Imperfect Competition, Secular Stagnation and Factor Shares

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Abstract

Secular stagnation has been used to describe the period of slower growth since roughly 1980. Among the potential causes of secular stagnation, the rise of monopoly rents has gained increasing attention in the current policy debates (Furman and Orszag, 2015; Summers, 2016; CEA, 2016). In the the post-1980 U.S. economy, several other trends have been observed including the rise of asset prices and corporate profits, the slowdown of output and investment, the stagnation of wages and the decline of the labor share. We build a growth model with monopolistic competition and a corporate sector to examine how well a model of increasing markups can explain these trends. Increasing markups can explain the decline in the labor share, low output, and real wages growing more slowly than productivity, but overpredicts the decline in the capital stock, which causes the model's fit to be poor on asset prices and asset returns.

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1 Motivation

In an influential speech at the 2013 IMF Annual Research Conference (Summers, 2013), Larry Summers suggested the possibility that advanced economies might be suffering from secular stagnation. Alvin Hansen originally discussed secular stagnation as a decline in growth due to less factor accumulation of land, labor and capital (Hansen, 1938). More recently, Secular stagnation has been redefined recently as a steady downward tendency of the real interest rate, reflecting an imbalance between an excess of desired saving and a decreasing propensity to invest (Eichengreen, 2015; Eggertsson et al., 2017), though we use the term in its original sense of persistently slow growth. According to secular stagnation proponents, this imbalance has occurred during the last three-decade period, characterized by persistent output gaps and lower rates of growth and inflation and only interrupted by brief periods of adequate growth during times of bubbles or other unsustainable stimulus. While growth did accelerate during the decade of 1995-2005, since then growth has plunged again across the globe (Ball, 2014).

The literature has proposed several explanations for this phenomenon: a decline in investment due to the lack of investment opportunities and low returns to innovation (Gordon, 2012), an excess of savings due to a persistent liquidity trap (Eggertsson and Mehrotra, 2014), and a decline of the relative price of investment goods (Thwaites, 2015). Recently, the increase in market power has gained increasing attention as another potential explanation for secular stagnation (De Loecker and Eeckhout, 2017). Jones and Philippon (2016) shows how a secular decline in competition can generate weak corporate investment and low interest rates. Summers (2016) has noted another trend occuring at roughly the same time: the secular increase in the stock market value of non-financial corporations.

If an economy is experiencing a secular rise in the market value of corporations, the return to capital should be expected to be unusually high, and a parallel rise in new capital investment would also be expected. But while equity have are far higher than historical averages, but this has not been accompanied by an increase in corporate investment which, with the exception of the technological boom in the late 90s, also has displayed a downward trend. Moreover, financial payouts in the form of dividends and equity buybacks have trended upward, consistent with the view that corporations have been cutting back on investment to raise the returns on financial capital (Gruber and Kamin, 2015). Quite striking from an economic perspective, the positive empirical relationship between corporate cash flow and borrowing to productive investment has disappeared in the three decades, and has been replaced with a positive relation to shareholder payouts (Mason, 2015). [1]

[1] Gutiérrez and Philippon (2016) show that increased concentration and a focus on short-term profits at the expense of long-term investments are the main determinants of both weak investment and the

The upswing of asset prices is not a uniquely U.S. phenomenon. The rise of stock market wealth, as measured by Tobin's Q, is a common phenomenon across all industrial economies. Not surprisingly, Piketty (2014) shows that asset prices and housing wealth have been the most important drivers of the observed rising wealth-income ratios in the advanced economies, though, in the case of asset prices, the largest increases have been seen in the Anglo-Saxon economies.

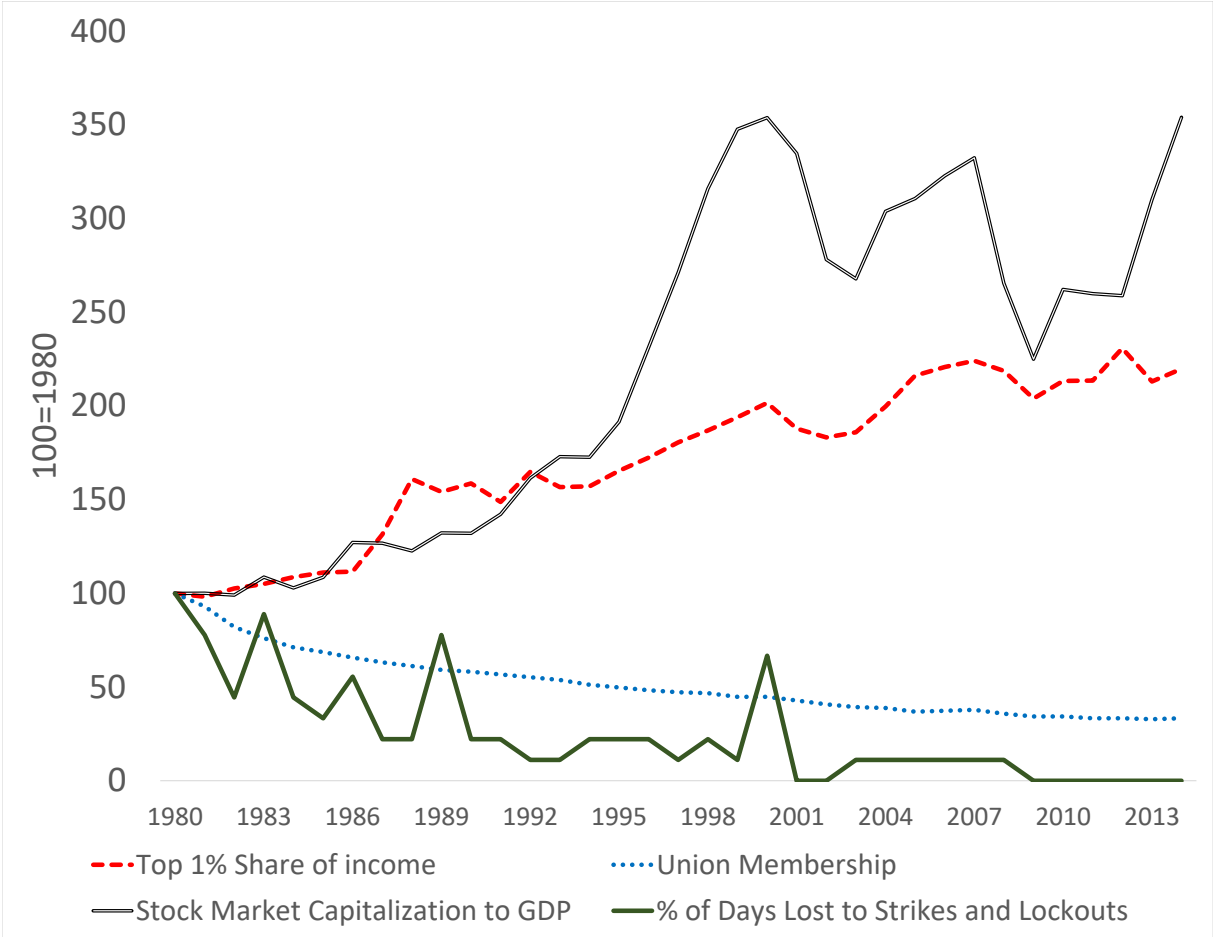
As Summers (2016) notes, the divergence between rising corporate profits and declining interest rates is also puzzling. If interest rates reflect the prevailing return to capital, then corporate profits should also comove with interest rates. One possible explanation for the disparity between these two variables is an increased prevalence of economic rents. An increase in market power could explain why we observe higher profits and higher stock market valuations but also lower investment and lower output growth. Furthermore, interest rates could fall because investment demand is lower, which could explain the lack of any correlation between borrowing and corporate investment.

Has monopoly power actually increased? Furman and Orszag (2015) and CEA (2016) document that i) many industries have become more concentrated, partly because the U.S. economy comes from a major merger wave, (ii) there is a growing disparity in returns to invested capital across corporations, iii) union membership has declined, and iv) business formation has also declined. Khan and Vaheesan (2016) and Gerhart (1982) shows how decreased antitrust enforcement since the early 1980s, based on legal theories as described in Bork's 1978 class *The Antitrust Paradox*, has resulted in significantly increased concentration. Baker and Salop (2015) and Baker (2007) argue that better competition policy could significantly reduce inequality and increase increase innovation, both trends which have arisen since 1980.

