume this information structure regarding agents' realizations of shocks to the inflation target for two reasons: first, it is hard to imagine that agents in early 1980s knew the entire path of the time-varying inflation target; second, 120 periods of anticipated shocks make our solution algorithm fail to find the equilibrium transitional dynamics.

[32] Allowing for indexation is a natural choice since our analysis covers the early 1980s where trend inflation rate is around 8 percent per annum. The cost for firms not being able to reset their prices in each period can be implausibly

Figure 10: Two Sticky Price Models



As is well known, the staggered price contract generates price dispersion, denoted by Δ_t, as some firms cannot reset their prices in each period. The price dispersion term appears in the aggregate production function, $y_t = z\Delta_t^{-1}k_{t-1}^{\alpha}n_t^{1-\alpha}$, and it works like a negative technology shock, lowering labor productivity. The price dispersion term in the aggregate production function is the channel through which disinflation policy may create real effects. It can be shown that price dispersion in steady state for a given trend inflation rate is given by:[33]

$$\Delta \equiv \int \left(\frac{P(i)}{P}\right)^{-\gamma} di = \left(\frac{\pi}{p_o(\pi)}\right)^{\gamma} \frac{1-\varphi}{1-\varphi\pi^{\gamma}}, \tag{16}$$

where $p_o(\pi)$ is the reset price inflation rate chosen by the firms with the opportunity to readjust their nominal prices. Equation (16) is a product of two terms. The first term is decreasing in the trend inflation rate. This decrease is because the reset price inflation must increase faster than the trend inflation rate, given that the reset pricing firms understand that there will be periods in which they cannot readjust their prices. The second term is evidently increasing in the trend inflation rate. Of these two terms, the second term dominates, and the price dispersion term is increasing in the trend inflation rate.

Panels (a) and (b) of Figure 10 show that in the exogenous contract duration model, both the frequency of the price adjustment and the slope of the Phillips Curve remain constant as trend inflation falls. Instead, the disinflation policy lowers price dispersion as shown in panel (c), boosting the effective total factor productivity (z/Δ) in the long run, and lowering real marginal costs as shown in panel (d). The reduction in real marginal costs has direct implications for factor shares because the production efficiency conditions, $\mu(1-\alpha) = wn/y$ and $\mu\alpha = rk/y$, imply that the labor and capital shares have to fall in response to the reduction in real marginal costs, and hence the rise of the profit share.[34]

Column (d) of Table 2 summarizes the results of a disinflation policy in the exogenous contract duration model that occurs at the same time as the changes in firm market power considered in

large without indexation, implying unrealistically large welfare gains from disinflation.

[33]For the simplicity of intuition, this expression ignores indexation. The exact expression in the presence of indexation is derived in Appendix C.

[34]This statement ignores search frictions in the labor market for exposition purposes.

our baseline case. We set all parameter values equal to our baseline model (see Table 1), and we use a moderate degree of price rigidities ($\varphi = 0.85$) and indexation ($\varepsilon = 0.6$) given that this is a calibration for a 30-year period. As expected, the disinflation policy does magnify the drop in labor and capital shares and the rise in the profit share. Such changes in income shares lead to additional accumulation of credit. However, under our standard calibration of nominal rigidities, the magnitude of the additional channel can be considered modest at best. The additional drop in the labor share for instance is only 1.5 percentage points. Note that if one were to assume a larger degree of price rigidities and a much lower degree of indexation, the efficiency gains generated through reduction in trend inflation would be much larger, and thus the contribution of disinflation to the secular trends more pronounced. However, as shown by Ascari (2004), the efficiency gains would then be implausibly large.

4.3.3 Endogenous Contract Duration Model

A limitation of the staggered pricing model just described is that the frequency of price adjustment is fixed over the 30-year period under analysis. However, Nakamura et al. (2018) provide evidence that the frequency of price adjustment has fallen over time as the trend inflation rate has declined. As an alternative to the staggered pricing model, we adopt the endogenous contract duration model developed by Levin and Yun (2007). In this model, firms optimally choose the frequency of price adjustment as the disinflation policy makes the trend inflation rate fall and the rising market power changes the curvature of the profit function. The frequency of price adjustment becomes a function of trend inflation rate and market power, i.e., $1-\varphi(\pi^*, \gamma)$. In this setting, and as shown in panel (a) of Figure 10, firms have incentives to reduce the frequency of price adjustment as trend inflation falls and the curvature of the profit function declines. The reason is that both elements make deviations from the optimal relative price less costly.[35]

The disinflation policy in the endogenous contract duration model is achieved through a flattening of the Phillips curve, not through the reduction in real marginal costs (see panels (b) and (d) of Figure 10). Therefore, given that the reduction in real marginal costs is the fundamental driver of widening income inequality and credit growth in our model, none of the secular trends stated above can be explained by the disinflation policy in the endogenous contract duration model. This can be seen in column (e) of Table 2, where the changes in the listed variables are almost identical to the changes in our baseline model. Overall, we conclude that the additional contribution of monetary policy to the secular trends in labor/profit shares, inequality, and financial instability are not materially important in both the exogenous and endogenous contract duration models.

[35]The possibility that the origin of the so-called "flat" Phillips curve can be found in the combination of rising firm market power and the decline of trend inflation rate in the context of an endogenous contract duration model is a novel finding that we believe deserves further analysis and is left for future research.