The rise of market power would have the additional merit of explaining some striking trends in inequality that have also characterized this period of stagnation. The rise of economic rents, for example, could have caused the rise in the capital share above the level implied by the behavior of conventional returns. This would add another potential explanation to the observed decline of the labor share during the last three decades.

weakening correlation between corporate profits and corporate investment.

Figure 1: Trends in inequality since 1980



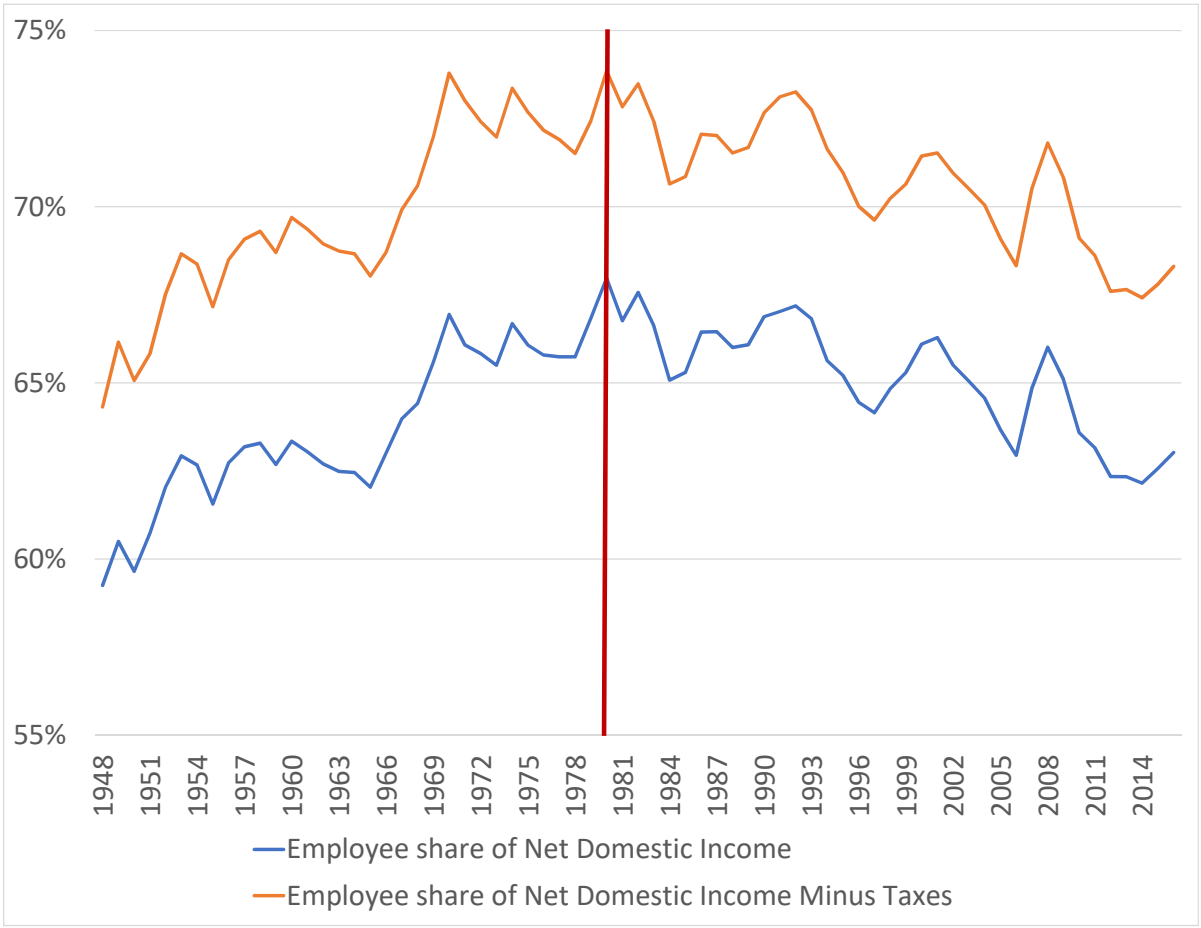
Sources: Bureau of Labor Statistics, Piketty and Saez (2003), World Bank

Figure 1 plots the trends in the share of income of the top 1%, stock market capitalization relative to GDP, private sector union membership as a fraction of all workers, and % of days lost to work stoppages, which is primarily strikes but also includes lockouts. The first two are positively related to inequality, as they relate to sources of income or wealth that accrue primarily to the wealthy. On the other hand, union membership and the importance of strikes are both indicative of workers' bargaining power, which both have declined significantly since 1980. Azar et al. (2017) found that labor markets are concentrated and there is a significant monopsony effect reducing wages. At the same time, the labor share (share of income received by employees as compensation) reversed its upward trend in 1980 and has declined steadily since then.[2] These trends can be seen

[2]This mirrors trends in inequality around the same time that declining inequality reversed itself. Bridgman (2017) found that labor share and inequality were not correlated when depreciation and production taxes were removed from national income. We use a slightly different labor share measure which does not include proprietor's income which is apportioned to labor and capital income based on rigid formulas. The employee labor share more closely mirrors our model concept of labor as well.

in Figure 2

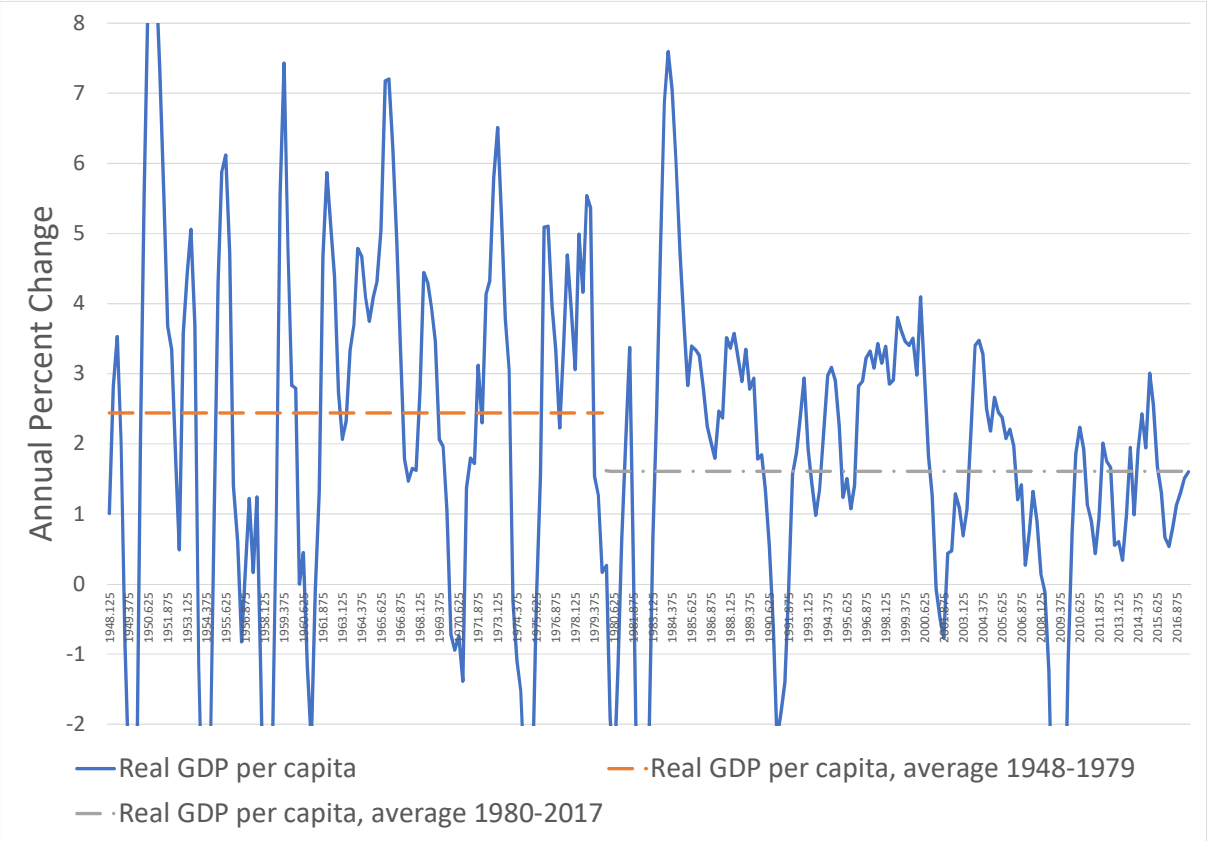
Figure 2: Labor Share: 1947-2016



Sources: Bureau of Economic Analysis (BEA): Compensation of Employees as a Share of National Income, excluding depreciation in both series, and excluding production taxes in the second.

Figure 3 shows annualized GDP per capita growth quarterly from 1948-1980, with the period since 1980s seeing much lower growth. While the US economy grew at an average rate of 3.9% the US economy has only grown at a 2.6% rate since then, a decline of roughly a third. We will model both the trend toward increasing equity wealth, declining labor bargaining power, and how both factor reduce GDP in our model.

Figure 3: Real GDP per capita growth: 1948-2016



Source: Bureau of Economic Analysis

This paper is a first step in developing a theory about secular stagnation and monopoly power. We build a standard growth model with imperfect competition in the goods and labor market, using the standard Dixit-Stiglitz framework. We show that under certain conditions the model is a good at explaining the trends of investment, capital-output ratio, Tobin's Q and the labor income share. Although much more computational and calibration work should be done, the predictions of the model are very explanatory and confirm the idea that market power might have played an important role in explaining secular stagnation.

The rest of the paper is organized as follows. Section 2 presents the model and some characterization of the equilibrium. Section 3 discusses the effects of market power in light of model's equations. Section 4 shows preliminary computational findings. An 5 concludes.

2 Model

We consider a dynamic economy that consists of two types of households, capitalists and workers. There are n varieties $y_1, ..., y_n$ of goods which can be used either for consumption or investment. Each variety is produced by a single firm which is an effective monopolist in the consumption and investment goods market for its particular commodity. The Dixit-Stiglitz aggregator is used so that each firm faces a downward-sloping demand curve and benefits from constant markups in monopolistic competition. Imperfect competition is also introduced in the labor market. Each of the firms is a monopsonist employer that faces an upward-sloping labor supply curve and maximizes its value by choosing the employment level.

Firms are owned by capitalists' households, who make savings decisions and only receive income from the ownership of stocks. At every period there is one equity share outstanding per firm. Therefore, the market clearing condition in the stock market requires $s_{jt} = 1$. Labor is solely provided by workers' households. As in Gali et al. (2007), worker households do not own any assets and, therefore, just consume all their current labor income. Campbell and Mankiw (1989) provide evidence of the importance for the aggregate economy of such rule-of-thumb households in the U.S. and other industrialized economies. Finally, although there is not a continuum of firms, we proceed by assuming that individual firms do not have the ability to influence aggregate output and prices. In this respect, we follow Acemoglu (2009).

2.1 Capitalists

An infinite lived representative capitalist household seeks to maximize

$$Max_{c^c_{jt}, s_{jt}} \sum_{t=0}^{\infty} \beta^t u\left(C^c_t\right)$$

subject to

$$C^c_t = \left(\sum_{j=1}^{n} \left(c^c_{jt}\right)^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}} \tag{1}$$

and

$$\sum_{j=1}^{n} p_{jt} c^c_{jt} + \sum_{j=1}^{n} v_{jt} s_{jt+1} = \sum_{j=1}^{n} \left(v_{jt} + d_{jt}\right) s_{jt} \quad \forall t \tag{2}$$

C^c_t is a CES composite consumption aggregator with elasticity of substitution $\xi > 1$. c^c_{jt} is the consumption level of good j, which can be purchased at price p_{jt}. s_{jt} is a state

variable and denotes the number of stocks of firm j held by the capitalist household at the beginning of period t. Stocks generate a dividend income d_{jt} and can be traded at any period t at price v_{jt}. s_{jt+1} is the number of stocks that the household buys in period t at the same price v_{jt}. Therefore, the value of financial wealth owned by the capitalist household at the end of period t is $\sum_{j=1}^{n} v_{jt} s_{jt+1}$.

The problem above can be solved in two stages. In the first stage, the capitalist households decide how to allocate a given financial income $m_{ct} = \sum_{j=1}^{n} (v_{jt} + d_{jt}) s_{jt} - \sum_{j=1}^{n} v_{jt} s_{jt+1}$ among the different goods. This stage results in the standard Dixit-Stiglitz relative demand function of good j equal to:

$$c_{jt}^{c} = \left(\frac{p_{jt}}{P_t} \right)^{-\xi} C_t^c \tag{3}$$

where $P_t = \left(\sum_{j=1}^{n} p_{jt}^{1-\xi} \right)^{\frac{1}{1-\xi}}$.

During the second stage, the household solves the intertemporal problem deciding how much they would like to spend on total consumption C_t^c and how many stocks he would like to buy given the current financial income. This stage results in a standard Euler equation which has to be satisfied for the returns of each firm's stocks:

$$\frac{u'\left(C_t^c\right)}{\beta u'\left(C_{t+1}^c\right)} = \frac{\frac{v_{jt+1}+d_{jt+1}}{P_{t+1}}}{\frac{v_{jt}}{P_t}} \tag{4}$$

Denoting $\frac{u'(C_t^c)}{\beta u'\left(C_{t+1}^c\right)}$ as $1+r_t'$, using forward substitution and imposing the transversality condition $lim_{t\to\infty} \frac{v_{jt}}{P_t} = 0$, we can express the real value of firm j's stock at period t as the stream of future dividends:

$$\frac{v_{jt}}{P_t} = \sum_{t=0}^{\infty} \frac{d_{jt+1}}{\prod_{h=1}^{t} P_{t+h} \left(1 + r_{t+h}\right)} \tag{5}$$

2.2 Workers

Workers' households only receive income from labor, and maximize total consumption C^w. Since they are forced to consume all their current income, their problem is static. To simplify the consumption-labor choice, I assume linear utility in consumption. As in the case of capitalist households, C^w is given by a CES aggregation function of all the varieties. To make the labor supply problem as tractable as possible, we assume

that each workers' households has n members and that each of them works in a different sector, which resembles the idea that labor markets are segmented. Disutility from labor is assumed to be the same across sectors. Therefore, the problem of workers can be expressed as follows:

$$Max_{c_{jt}^w, l_{jt}} C_t^w - \gamma \sum_{j=1}^{n} \frac{l_{jt}^{1+\theta}}{1+\theta} \tag{6}$$

subject to

$$C_t^w = \left(\sum_{j=1}^{n} \left(c_{jt}^w \right)^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}} \tag{7}$$

and

$$\sum_{j=1}^{n} p_{jt} c_{jt}^w = \sum_{j=1}^{n} w_{jt} l_{jt} \tag{8}$$

where θ is assumed to be positive. This problem can also be solved in two stages. In the first stage, the household decides how to allocate a given labor income $m_{wt} = \sum_{j=1}^{n} w_{jt} l_{jt}$ among the different goods. This stage results in a standard Dixit-Stiglitz relative demand function of good j equal to:

$$c_{jt}^w = \left(\frac{p_{jt}}{P_t} \right)^{-\xi} C_t^w \tag{9}$$

where $P_t = \left(\sum_{j=1}^{n} p_{jt}^{1-\xi} \right)^{\frac{1}{1-\xi}}$. In the second stage, the household decides how much labor he supplies. Since utility is linear in total consumption C^w, this stage results in the following tractable labor supply equation:

$$\frac{w_{jt}}{P_t} = \gamma l_{jt}^{\theta} \tag{10}$$

for all j. Note that the labor supply is upward-sloping if $\gamma > 0$ and $\theta > 0$.

2.3 Firms

Each of the n varieties is produced by a monopolistically competitive firm. At each period t, a typical firm j uses K_{jt} and labor L_{jt} to produce a differentiated good Y_{jt} with a CES production technology of the following type:

$$F\left(K_{jt}, L_{jt}\right) = \left(\phi K_{jt}^{\frac{\sigma-1}{\sigma}} + (1-\phi) L_{jt}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{11}$$

where ϕ is a distributional parameter and σ is the elasticity of substitution between labor and capital. Firm j purchases capital goods from each of the other firms. Let i_{jh} denote the flow of capital goods produced by firm h and puchased by firm j. Firm's j

capital stock evolves according to the law of motion

$$K_{jt+1} - K_{jt} = i_{jt} - \delta K_{jt} \tag{12}$$

where gross investment i_j is given at each period t by the CES aggregation function

$$i_{jt} = \left(\sum_{h=1}^{n} (i_{jht})^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}} \tag{13}$$

Parameter $\xi > 1$ denotes the elasticity of substitution between different goods within the production process of firm j. Note that this parameter is the same as the elasticity parameter in the CES composite consumption index. In principle, the elasticities of consumption and investment demand functions may be different, but this would open the door to the existence of multiple equilibria (Gali, 1996), making the problem unnecessarily complex. Therefore, for simplicity, the elasticity is assumed to be the same.