5 Implications for Macroprudential Policy

We finish our discussion by exploring the macroprudential policy implications of redistributive taxation. To that end, we return to our baseline model without nominal rigidities. In the baseline, we have assumed no taxation other than the lump sum tax to fund UI benefits. We now introduce dividend income tax rate τ^d such that the budget constraint of agents K becomes

$$c_t^K = (l_t - q_t^B b_t)\frac{1-\chi}{\chi} + \frac{1}{\chi}\left\{r_t k_{t-1} + (1-\tau^d)\Pi_t - q_t^K\left[k_t - (1-\delta)k_{t-1}\right]\right\}.$$

Since we assume that aggregate profits are transferred to agents K in a lump sum fashion, the introduction of the dividend taxation does not modify the first-order conditions (FOCs) of the maximization problem of agents K.

We assume that the proceeds of dividend income taxation are transferred in a lump sum fashion to agents W as social security spending, $S_t = \tau^d \Pi_t$. Thus, the budget constraint of agents W becomes

$$c_t^W = q_t^B b_t - l_t + \frac{1}{1-\chi}\left[S_t + \int_0^1 w_t(i)n_t(i)di - \nu_t y_t\right].$$

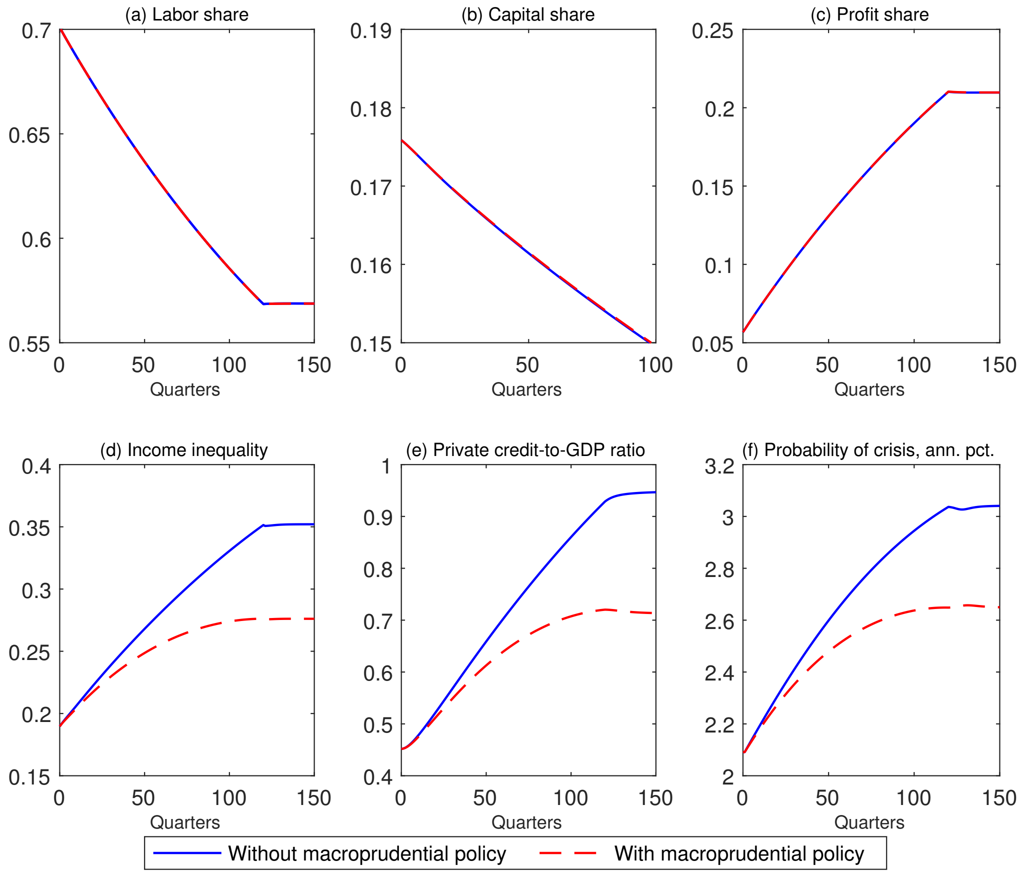
The FOCs of agents W are also not affected by the social security spending.

For illustrative purposes, we consider a case in which the dividend income tax rate is linearly raised from 0 to 30 percent over 120 quarters. As we did to model the process for firm market power, we assume that the law of motion for the tax rate is given by a random work: $\tau_t^d = \tau_{t-1}^d + \epsilon_t^d$. At the end of each period, agents' expectations are given by $\mathbb{E}_{t-1}[\tau_t^d] = \tau_{t-1}^d$. At the beginning of next period, agents realize that the tax rate is adjusted by an amount ϵ_t^d.

Figure 11 shows the results. The blue solid line corresponds to our baseline case without the taxation and the red dashed line to the case with taxation. In the top three panels, we can see that labor, capital, and profit shares are not affected by the taxation. The two lines are basically indistinguishable from each other. This result is because the taxation leaves the efficiency conditions of production intact. However, in the bottom three panels, we observe that taxation can have powerful effects on income inequality and credit accumulation. As shown in panel (d), the top 5 percent income share rises to 0.28 by the end of the simulation, only about half of the increase in the baseline. As the unused income that used to be drained into financial investment is eliminated by the taxation, the over-accumulation of credit is much more subdued. Without the tax policy, the combined forces of rising market power and declining bargaining power double the household sector credit-to-GDP ratio by the end of simulation. With the tax policy, a half of the credit growth is now eliminated as shown in panel (e). As the indebtedness of borrowers is stabilized, the probability of financial crisis is contained at a much lower level (see panel (f)).

Note that the stock of credit is not part of the wealth of nation because it is offset by the liabilities of the debtors. Only the capital stock is the wealth of nation. Therefore, the taxation does not affect the wealth of nation, it simply breaks the link between the decline of the labor income share and the increase in income inequality. It does so by redistributing income from

Figure 11: The Effects of Macroprudential Policy



agents K to agents W with no significant changes in product and labor market equilibrium.

This experiment has important implications for macroprudential policies. Since the GFC, most of the focus of macroprudential policies has been on building the resilience of financial intermediaries by bolstering their capital positions, restricting their risk exposures, and restraining excessive interconnectedness among them. These policies are useful in maintaining financial stability. However, these policies might not address a much more fundamental issue: Why is there so much income "to be intermediated" to begin with? In our framework, the root cause of financial instability is income inequality driven by changes in market structure and institutional changes that reward the groups at the top of the income distribution. Our experiment suggests that if an important goal for public policy is to limit the probability of tail events, such as financial crises, a powerful macroprudential policy may be a redistribution policy that moderates the rise in income inequality. We believe that more research is warranted in this area.

6 Conclusion

We develop a theoretical model in which the income distribution is endogenously determined by firm market power in both product and labor markets and the probability of financial crisis is endogenously determined by the accumulation of household credit. Using the model, we analyze the transitional dynamics of an economy undergoing structural changes in product and labor markets. We find that the secular rise of firm market power in both product and labor markets can be an important driver behind a few secular trends experienced by the U.S. economy in the last few decades: the decrease in the labor/capital share, the increase in the profit share, income inequality, the credit-to-GDP ratio, and the associated rise in financial instability summarized by the probability of a financial crisis event. We also show that redistribution policies that moderate income inequality can be used as strong macroprudential tools in preventing financial crises.

The analysis of this paper has focused on understanding the macroeconomic effects of an increase in firm market power and relates them to several important trends observed in the U.S. economy in the last four decades. Identifying the underlying forces behind the changes in market structure is beyond the scope of this paper but stands as a compelling macroeconomic question that is left for future research.

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Online Appendix - Not Intended for Publication

A Data

This appendix provides the sources for the data series used in the paper.

- The unemployment rate corresponds to the civilian unemployment rate, reported by the U.S. Bureau of Labor Statistics (BLS) as series LNS14000000.
- The labor share corresponds to the average labor share in the nonfarm business sector, reported by the BLS and retrieved from FRED (Federal Reserve Bank of St. Louis) as series PRS85006173.
- The capital share and profit share are from Barkai (2020).
- The income share of the top 5 percent income earners comes from the 2016 update of Piketty and Saez (2003) under Table A1, excluding capital gains.
- The net worth of the top 5 percent of households ranked by net worth comes from the Survey of Consumer Finances, computed by Wolff (2017).
- The private credit-to-GDP ratio is computed as the ratio of liabilities from the domestic nonfinancial household sector, taken from the Federal Reserve Board's Financial Accounts of the United States (series LA154104005), divided by nominal GDP from the Bureau of Economic Analysis (BEA).
- The probability of financial crisis for the United States is computed using the empirical estimates of the multi-country logit model of financial crises by Schularick and Taylor (2012) using loans-to-GDP as the credit measure.
- The stock market capitalization-to-GDP ratio corresponds to the World Bank series DDDM01USA156NWDB and is retrieved from FRED.
- We follow Gutiérrez and Philippon (2017) to compute Tobin's Q according to equation (A.1), where V_e denotes the value of equities, L corporate liabilities, FA financial assets, and P_kK the value of corporate capital. The data sources for these series are the following. Series for V_e, L, FA, and inventories correspond to the nonfinancial corporate business sector and are taken from the Financial Accounts of the United States published by the Federal Reserve Board. In particular, V_e is series NCBCEL, L is series TLBSNNCB, FA is series TFAABSNNCB, and inventories (excluding IVA, at current cost basis) is series IABSNNCB – all of them retrieved from FRED. Series P_kK is taken from the BEA under Table 6.1 (private fixed assets for the nonfinancial corporate business sector).

$$Q = \frac{V_e + (L - FA) - Inventories}{P_kK} \tag{A.1}$$

- The net investment-to-GDP ratio is computed as the ratio of net investment for private domestic businesses from the BEA (corresponding to series W790RC1Q027SBEA and retrieved from FRED) divided by nominal GDP.

B Additional Results

Figure 12 shows that our baseline simulation results are robust to two alternative calibration of the parameters ψ^B and σ_b that imply the same MPS of top income earners as in the baseline. In particular, different combinations of ψ^B and σ_b that generate the same baseline MPS of 0.43 have only a very small effect on the implications of the model for the debt-to-GDP ratio and the probability of crisis (the implications for the labor share, capital share, profit share, and income inequality are almost identical to the baseline case and not shown, but available upon request). These results underscore the role that the MPS of top income earners plays for our results, which can be achieved by different combinations of the parameters ψ^B and σ_b.