The problem of the firm can also be solved also in two stages. During the first stage, firm j demands investment i_{jh} to maximize the amount of gross investment conditional on the amount of available resources m_j:

$$Max_{i_{jht}} \left(\sum_{h=1}^{n} (i_{jht})^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}} \tag{14}$$

subject to

$$\sum_{h=1}^{n} p_{ht} i_{jht} = m_{jt} \tag{15}$$

where p_h is the price of variety h. This problem results in a standard Dixit-Stiglitz relative demand function of good h by firm j

$$\left(\frac{i_{jht}}{i_{jzt}} \right)^{\frac{-1}{\xi}} = \frac{p_{ht}}{p_{zt}} \tag{16}$$

which can be expressed in terms of gross investment i_j by using the price index P:

$$\left(\frac{i_{jht}}{i_{jt}} \right)^{\frac{-1}{\xi}} = \frac{p_{ht}}{P_t} \tag{17}$$

Note that since the elasticity parameter is the same as the parameter in the households' problem, the resulting price index P is also the same. Since all the firms face the same problem, the demand of good h by all the firms, which I denote i^{dh}, is given by the

following sum:

$$i_t^{dh} = \sum_{j=1}^{n} i_{jht} = \left(\frac{p_{ht}}{P_t}\right)^{-\xi} \sum_{j=1}^{n} i_{jt} = \left(\frac{p_{ht}}{p_t}\right)^{-\xi} i_t^T \tag{18}$$

where i_t^T is total gross investment in the economy. Note also that $i^{dj}$and i_j refer to different concepts. While the former refers to the total amount of good j demanded by the whole firms' sector, the latter refers to the gross investment decided by the firm j.

During the second stage, firms choose the levels of capital and employment that maximize their real value. Since they are monopolists in the goods market and monopsonists in the labor market, they internalize the effect of their demand for goods and the supply of labor respectively. Total demand of good j is given by the sum of the capitalists', workers' and firms' individual demands for variety j:

$$y_j = i^{dj} + c_j^w + c_j^c = \left(\frac{p_j}{P}\right)^{-\xi} \left(i^T + C^w + C^c\right) \tag{19}$$

where $C_t^w + C_t^c + i_t^T = y_t^T$ is merely the aggregate demand of the whole economy. The supply of labor faced by firm j is given by equation 10. Given that capital K_j is the only individual state, the optimization problem of the firm, expressed in recursive formulation, is:

$$V\left(K_j\right) = Max_{K_j', L_j} \left\{ \frac{d_j}{P} + \frac{V\left(K_j'\right)}{1 + r'} \right\} \tag{20}$$

subject to the following constraints

$$d_j = p_j F(K_j, L_j) - w_j L_j - \sum_{h=1}^{n} p_h i_{jh} \tag{21}$$

$$\frac{p_j}{P} = \left(\frac{y_j}{y^T}\right)^{\frac{-1}{\xi}} \tag{22}$$

$$\sum_{h=1}^{n} p_h i_{jh} = i_j P \tag{23}$$

$$i_j = K_j' - (1 + \delta) K_j \tag{24}$$

$$\frac{w_j}{P} = \gamma L_j^{\theta} \tag{25}$$

where, to make the problem of the firms consistent with that of the households, $\frac{1}{1+r'}$ equals the discount factor of capitalists. Equation 21 is the flow and funds constraint of firm j. Equation 22 is the total demand of variety j. Equation 23 results from the combination

of the investment demand in equation 17 and the price index $P_t = \left(\sum_{j=1}^{n} p_{jt}^{1-\xi}\right)^{\frac{1}{1-\xi}}$. Equation 24 is the law if motion of capital. Lastly, equation 25 is the labor supply. Since firm j is monopsonist employer, he internalizes the entire supply of labor in sector j and chooses the level of employment L_j. The problem of firm j results in the following first-order conditions for labor and capital respectively:

$$\frac{w_j}{P} = \left(\frac{\xi - 1}{\xi}\right)\left(\frac{1}{1+\theta}\right)\frac{p_j F_L(K_j, L_j)}{P} \tag{26}$$

$$P\,(1 + r') = \left(\frac{\xi - 1}{\xi}\right) p'_j F_K(K'_j, L'_j) + P'\,(1 - \delta) \tag{27}$$

The presence of ξ affects the first-order conditions of both labor and capital (Equations 26 and 27). The deviation from competitive behavior affects the equilibrium wage and return to capital and gives a constant mark-up equal to $\frac{1}{1-\frac{1}{\xi}}$, which measures the degree of monopoly power in the goods market. When the elasticity ξ increases, the degree of substitution between varieties increases and the degree of monopoly of a particular sector j falls, bringing the real interest rate and the real wage closer to their respective marginal products.

The presence of θ only adjusts the first order condition of labor. The deviation from competitive behavior in the labor market introduces an additional wedge between the real wage and the marginal productivity of labor which measures the degree of monopsony power. Note that given the preference structure of workers' households, $\frac{1}{\theta}$ measures the elasticity of labor supply with respect to the real wage, keeping the marginal utility of wealth constant. That is, $\frac{1}{\theta}$ is the Frisch elasticity that captures the pure substitution effect of a change in the real wage. Since the utility of consumption is linear, wealth effects are absent and, for a given γ, the parameter θ alone determines the shape of the labor supply. The higher θ is, the lower the elasticity of the labor supply is. The labor supply is then more vertical and the degree of monopsony power, as measured by the constant mark-up $1 + \theta$, is higher.

As shown below, both ξ and θ have important implications in the dynamics of capital accumulation, asset prices and factor shares.

2.4 Equilibrium

Given the firms' symmetry existing in the model, all firms make the same investment decision, produce the same quantity and set the same price. Accordingly, $i_{jt} = i_t$, $i_t^{dj} = i_t^d$,

$c^w_{jt} = c^w_t$, $c^c_{jt} = c^c_t$, $L_{jt} = L_t$, $K_{jt} = K_t$, $w_{jt} = w_t$, $y_{jt} = y_t$, $p_{jt} = p_t$, $d_{jt} = d_t$, $v_{jt} = v_t$ for all j and all t. Since each firm charges the same price, the price index P can be computed as

$$P_t = N^{\frac{-1}{\xi-1}} p_t \tag{28}$$

Since each firm produce the same quantity and the equilibrium demand $\frac{p}{P} = \left(\frac{y}{y^T}\right)^{\frac{-1}{\xi}}$ holds in equilibrium, aggregate output can be computed as y^T

$$y^T_t = N^{\frac{\xi}{\xi-1}} y_t \tag{29}$$

Market clearing in the goods market requires

$$F\left(K_t, L_t\right) = i^d_t + c^w_t + c^c_t \quad \forall t \tag{30}$$

Market clearing in the assets market requires

$$s_t = 1 \quad \forall t \tag{31}$$

The market clearing condition in the labor market is expressed in equation 25, where the amount of labor supplied by households, l_{jt}, has been replaced by the employment level L_{jt} chosen by the firm.

Definition 1. *An equilibrium in this economy is a sequence of prices* $\{p_t, v_t, w_t\}^{\infty}_{t=0}$ *and allocations of consumption, asset holdings, investment, dividends, labor and capital* $\{c^w_t, c^c_t, s_{t+1}, i_t, d_t, L_t, K_{t+1}\}^{\infty}_{t=0}$ *such that*

1. Given K_0 and prices, $\{i_t, d_t, L_t, K_{t+1}\}^{\infty}_{t=0}$ solve the problem of each firm.
2. Given prices and d_t, $\{c^c_t, s_{t+1}\}^{\infty}_{t=0}$ solve the problem of the capitalists household.
3. Given prices and L_t, $\{c^w_t\}^{\infty}_{t=0}$ solve the problem of the workers household.
4. The allocations $\{c^w_t, c^c_t, s_{t+1}, i_t, L_t, K_{t+1}\}$ are such that all markets clear at each period t.