Figure 12: Sensitivity Analysis: Alternative Values for ψ^B and σ_b

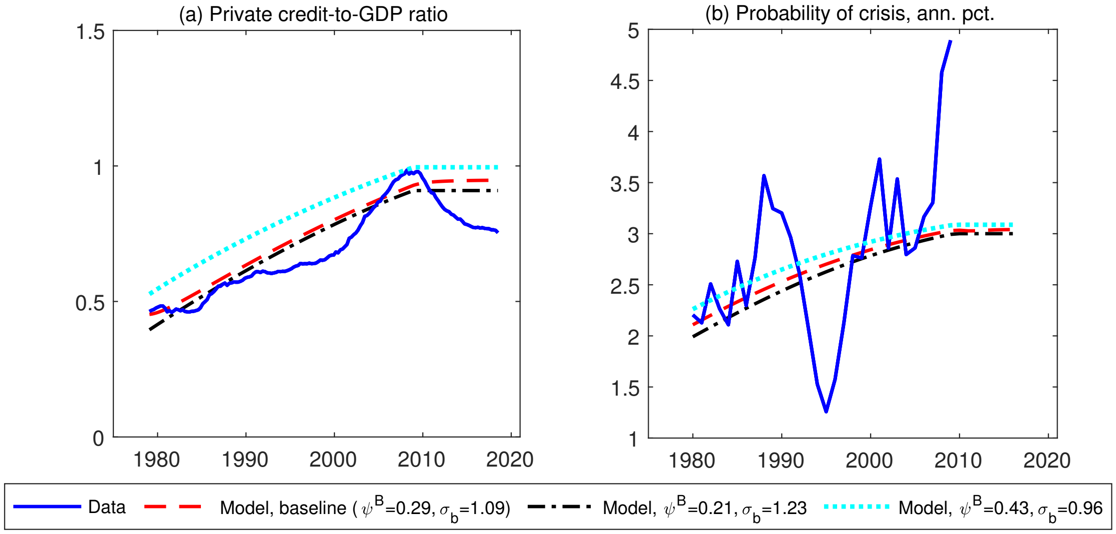


Figure 13 shows that varying the parameter σ_b, while keeping the rest of the parameters constant to their baseline values, results in similar results as varying the parameter ψ^B. In other words, assigning higher (lower) values for σ_b results in higher (smaller) MPS for top income earners, and therefore larger (smaller) credit-to-GDP ratios, and a higher (lower) probability of default. The alternative value of $\sigma_b = 0.85$ is consistent with a MPS of 0.25, while the alternative value of $\sigma_b = 1.18$ is consistent with a MPS of 0.50, making this exercise comparable to the one in Figure 4.

Figure 13: Sensitivity Analysis: Alternative Values for σ_b

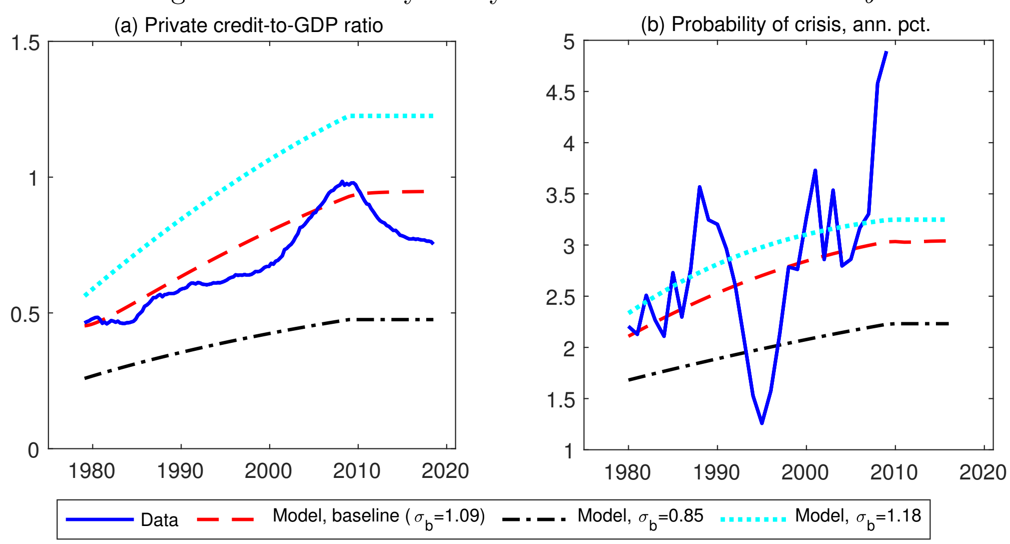
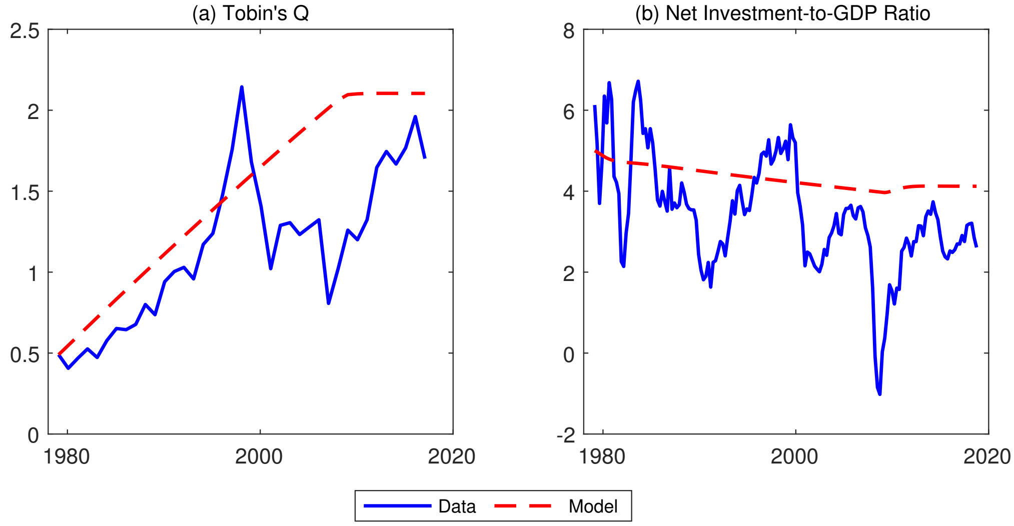


Figure 14 shows that our baseline simulation results have implications of the Tobin's Q and investment-to-output that are consistent with the data.

Figure 14: The Rise in Tobin's Q and the Fall of Net Investment Ratio



Notes: We normalize the initial value of Tobin's Q in the model to its data counterpart.

C Model with Nominal Rigidities and Non-Zero Trend Inflation

This appendix briefly outlines the model with nominal rigidities used in Section 4.3.

C.1 Monopolistic Competitors

A monopolistic competitor indexed by $i \in [0,1]$, owned by agents K, employs capital and labor in its technology

$$y_t(i) = zk_{t-1}(i)^{\alpha} n_t(i)^{1-\alpha},$$

to produce a differentiated product $y_t(i)$, where z is the level of aggregate productivity, which is taken as a constant throughout the analysis. The differentiated product is then sold to a competitive retailer at price $P_t(i)$, who then aggregates the differentiated products in a CES aggregator,

$$y_t = \left[\int_0^1 y_t(i)^{1-1/\gamma} di\right]^{1/(1-1/\gamma)}$$

and sells the final product to households at price $P_t = \left[\int_0^1 P_t(i)^{1-\gamma} di\right]^{1/(1-\gamma)}$, where γ is the elasticity of substitution between goods. In setting $P_t(i)$, monopolistic competitors face a friction that makes their adjustment of product price infrequent. We consider two types of staggered pricing, one in which the duration of the price contract is exogenously fixed and the other in which firms can optimally readjust the duration of the contract in response to changes in the trend inflation rate. In both cases, we assume that the central bank is in perfect control of trend inflation rate.

C.1.1 Staggered Price Contract

Optimal pricing strategy. This model is relatively well known in the literature and we take a minimalist approach in its description. However, the trend inflation rate is less well known, and we provide a brief description of the real effects of a non-zero trend inflation rate. This is useful to understand the real effects of a disinflation policy.

The staggered price contract model formalized by Calvo (1983) assumes that regardless of the history of pricing, all firms have a probability $1-\varphi$ of resetting their prices. This means that there exists a fraction $1-\varphi$ of firms resetting their prices and a fraction φ of firms setting their prices as $P_t(i) = P_{t-1}(i)$ at any point in given time. This also implies that the average duration of price contract is fixed at $1/(1-\varphi)$ over time, hence the name, exogenous contract duration model.

We make an additional assumption that firms with no opportunity to optimally reset their prices set their prices with indexation, i.e., $P_t(i) = P_{t-1}(i)\pi_{t-1}^{\varepsilon}$ where $\varepsilon \in [0,1)$ is the degree of indexation. This is a natural choice since our analysis covers a time period (the early 1980s) where the trend inflation rate is close to 8 percent per annum. As will be shown below, without indexation, the degree of price dispersion would generate implausibly large real effects of a disinflation policy.

The efficiency conditions for the pricing decision in this environment are summarized by the following three equations describing the optimal reset price inflation rate, $p_{0,t} \equiv P_t^*/P_{t-1}$:

$$p_{0,t} = \frac{\mathcal{P}_t^N}{\mathcal{P}_t^D}, \tag{C.1}$$

where $\mathcal{P}_t^N$ and $\mathcal{P}_t^D$ satisfy the following recursions:

$$\mathcal{P}_t^N = \pi_t^{(1-\varepsilon)\gamma}\left\{\pi_t^{\varepsilon\gamma}\gamma\mu_t y_t + \varphi\mathbb{E}_t\left[m_{t,t+1}^K \mathcal{P}_{t+1}^N\right]\right\}, \tag{C.2}$$

and

$$\mathcal{P}_t^D = \pi_t^{(1-\varepsilon)(\gamma-1)}\left\{\pi_t^{\varepsilon(\gamma-1)}(\gamma-1)y_t + \varphi\mathbb{E}_t\left[m_{t,t+1}^K \mathcal{P}_{t+1}^D\right]\right\}, \tag{C.3}$$

where μ_t is the real marginal cost, and $m_{t,t+1}^K$ is the stochastic discount factor of the owners of the firm, i.e., agents K. Inflation dynamics in this model are then summarized by equations (C.1)∼(C.3) and the following price aggregation condition:

$$\pi_t = \left[(1-\varphi)p_{0,t}^{1-\gamma} + \varphi\pi_{t-1}^{\varepsilon(1-\gamma)}\right]^{1/(1-\gamma)}. \tag{C.4}$$