Note that in absence of monopsony power in the labor market (i.e. when firms do not internalize the upward-sloping labor supply or when θ is zero)[3] and in absence of monopoly power in the goods market (i.e. when the elasticity ξ tends to infinity and, therefore, the varieties are perfect substitutes), the frictions from imperfect competition

[3]When $\theta = 0$, the real wage $\frac{w}{p}$ is constant and equal to γ.

dissapear from the first order conditions, markups are equal to 1 and the model collapses to the standard neoclassical growth model. On the contrary, when θ and ξ are positive and finite, the equilibrium allocation differs from the perfectly competitive allocation. But also in this case, since markups are constant, the economy would be characterized by the existence of a unique steady state and the corresponding capital accumulation dynamics would be qualitatitive similar to those obtained with the frictionless canonical model. The interesting analysis, however, is to see how the economy responds to changes in the degree of market power. In particular, we are interested in seeing whether the equilibrium dynamics are qualititatively similar to those observed in the U.S. economy since 1980, which will show whether market power is a plausible explanation for secular stagnation in the United States since 1980. The remaining sections of the paper are devoted to addressing this question.

2.5 Some characterization of the equilibrium

Proposition 2. *If the production function displays constant returns to scale, the long-run equilibrium with no inflation is characterized by the following Tobin's Q:*

$$Q_t = 1 + \frac{\sum_{t=0}^{\infty} \frac{(\theta w_{t+1} L_{t+1}) + \frac{1}{\xi}(pF(K_{t+1}, L_{t+1}))}{\prod_{h=1}^{t}(1+r_{t+h})}}{PK_{t+1}} \tag{32}$$

Proof. Using the first-order condition with respect to capital 27 in non-recursive form and multiplying both sides by K_{t+1}, we get

$$\frac{P_t K_{t+1} = \left(\frac{\xi-1}{\xi}\right) p_{t+1} K_{t+1} F_K(K_{t+1}, L_{t+1}) + K_{t+1} P_{t+1} (1-\delta)}{1 + r_{t+1}} \tag{33}$$

Using the assumption of constant returns to scale and the first-order condition with respect to labor (Equation 26), we get the following decomposition of firm's output:

$$\left(\frac{\xi-1}{\xi}\right) F(K_{t+1}, L_{t+1}) = \left(\frac{\xi-1}{\xi}\right) K_{t+1} F_K(K_{t+1}, L_{t+1}) + \frac{w_{t+1} L_{t+1}(1+\theta)}{p_{t+1}} \tag{34}$$

Combining 33 and 34 and using constraints 21, 23 and 24, the following expression for the replacement cost of capital is obtained:

$$P_t K_{t+1} = \frac{d_{t+1} + P_{t+1} K_{t+2} - \left(\frac{1}{\xi} p_{t+1} F(K_{t+1}, L_{t+1})\right) - (\theta w_{t+1} L_{t+1})}{1 + r_{t+1}} \tag{35}$$

Using forward substitution and imposing the no-inflation condition:

$$PK_{t+1} = \sum_{t=0}^{\infty} \frac{d_{t+1}}{\prod_{h=1}^{t} (1 + r_{t+h})} - \sum_{t=0}^{\infty} \frac{\left(\frac{1}{\xi} pF(K_{t+1}, L_{t+1})\right) + (\theta w_{t+1} L_{t+1})}{\prod_{h=1}^{t} (1 + r_{t+h})} \tag{36}$$

In absence of inflation, equation 5 becomes

$$v_t = \sum_{t=0}^{\infty} \frac{d_{t+1}}{\prod_{h=1}^{t} (1 + r_{t+h})} \tag{37}$$

Then, by combining 36 and 37

$$v_t = PK_{t+1} + \left(\sum_{t=0}^{\infty} \frac{\left(\frac{1}{\xi} pF(K_{t+1}, L_{t+1})\right) + (\theta w_{t+1} L_{t+1})}{\prod_{h=1}^{t} (1 + r_{t+h})} \right) \tag{38}$$

and Tobin's Q, which is the ratio $\frac{v_t}{PK_{t+1}}$, results in equation 32. ■

Tobin's Q is the ratio between the equity value (we abstract here from non-equity liabilities) and the replacement cost of capital. Equation 32 indicates that moderate levels of monopoly power in the goods and labor market would result in Tobin's Q exceeding one. In that case, equity valuation would capture not only the market value or replacement cost of the existing physical capital, but also the discounted sum of the future monopoly rents. Therefore, monopoly rents show up as capital gains.

To understand the nature of these rents, note that they represent the amount of total value added by a firm once conventional returns to capital are considered, the wage bill has been paid and the depreciated capital has been restored. To see this, note that the total output of a firm can be decomposed into the following sum:

$$pF(K, L) = L \left(\frac{\xi - 1}{\xi} \right) pF_L(K, L) + K \left(\frac{\xi - 1}{\xi} \right) pF_K(K, L) + \frac{1}{\xi} pF(K, L) \tag{39}$$

where the first term in the RHS of 39 can be decomposed using 26 into the wage bill and the monopsony rent, that is;

$$L\left(\frac{\xi-1}{\xi}\right)pF_L(K,L) = Lw + \theta Lw \tag{40}$$

and where the second term $K\left(\frac{\xi-1}{\xi}\right)pF_K(K,L)$ represents the sum of the conventional returns and the replacement of depreciated capital.

Equation 40 implies that monopsony rents in the labor market can be equal or larger than the wage bill itself. This is certainly the case when θ is larger than one. But $\theta \geq 1$ is not the result that one should reasonably expect. Even in presence of imperfect competition in the labor market, the wage bill should be considerably higher than the monopsony rents, suggesting that realistic magnitudes of θ should be much lower than 1. This is consistent with macro estimates of the Frisch elasticity, which are often in the range of 2 to 4, implying values of θ between 0.25 and 0.5. In any case, note that the present structure of workers' preferences, where consumption enters in linear form, might increase the value of θ mechanically. This is because, in absence of wealth effects that make the labor supply more inelastic, the inelasticity required to obtain certain levels of monopsony rents can only be achieved by decreasing the substitution effect (that is, by increasing θ). As high values of θ cause drastic quantitative changes in the behavior of other variables, we limit θ to be relatively small.

Proposition 3. *For any given r, the steady state is characterized by more capital K when the economy is more competitive if $\frac{\xi}{\xi-1} < \frac{1}{\ln N}$.*

Proof. Using the FOC with respect to capital 27 and imposing the steady state condition, we define function G like

$$G(K,\xi) = \frac{P(r+\delta)}{p} - \left(1-\frac{1}{\xi}\right)F_K(K,L) = N^{\frac{1}{1-\xi}}(r+\delta) - \left(1-\frac{1}{\xi}\right)F_K(K,L) \tag{41}$$