Price dispersion and real cost of trend inflation. The staggered price contract generates price dispersion as some firms cannot reset their prices in each period, and the amount of price dispersion is given by

$$\Delta_t \equiv \int \left(\frac{P_t(i)}{P_t}\right)^{-\gamma} di = \pi_t^{\gamma}\left[(1-\varphi)p_{0,t}^{-\gamma} + \varphi\pi_{t-1}^{-\varepsilon\gamma}\Delta_{t-1}\right]. \tag{C.5}$$

The price dispersion appears in the aggregate production function, $y_t = z\Delta_t^{-1}k_{t-1}^{\alpha}n_t^{1-\alpha}$, and it works like a negative technology shock lowering labor productivity.

Equations (C.1)∼(C.3) imply that in steady state, the optimal reset price inflation is given by

$$p_o = \frac{\gamma}{\gamma-1}\frac{1-\varphi\beta^K\pi^{(1-\epsilon)(\gamma-1)}}{1-\varphi\beta^K\pi^{(1-\epsilon)\gamma}}\mu. \tag{C.6}$$

In a steady state with zero trend inflation, i.e., $\pi = 1$, equation (C.4) determines the reset price inflation as $p_o = 1$. Then, $\pi = 1$, $p_o = 1$ and equation (C.6) determine the steady state value of real marginal cost as $\mu = (\gamma-1)/\gamma$. However, $\{\pi, p_o, \mu\} = \{1, 1, (\gamma-1)/\gamma\}$ is not a unique solution. Substituting equation (C.6) in equation (C.4) and solving the resulting expression for the real marginal cost yields

$$\mu = \frac{\gamma-1}{\gamma}\frac{1-\varphi\beta^K\pi^{(1-\varepsilon)\gamma}}{1-\varphi\beta^K\pi^{(1-\varepsilon)(\gamma-1)}}\left(\frac{1-\varphi\pi^{(1-\varepsilon)(\gamma-1)}}{1-\varphi}\right)^{1/(1-\gamma)}. \tag{C.7}$$

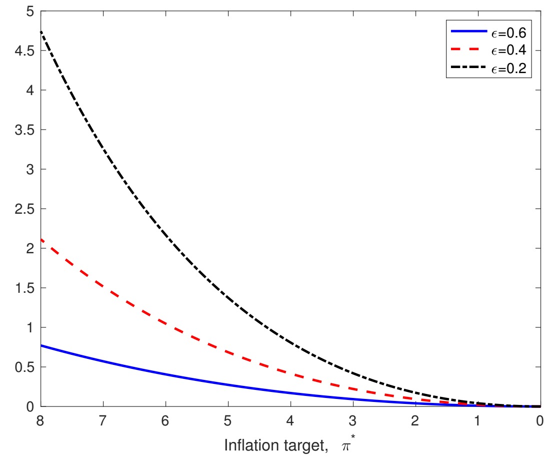
Assuming that the central bank is in perfect control of trend inflation, there can be a continuum of solutions for $\{\pi, p_o, \mu\} = \{\pi^*, p_o(\pi^*), \mu(\pi^*)\}$. Since the real marginal cost has a linear relationship with output, $\mu'(\pi^*) > 0$ implies that disinflation has positive welfare effects.[36]

Equations (C.6) and (C.5) then determine the steady state of price dispersion as

$$\Delta = \frac{1-\varphi}{1-\varphi\pi^{\gamma(1-\varepsilon)}}\left(\frac{1-\varphi\pi^{(\varepsilon-1)(1-\gamma)}}{1-\varphi}\right)^{-\gamma/(1-\gamma)}$$

[36] The statement, $\mu'(\pi^*) > 0$, is an over-simplification. It can be shown that the relationship is not monotonic, but $\mu'(\pi^*) > 0$ holds in most of the trend inflation region.

Figure 15: Price Dispersion and Trend Inflation: The Role of Indexation



Notes: The annual trend inflation rate is shown on the horizontal axis, and price dispersion is shown on the vertical axis as a percent deviation from no dispersion $\Delta = 1$. This figure assumes that $\varphi = 0.85$ and $\gamma = 5$.

Note that the price dispersion is a decreasing function of price indexation ε and has a limit point of $\Delta = 1$ when $\varepsilon = 1$ (full indexation). Intuitively, a high degree of indexation means that the relative price of inactive firms that do not reset their prices optimally does not deviate much from the average price level. Figure 15 illustrates this for three cases, $\varepsilon = 0.2$, 0.4 and 0.6. The figure makes three things clear: (i) price dispersion is an increasing function of trend inflation rate; (ii) price dispersion is a decreasing function of indexation; and (iii) price dispersion can be implausibly large without indexation, suggesting unrealistic costs of inflation or, equivalently, unrealistically large benefits of disinflation. Note that Figure 15 assumes that firms do not reoptimize their frequency of price adjustment and therefore their average contract duration $1/(1-\varphi)$ remains constant in response to changes in the trend inflation rate. Next, we consider an opposite assumption.

C.1.2 Contract Duration

Until now we have assumed that the inflation target and the contract duration are exogenously fixed. In this section, we consider a situation where the central bank announces a new inflation target, which is assumed to be perfectly credible. The perfect credibility assumption is captured by the law of motion of the inflation target:

$$\pi_t^* = \pi_{t-1}^* + \epsilon_{\pi,t}.$$

This announcement leads firms to believe that the new trend (steady state) inflation rate will be the same as the newly announced inflation target, i.e., $\pi = \mathbb{E}_t(\pi_{t+s}^*) = \pi_t^*$ for any $s \geq 0$. In response, firms reoptimize their frequency of price adjustment in a way that the long-run profits of the firms are optimized. This process is modeled after Levin and Yun (2007). Note that equations (C.1)∼(C.3) still describe firms' pricing strategy each period. The difference is that $\varphi(\pi)$ is reoptimized each period with *long-run considerations*. If there is no news about the inflation target today, firms do not reoptimize their frequency of price adjustment. Below we describe this long-run consideration briefly (see also Kurozumi (2016)).[37]

Suppose that a firm's optimal price, denoted by P_{t-j}^*, was chosen j periods ago. Today this firm's relative price is given by

$$\frac{P_{j,t-j}^*}{P_t} = \frac{P_{t-j}^*}{P_{t-j}} \frac{P_{t-j}}{P_{t-j+1}} \cdots \frac{P_{t-1}}{P_t} \equiv \frac{\tilde{P}^*}{\pi^j}$$

where $\tilde{P}^* \equiv P_{t-j}^*/P_{t-j}$ in the steady state. The value function of a firm with a j-period-old reset price is given by

$$V_j(\varphi) = \Pi(\tilde{P}^*/\pi^j) - I_{\{j=0\}} \digamma y + \beta^K [\varphi V_{j+1}(\varphi) + (1-\varphi) V_0(\varphi)] \tag{C.8}$$

[37]Since firms can reoptimize their frequency of price adjustment, we drop the indexation assumption in this section. If the trend inflation is too high and deviating from the optimal price is large enough, firms simply choose a high frequency of price adjustment, which has the same effect of preventing too large price dispersion as indexation.

where $F y$ is the menu cost, which is a fraction F of output in the steady state and the profit Π is

$$\Pi(\tilde{P}^*/\pi^j) = [(\tilde{P}^*/\pi^j)^{1-\gamma} - \mu(\tilde{P}^*/\pi^j)^{-\gamma}]y.$$

Here one can view π^j as a measure of how fast the relative price of the firm erodes. The erosion is faster when the trend inflation is high.

Setting $j = 0$ in equation (C.8) and iterating on $j = 1, 2, 3, ...$, we can show V_0 is equivalent with

$$V_0(\varphi) = \max_{\varphi\in[0,1]} \frac{1-\beta^K\varphi}{1-\beta^K} \left\{ \sum_{j=0}^{\infty} (\beta^K\varphi)^j [(\tilde{P}^*/\pi^j)^{1-\gamma} - \mu \cdot (\tilde{P}^*/\pi^j)^{-\gamma}] - F \right\} y.$$

The efficiency condition for φ is given by

$$\begin{aligned} 0 = {} & \gamma F(1-\varphi)(1-\beta^K\varphi\pi^{\gamma-1})^2(1-\beta^K\varphi\pi^{\gamma}) - (1-\varphi\pi^{\gamma-1}) \\ & \times[\gamma\pi^{\gamma-1}(\pi-1)(1-\beta^K\varphi) - (\pi^{\gamma}-1)(1-\beta^K\varphi\pi^{\gamma-1})]. \end{aligned}$$

This condition implicitly defines a mapping, $\varphi = \varphi(\pi; \boldsymbol{\theta})$ where the vector $\boldsymbol{\theta}$ collects all the parameters of the model other than the trend inflation rate.

One might wonder if the presence of menu costs might introduce a structural break between the pricing strategy given by equations (C.1)$\sim$(C.3) and the reoptimization of the frequency of price adjustment, and if equations (C.1)$\sim$(C.3) may not describe the pricing strategy once $\varphi(\pi; \boldsymbol{\theta})$ is reoptimized due to the presence of menu costs. Equations (C.1)$\sim$(C.3) still describe the optimal pricing strategy. This is the difference between the endogenous contract duration model of Levin and Yun (2007) and conventional menu cost models such as Dotsey et al. (1999) and Golosov and Lucas (2007).

In conventional menu cost models, action/inaction decisions at each point in time are based on a comparison of benefits and costs of action. The benefits of action are measured by the difference between the values of action and inaction. The costs of adjustment take the form of fixed costs, one of which is the menu cost. In the endogenous contract duration model, action/inaction decisions are still determined by probability $\varphi(\pi; \boldsymbol{\theta})$, which is chosen optimally by the firm.[38] In other words, the endogenous contract duration model is still a staggered price contract model. The economic problem of determining $\varphi(\pi; \boldsymbol{\theta})$ is based upon long-run consideration of the benefits and costs of a given frequency. For a particular frequency of adjustment, average profits of the firm and the costs of adjusting prices are compared such that overall long-run profit is maximized. The question in this model is how often you should adjust your price given the fixed cost that you have to pay each time you adjust your price. Once the frequency is chosen, the menu cost is irrelevant because the pricing is determined according to probability $\varphi(\pi; \boldsymbol{\theta})$, and equations (C.1)$\sim$(C.3) sill describe the optimal pricing strategy.