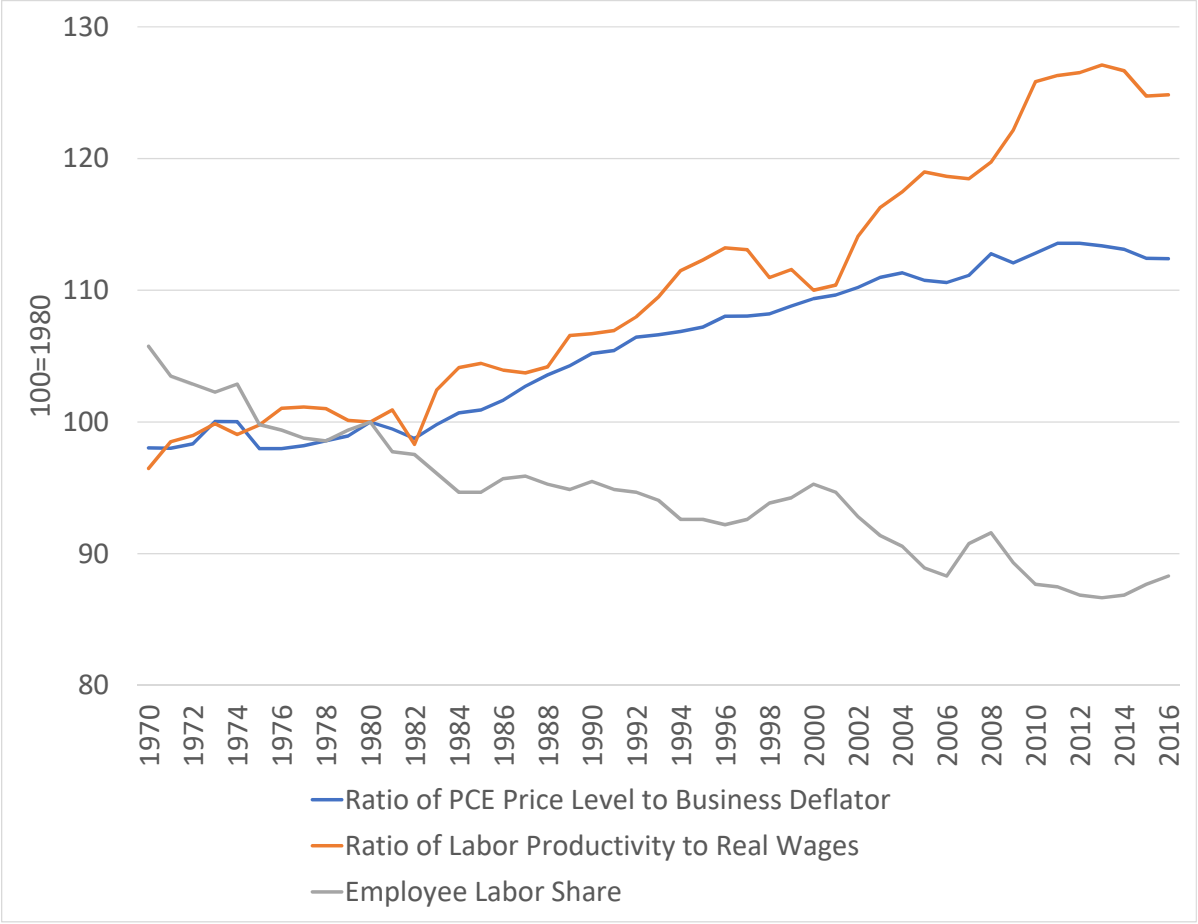
Applying the implicit function theorem, we have that

$$\frac{dK}{d\xi} = \frac{-\left(\frac{\partial G}{\partial \xi}\right)}{\left(\frac{\partial G}{\partial K}\right)} = \frac{-\left((r+\delta)\frac{1}{(1-\xi)^2}N^{\frac{1}{1-\xi}}\ln N - \frac{1}{\xi^2}F_K(K,L)\right)}{-\left(1-\frac{1}{\xi}\right)F_{KK}(K,L)} \tag{42}$$

Using the FOC with respect to capital, it is straightforward to see that the numerator is positive for any $N > 1$ only if $\frac{\xi}{\xi-1} < \frac{1}{\ln N}$. The denominator of 42 is always positive because $\xi > 1$ and $F_{KK}(K,L) < 0$. Therefore, $\frac{dK}{d\xi}$ is positive for any $N > 1$ and ξ such that $\frac{\xi}{\xi-1} < \frac{1}{\ln N}$. ■

The previous proposition implies that a growing market power, manifested by higher markups in the market for goods, reduces the capital stock when the condition $\frac{\xi}{\xi-1} < \frac{1}{\ln N}$ is satisfied. This condition imposes the upper bound $\frac{1}{\ln N}$ to the markup level $\frac{\xi}{\xi-1}$. For example, when $N = 1$, any possible markup gives a positive relation between the elasticity ξ and the steady state capital stock. When $N = 2$, the highest possible markup is 1.443, which requires an elasticity ξ at least equal to 3.26. Note that since the markup cannot be lower than one (which occurs when ξ approaches infinity asymptotically), the maximum number of varieties required to have $\frac{dK^{ss}}{d\xi} > 0$ and $\frac{\xi}{\xi-1} \geq 1$ is $N = \exp(1)$. Using the FOC with respect to labor and applying again the implicit function theorem, one can easily deduce that the same condition should hold to have $\frac{dL}{d\xi} > 0$.

Figure 4: Evidence of growing Market Power since 1980



Source: Bureau of Economic Analysis. "Personal Consumption Expenditures Chain-Type Price Index" (PCE) is an alternative consumer price index to the consumer price index. Business Deflator is "Nonfarm Business Sector: Implicit Price Deflator". 1980=100 for all series. Labor Productivity is "Nonfarm Business Sector: Real Output Per Hour of All Persons". Employee Labor Share is "Shares of gross domestic income: Compensation of employees, paid: Wage and salary accruals: Disbursements: To persons."

The idea that the U.S. economy has been stuck in a period of low investment and weak economic growth due to the rise of monopoly power is consistent with the previous proposition. It is also consistent with Figure 4, which shows some other evidence of rising

market power since 1980. The employee labor share[4] has been falling since 1980, while the ratio of labor productivity per hour has risen faster than real labor compensation per hour, as deflated by the PCE price index. [5] Both of these series should be constant if monopsony power in labor markets is constant, but these trends of a falling labor share and productivity outstripping wages are consistent with rising monopsony power of firms over workers since 1980. Rising markups of final goods prices over the cost of the inputs businesses use would be expected in an era of rising market power, which we measure as the ratio of the PCE price index to the nonfarm business price deflator. As expected, this series rises since 1980, over the same period that we see so many other trends indicative of rising market power.

These trends are also consistent with the observed decline of the physical-capital-output ratio as shown in Gonzalez (2016) and the idea, emphasized by Stiglitz (2015), that the rise of monopoly rents can be accompanied by a decrease in productive capital, leading to the stagnation or decrease in the mean marginal productivity or average wage of workers. The prediction of the model with respect to labor seems to be also reasonable. The evolution of the employment-population ratio, as shown by Glaeser (2014), illustrates that employment growth has been sluggish in the same period considered elsewhere in this paper, i.e. since 1980.

3 The Rise of Monopoly Power and its Effects.

As mentioned before, the post-1980 period has been characterized by an astonishing rise of stock market wealth, as measured by the Tobin's q for the corporate sector. Also, the ratio of the market value of equities to corporate gross value added has been unusually high and it has followed a trend similar to Tobin's Q.[6] The rate of profitability in the U.S. corporate sector, therefore, has been very high and so has been the share of corporate

[4]The standard estimate of the labor share includes proprietor's income, which is both hard to measure and includes managerial labor which is not what we are modelling in our labor share measure Giandrea and Sprague (2017).

[5]"Personal Consumption Expenditures Chain-Type Price Index" (PCE) is an alternative consumer price index to the consumer price index. The PCE better accounts for inflation resulting from the appreciation of home prices, and generally finds a lower inflation rate and so is a more conservative measure which will produce a series with a faster growth in real wages than when deflated by the consumer price index (CPI).

[6]This fact casts some doubts on intangible capital as one of the usual candidates to explain the post-1980 trend of Tobin's Q. Intangible capital might not be properly measured in aggregate corporate fixed assets (although, for example, BEA data includes stocks of R&D and other forms intellectual property products), and this mismeasurement could explain why Tobin's Q has gone upwards during periods of high intangible investment. But if that were the case, since the contribution of intangible capital is properly captured in corporate gross value added, we should have observed a roughly constant ratio of the stock market value to corporate gross value added. This is not what has happened. This ratio has followed a very similar trend to Tobin's Q (see https://fred.stlouisfed.org/graph/?g=3YJg)

value added going to capital.

These facts might be considered as evidence that investment has been highly profitable and this high payoff should have acted as an incentive to invest in more capital. But this is not what has happened. On the contrary, we know that the U.S. economy has suffered low economic growth, a decline in investment propensity and low real interest rates by historical standards.

Given these facts, the rise of corporate monopoly power emerges as a plausible explanation for this apparent puzzle. To see this, first note that an increase in monopoly power can explain the decline of capital accumulation. Proposition 3 clearly shows that when the degree of monopoly, measured by markup $\frac{\xi}{\xi-1}$, rises, capital stock can be lower in the steady state.

Monopoly power can also explain the evolution of Tobin's Q ratio. When monopoly power rises, monopoly rents boost asset prices driving Tobin's Q upwards. In that case, Tobin's Q is rising due to higher profits, but these profits do not grow reflecting improves in the productivity of capital, but increases in monopoly rents. To see this, we can use the steady state equation of Tobin's Q:

$$Q_t = 1 + \frac{\theta\gamma L^{\theta+1}}{rK} + \frac{\frac{1}{\xi}F(K,L)N^{\frac{1}{\xi-1}}}{rK} \tag{43}$$

where we have used γL^{θ} and $N^{\frac{1}{\xi-1}}$ instead of the real wage $\frac{w}{P}$ and the price relation $\frac{p}{P}$ respectively. When $\theta = 0$ (i.e. when the labor supply is completely elastic) and when ξ tends to infinity (i.e. when demand elastricity for each variety is completely elastic), then imperfect competition frictions disappear, the second and third terms of 43 become zero and then the steady state Tobin's Q equals one. In absence of monopoly rents, the model achieves the same equilibrium than the frictionless version of the McGrattan and Prescott (2005) model.

Although monopoly power has a clear positive effect in Tobin's Q, this effect is not so evident in the stock market value itself. To see this, note that the steady state equity value in real terms is:

$$\frac{v}{P} = K + \frac{\left(\frac{\frac{1}{\xi}pF(K,L)}{P}\right) + \left(\frac{\theta wL}{P}\right)}{r} \tag{44}$$

When monopoly power increases, the discounted value of future monopoly rents increases but, due to the negative effect on K that proposition 3 shows, the final effect on

$\frac{v}{P}$ might turn out to be negative. Whether the increase in rents offsets the decline in productive capital is a question that can be determined computationally, which we do in the next section.

The model can also be used to test if the change in the factor shares can be explained with the rise of monopoly rents. The decline in the labor share can come from different sources. Recent research has pointed out the evolution of the price of capital goods (Karabarbounis and Neiman, 2014), the shift towards an economy that uses intellectual property more intensely (Dongya Koh and Zheng, 2015), the offshoring of the labor-intensive component of the U.S. economy (Elsby et al., 2013) and mechanisms (other than monopoly power) that alter Tobin's Q, such as the capital income tax (Gonzalez, 2016). Barkai (2016) shows that only markups can explain the increase in the profit share at the expense of decline in both the labor and the capital share.[7]

Raurich et al. (2012) show that when markups are ignored, the estimates of the elasticity of substitution in the U.S. are downward biased because of a misspecification of the output elasticity of labor. Stiglitz (2016) suggests that monopoly rents might explain the divergence between wealth and productive capital. In a context of imperfect competition, monopoly rents would swell asset prices as a form of unproductive wealth and this would be perfectly compatible with a decline of productive capital. In addition to the subtraction of unproductive rents, the decline of the productive-capital ratio would also drive the labor share down for standard values of the elasticity of substitution.

The Council of Economic Advisors (CEA, 2016) has also examined policies that can strengthen productivity while addressing inequality, and their diagnosis suggests that much of the rise in inequality stem from cases in which markets have become less competitive. Among different pieces of evidence, they underline two. First, union power and union membership have declined consistently since the late 1970s. There has also been a divergence between labor compensation and productivity growth since the 1980s (Mishel et al., 2012). Therefore, the fact that they have decoupled from each other since then could indicate that unions were an important levelling mechanism. With a decline of their power, the balance would have been tilted towards firms. Second, they show that there has been increased market concentration across a number of industries, consistent with increasing shares of revenue earned by the largest firms. That way, market concentration can easily explain the striking return to capital obtained by major corporations.

There are two principal channels through which rents could increase inequality between factors of production. The reader will note from equations 39 and 40 that, in absence of inflation, the labor share equals:

[7] In a recent press article, Solow discusses monopoly rents as the source of divergence between productivity and wages. The article is available at https://psmag.com/the-future-of-work-why-wages-aren-t-keeping-up-6fcfac468e4.h0ty5j7av

$$\frac{wL}{py} = \frac{1 - rPK - \delta PK - \frac{1}{\xi} pF(K,L) - \theta Lw}{py} \tag{45}$$

When monopoly rents increase, the terms $\frac{1}{\xi} pF(K,L)$ and θLw increase at the expense of wages and the rental rate of capital. The first term resembles the additional rents obtained from increasing concentration in the goods market. The second term, θLw, is the rent that workers lose when firms increase its monopsony power, which would correspond to the reduced bargaining power of labor as labor unions have weakened. In the context of the model, they represent the two channels subject of concern in CEA (2016). However, there is an indirect "technology channel" which also affects the labor share. When monopoly power increases, the stock of capital falls, having an impact on wages through the marginal productivity of labor. If capital and labor are complements, this also has negative impact on the labor share.[8] From Bentolila and Saint-Paul (2003), we know that this happens if the environment is characterized by a CES technology and $\sigma < 1$. The two mechanisms will be examined in the computational exercise that follows.

4 Findings

Since we are mostly interested in the effects of markups, we proceed by assuming that there is only one variety. That way, we manage to abstract from the effect that a rise of monopoly power can have on the "love-for-variety" externality, captured by the relative price relation $P_t = N^{\frac{-1}{\xi-1}} p_t$. We calibrate the markup using the corporate operating surplus, which goes from approximately 20% in 1980 to 25% currently. This corresponds to a parameter of ξ of 5 in 1980 and 6 in 2016. We, therefore, parameterize the model with an initial steady-state of ξ=6, with this parameter taking the average value of 5.5 for the next 150 periods, with the model then ending at its final parameterization of ξ=5 for the remaining 350 periods. The model runs for 500 periods so there are no jumps to steady states. Given that it is more likely than not that these trends will continue in the future, this is likely an underestimate of the level of markups that can be expected to prevail going forward.

The parameter values we use are in the range of those found in other studies and can be found in Table 1:

The first series of variables relate to the capital stock, which falls significantly. This is due to two offsetting effects. While the markup tends to increase the return to capital, the

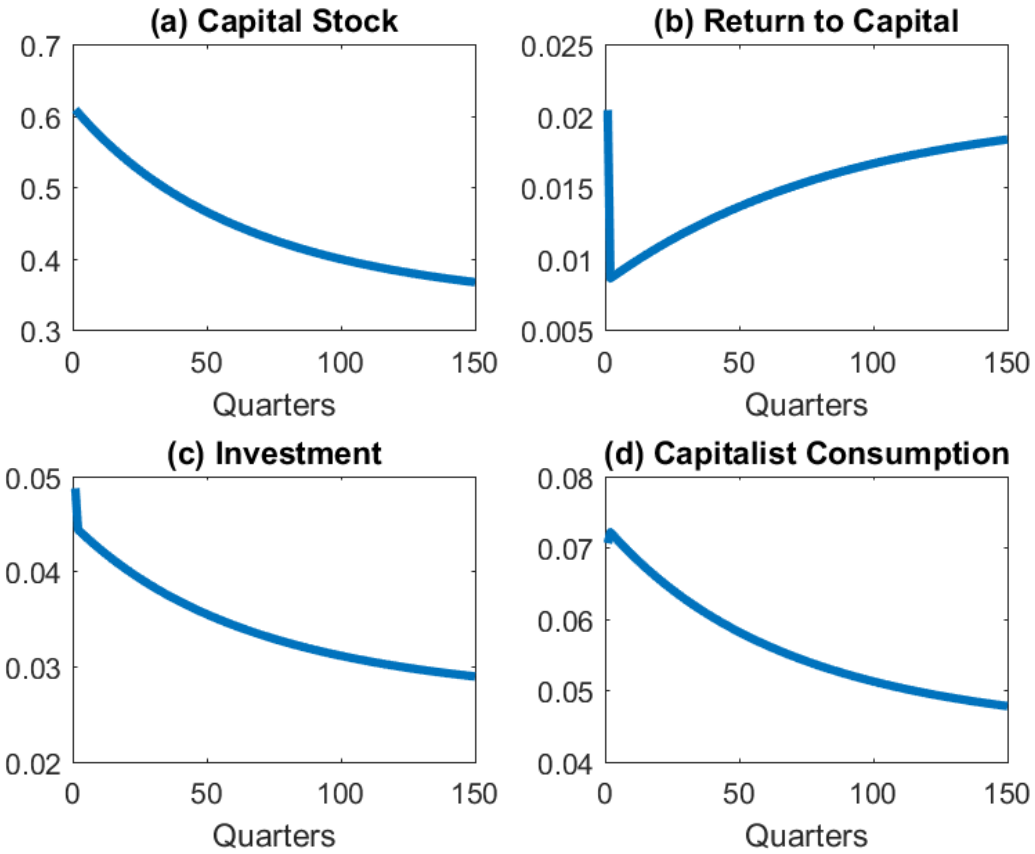
[8]The opposite would occur if capital and labor were substitutes. In that case, the technology channel would go in opposite direction to the effect of rents.