C.2 Agents K

With nominal rigidities, we need to create a transmission channel for monetary policy. We assume that the government issues nominal bonds, which are purchased by agents K, and the government bonds enter the utility function of agents K in a symmetric way to private bonds. The preferences of agents K take the following form:

$$U_t^K = \mathbb{E}_t \sum_{t=0}^{\infty} (\beta^K)^t \left\{ \frac{(c_t^K)^{1-1/\sigma_c}}{1-1/\sigma_c} + \psi^B \frac{[1+b_t(1-\chi)/\chi]^{1-1/\sigma_b}}{1-1/\sigma_b} + \psi^G \frac{(1+b_t^G)^{1-1/\sigma_g}}{1-1/\sigma_g} \right\}, \tag{C.9}$$

where b_t^G is per-capita holdings of public bonds. The per-capita budget constraint of agents K is given by

$$\begin{aligned} c_t^K = {} & (l_t - q_t^B b_t)\frac{1-\chi}{\chi} + \frac{1}{\chi}\{r_t k_{t-1} + \Pi_t - q_t^K[k_t - (1-\delta)k_{t-1}]\} \\ & + \frac{b_{t-1}^G}{\pi_t} - \frac{1}{1+i_t} b_t^G, \end{aligned} \tag{C.10}$$

[38]Without the menu cost, i.e., $F = 0$, $\varphi(\pi; \boldsymbol{\theta}) = 0$ is optimal. With $F > 0$, $\varphi(\pi; \boldsymbol{\theta}) > 0$ is optimal.

where

$$l_t = (1 - h\delta_t^B)\frac{b_{t-1}}{\pi_t}.$$

The efficiency conditions for maximization of (C.9) subject to (C.10) are given by

$$\Lambda_t^K = (c_t^K - sc_{t-1}^K)^{-1/\sigma_c}, \tag{C.11}$$

$$q_t^B + \tau_b(1 - q_t^B) = \beta^K \mathbb{E}_t\left[\frac{\Lambda_{t+1}^K}{\Lambda_t^K}(1 - hp_{t+1}^\delta)\frac{1}{\pi_{t+1}}\right] + \frac{\psi^B}{\Lambda_t^K}\left[1 + b_t\left(\frac{1-\chi}{\chi}\right)\right]^{-1/\sigma_b}, \tag{C.12}$$

$$1 = \beta^K \mathbb{E}_t\left[\frac{\Lambda_{t+1}^K}{\Lambda_t^K}\left(\frac{r_{t+1} + (1-\delta)q_{t+1}^K}{q_t^K}\right)\right], \tag{C.13}$$

$$\frac{1 + \tau_b i_t}{1 + i_t} = \beta^K \mathbb{E}_t\left[\frac{\Lambda_{t+1}^K}{\Lambda_t^K}\frac{1}{\pi_{t+1}}\right] + \frac{\psi^G}{\Lambda_t^K}(1 + b_t^G)^{-1/\sigma_g}, \tag{C.14}$$

where Λ_t^K is the shadow value of the budget constraint for agents K. Equation (C.12) plays the role of credit supply. The problem for agents W remains the same as in the main text.

C.3 Government

Two branches of government exist: fiscal and monetary authorities. The fiscal authority runs a balanced budget each period. To achieve the balanced budget, the fiscal authority funds UI benefits and interest rate expenses on government debt by imposing a lump-sum tax on agents W:

$$T_t = (1 - \chi - n_t)b^U + \chi\left(\frac{b_{t-1}^G}{\pi_t} - \frac{b_t^G}{1 + i_t}\right).$$

We assume that the supply of government bonds is fixed, i.e., $b_t^G = b_{t-1}^G = b^G$. The fiscal authority funds the social security spending by imposing interest and dividend income taxes on agents W.

The monetary authority conducts monetary policy according to a Taylor rule given by

$$i_t = \max\{0, i^*(\pi^*) + \rho_\pi(\pi_t^Y - \pi^*)\},$$

where π_t^Y is the annual inflation rate and π^* is annual trend inflation. Note that the long-run level of the nominal interest rate depends on trend inflation such that the real interest rate remains constant. Also note that the monetary authority faces the zero lower bound constraint on nominal interest rates.

C.4 Calibration

To calibrate both models with nominal rigidities, we follow the same calibration as the baseline model, see Table 1. Then, we set $\psi^G = \psi^B$ and $\sigma_g = \sigma_b$ such that the preferences are modeled symmetrically between private and public bond holdings. Regarding the parameters of the Taylor rule, we use a real interest rate of 0.5 percent quarterly for the monetary policy rule, $\rho_\pi = 70$ for the exogenous contract duration model, and $\rho_\pi = 2.5$ for the endogenous contract duration model. As shown by Kurozumi (2016), too high a level of a trend inflation rate in the context of an exogenous contract duration model suffers from indeterminacy. Our choice, $\rho_\pi = 70$, is to avoid such indeterminacy, which disappears in the environment of the endogenous contract duration. Additionally, for the endogenous contract duration model, we use a menu cost Fy equal to 0.225 percent of output.