Table 1: Calibration parameters

β	μ	ϕ	δ	σ	θ
0.98	2	0.4	0.08	0.7	0.075

markup also reduces investment significantly, and the second effect dominates. Similar effects can be expected on the return to capital, which is increased by the markup but on net declines as the capital stock is declining. The consumption by the capitalist households also falls, which is counterfactual.

Figure 5: Capital variables



The second series of variables are those related to labor markets which appear in Figure 6. The real wage falls significantly in the model due to the large decline in the capital stock. The sharp decline in the capital stock and output explain the large decline in hours worked, while worker households consumption falls in tandem with the real wage and hours worked. The labor share falls significantly due primarily to the markup effect, though the monopsony effect in labor markets also plays a role.

To understand these two effects, note that, since firms' technology is CES, the ratio of marginal productivity of labor to output can be expressed in terms of the capital-output ratio:

$$\frac{LF_L(K,L)}{y} = 1 - \phi\left(\frac{K}{y}\right)^{\frac{\sigma-1}{\sigma}} \tag{46}$$

Accordingly, the labor share can be expressed in terms of $\frac{K}{y}$ and ξ:

$$\frac{wL}{py} = \left(1 - \frac{1}{\xi}\right)\left(1 - \phi\left(\frac{K}{y}\right)^{\frac{\sigma-1}{\sigma}}\right) \tag{47}$$

Figure 6: Labor variables

The third set of variables, in Figure 7, related to the firms. Real dividends fall, as a result of the effect of the falling capital stock outweighing the effect of higher profitability from a higher markup. The effect on firm value from a rise in the markup is similar. Tobin's Q also rises as the market capitalization of a firm in increased by higher markups. Output falls as both the capital stock and hours worked falls.

Figure 7: Firm variables

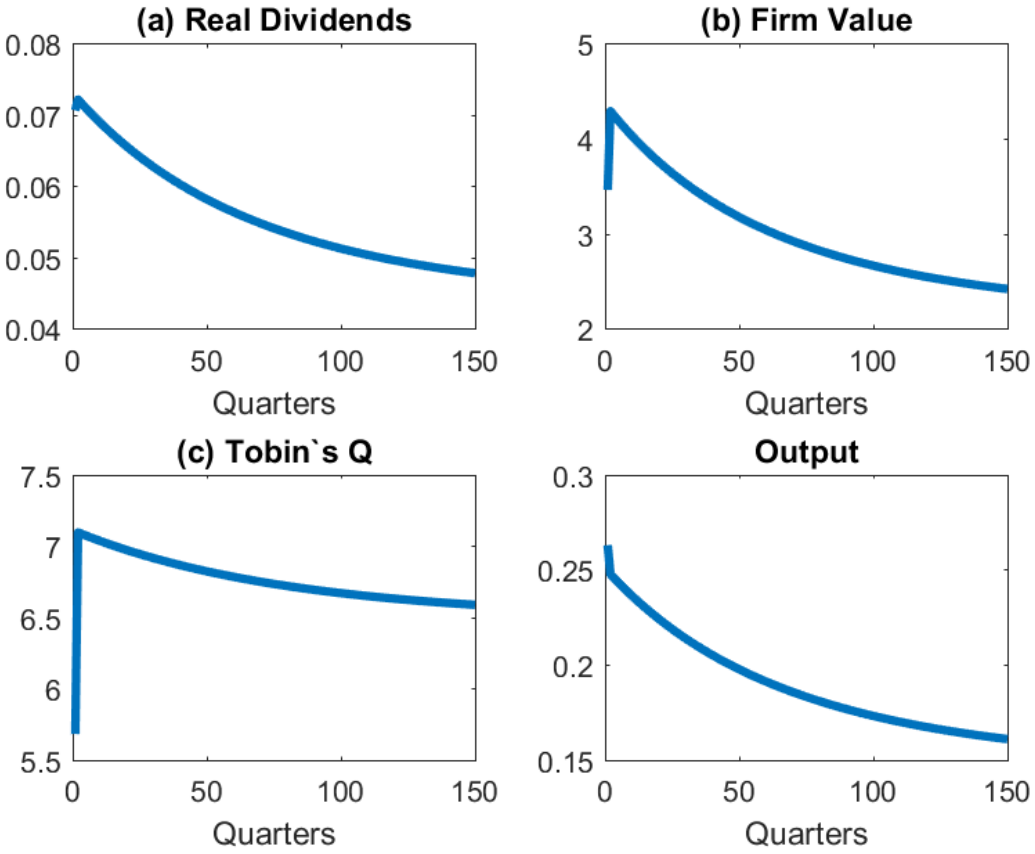


Table 2: Model and Data comparison: Percent changes since January 1980

Variable	Model	Data
Real Wage	-4.7	-24.8
Capital Stock	-39.7	-52.4
Output	-38.8	-17.3
Dividends	-2.3	41.5
Tobin‘s Q	16	204
Labor Share	-4.22 pp	-4.95 pp

Table 2 gives a comparison of certain data series with their corresponding values in the data.[9] All variables are in percent changes since January 1980 with the exception

[9] The data sources for the above section are as follows: Real Wage is the ratio of Compensation per Hour in the Nonfarm Business Sector to the Personal Consumption Expenditure price index from the BLS. This series is detrended by labor productivity, measured by Real Output Per Hour of All Persons in the Nonfarm Business Sector from the BEA. Output and Capital Stock comes from the BEA. Dividends are “Dividends paid: Domestic corporate business: Nonfinancial ” from the BEA. The Labor Share is

of the labor share which is percentage points. As we can see, the model matches the data along some dimensions better than others. The real wage declines much more in the data than in the model, likely due to the weak labor monopsony channel in the current calibration, while the real wage has declined relative to productivity in the data. The decline in the capital stock is large in the model, and this appears to match the decline in the data fairly well, though this is likely due to issues with detrending the capital stock, which itself can only be measured indirectly and with error. The decline in output in the model is much larger than seen in the data, due to the effect stemming from the large decline in the capital stock in the model, though output has fallen below the previous trend since 1980. Nevertheless, the model does help explain both rising inequality and sluggish output growth since 1980.

The behavior of dividends sees the largest deviation between the model and the data, as dividends fall in the model while the rise in the data. There are two effects working on dividends: first, the rise in the markup, which tends to increase dividends, and second, the decline in the capital stock, which tends to depress dividend payments. Here the latter effect dominates. Tobin's Q sees a slight increase since 1980 in the model, while in the data Tobin's Q rises significantly. This happens for several reasons. While an increase in the markup tends to increase the market value of the firm above its replacement value, the decline in the capital stock has the opposite effect. The change in the labor share is similar to what is seen in the data. This is likely due to a similar decline in both real wages and in the capital stock, with a slightly larger effect from the markup for labor than for capital.

5 Conclusion

Is monopoly power a plausible explanation for secular stagnation? The analysis of this paper suggests that monopoly power is an important factor in explaining slow GDP growth in the United States. We proposed and simulated a growth model that incorporates imperfect competition in the goods and labor market. Within the context of the model, we derive an expression for Tobin's Q in terms of future monopoly rents and we show that, under certain conditions and for a given return to capital, a higher degree of monopoly power implies lower output and lower capital stock. More importantly, the model predicts phenomena that have actually happened during the last three decades in the U.S. economy. In response to an increase of monopoly markups, the model helps explain trends since 1980 of sluggish output growth, a declining labor share, and sluggish wage growth.

"Shares of gross domestic income: Compensation of employees, paid" from the BEA. Tobin's Q is the ratio of "Nonfinancial Corporate Business; Corporate Equities" and "Nonfinancial Corporate Business; Net Worth", both from the BEA.

However, the model does a poor job of matching the dynamics of the capital stock, which falls too much, a failing which will be addressed in future research. The model also provides a good framework to study the distributional aspects of secular stagnation caused by monopoly power because it is able to disentangle between the pure distributional effects of monopoly power and the distributional implications of the allocative effects of monopoly power. These results, along with the existing evidence of increases in monopoly power, suggests that market power deserves increased attention to understand the last decades of the U.S. and, possibly, other advanced economies. Future work will examine alternate methods to model increased monopoly power such as relaxing the zero-profit condition due to increased barriers to entry due to less aggressive antitrust enforcement since 1980, as well as the implication for firm entry and exit from increased market power.

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