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Competition and Inequality: Aiyagari meets Bertrand and Cournot*

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Abstract

This paper provides an incomplete markets model with oligopolistic competition among an endogenous number of producers. The model matches the empirical distribution of income and wealth in the United States. The interaction between oligopolistic competition and incomplete markets reconciles the increase in the profit share of income with the decrease in the labor share of income and the increase in income inequality observed over the last three decades in the United States. Welfare costs associated with an increase in market power are large and unequally distributed across households.

1 Introduction

This paper explores the link between imperfect competition in the goods market and the distribution of income and wealth across households. Toward that goal, we provide a general equilibrium incomplete markets model, in the spirit of Aiyagari (1994), where agents are subject to uninsurable idiosyncratic earning shocks and enrich it with aspects of industrial organization. Market structures are endogenous (EMSs, henceforth) since the number of producers and price markups are endogenously determined through sunk entry costs and oligopolistic competition *a là* Bertrand or *a là* Cournot.

The economy features distinct sectors, each one characterized by many firms supplying goods that can be imperfectly substitutable to a different degree, taking strategic interactions into account. Earning shocks, together with incomplete financial markets, lead to cross-sectional heterogeneity in income and wealth.

The degree of market power, as measured by the price markup, depends endogenously on the form of competition, on the degree of substitutability between goods and on the equilibrium number of firms. The investment in new productive units is financed by households through the accumulation of shares in the portfolio of firms. As in Bilbiie et al. (2012), Jaimovich & Floetotto (2008) and Etro & Colciago (2010) the entry of a new firm into the market amounts to the creation of a new product.

The stock-market price of this investment is determined by technological sunk entry costs and by the extent of competition in the market for final goods. Together with the shares' payoff, coming from oligopolistic profits, it endogenizes the return on investment. The level of the price markup determines the allocation of income across labor and profits.

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In the United States wealth is highly concentrated and very unequally distributed, much more so than income. We describe an environment with no aggregate uncertainty, calibrate it to resemble the U.S. economy in 1989, and solve for the ergodic distribution or steady state of the model.[1]

Both the Bertrand and the Cournot frameworks endogenously match the distribution of wealth and income in the data. In particular, both frameworks imply that more than 80 percent of total wealth is in the hands of the top quintile of the wealth distribution. This results in a Gini concentration coefficient of about 80 percent, as in US data.

Given the high concentration of stock ownership, dividend income benefits disproportionately a restricted group of households. As a result, both models deliver an income distribution characterized by a Gini concentration coefficient of about 50 percent, like that in the US. Since the price markup is higher under Cournot with respect to Bertrand, the labor share of income is lower under the former market structure and for this reason, income is slightly more unequally distributed.

Besides showing that market power helps to address inequality in wealth and income at a point in time, our analysis shows that the interaction between EMSs and incomplete markets helps explaining five macroeconomics trends which characterized the US over the last thirty years.

In the last three decades the US has been characterized by (i) a decrease in the number of publicly traded firms and an increase in the price markup; (ii) an increase in the profit share of income; (iii) a decrease in the labor share of income; (iv) an increase in the value of stock market capitalization over GDP and (v) an increase in income inequality.

We argue that these facts are intertwined.[2] Our model with strategic interactions among an endogenous number of producers can jointly reconcile these facts through an increase in the technological sunk entry costs faced by potential entrants in the markets for final goods.[3]

The mechanism which allows the model to capture facts (i)-(v), both qualitatively and quantitatively, is based on one hand on the ability of the model to capture the concentration in the wealth distribution, and on the other hand on the negative relationship between the number of competitors in the market and the price markup implied by oligopolistic competition. An increase in entry costs leads to lower firms' entry. As a result, competition is less intense and the price markup increases. The higher price markup is mirrored in a reduction in the labor share of income and in an increase in the profit share. The high concentration in the wealth distribution implies that the increase in dividend income benefits just asset holders, leading to an increase in income inequality.

To see that both features are necessary to explain facts (i)-(v), we compare our results under oligopolistic competition to those under monopolistic competition. Under monopolistic competition, strategic interactions between firms are neglected. In this case, the price markup depends uniquely on the elasticity of substitution between goods. As a result, a change in entry costs which affect the number of competitors in the market leaves the price markup unaffected. While monopolistic profits help to explain the concentration characterizing the US wealth distribution, the absence of a link between the intensity of competition and the price markup implies that the monopolistically competitive market structure cannot jointly explain the decrease in labor income and the increase in income inequality observed in the data.

We find that the welfare costs associated with an increase in market power are large and unevenly distributed across households. The majority of the population loses during the transition

[1] We select 1989 as baseline year because this is the earliest year available of the Survey of Consumer Finance (SCF), which we take as a benchmark to evaluate the ability of the model to match the income and wealth distributions in the U.S. The year 2007 is taken as the last one in the analysis because our model is not designed to address the business cycle which started at the end of that year.

[2] We discuss the evidence about these facts in Section 2.

[3] The increase in technological sunk entry costs is supported by evidence provided by Grullon et al. (2017), which we discuss in the next section.

from the initial to the final, high-market-concentration, steady state. Specifically, those who lose are the agents for whom labor income represents the majority of total income. This is so since the increase in price markup resulting from higher concentration in the final goods market reduces the real wage, and thus their consumption during the transition to the new long-run equilibrium.

This paper is related to two strands of the macroeconomic literature. The first one is the quantitative literature on wealth and income inequality. Understanding the determinants of wealth inequality is a challenge for many economic models. De Nardi & Fella (2017) and Krueger et al. (2016) provide a quantitative assessment of the mechanisms which could lead to a concentrated wealth distribution in Bewley-Aiyagari models. Essentially, these mechanisms aim at providing agents with additional reasons to save besides the, standard, precautionary motive associated with income uncertainty. De Nardi & Fella (2017) review the main mechanisms which have been adopted in the literature. These are the inter-generational transmission of bequests and human capital, preference heterogeneity, complex earning dynamics, only partially insured medical expenditure shocks in old age, entrepreneurship as in Cagetti & De Nardi (2006), or idiosyncratic shocks to investment opportunities or its returns, as in Benhabib et al. (2011).

Our work suggests that a relatively straightforward extension of the baseline incomplete markets model, namely oligopolistic competition with endogenous firms' dynamics, is successful at matching concentration facts. At the basis of this result is the endogeneity of the stock-market price together with the shares' payoff due to oligopolistic profits.

The second related strand of the literature is that which studies the relationship between final goods market concentration, price markups, and factors' share. Autor et al. (2017) hypothesize that industries are increasingly characterized by a "winner takes all" feature, where few firms can gain a very large share of the market. Large firms have lower labor shares if production requires a fixed amount of overhead labor in addition to size-dependent variable labor input, or if markups in the product market correlate positively with firm size. At the same time, Gao et al. (2013), Doidge et al. (2017), Grullon et al. (2017) and others, show that the number of public firms has significantly declined since the late 1990s. Grullon et al. (2017) find that the profitability of firms, as measured by the Return on Asset, is negatively related to the number of peers in the market. Concentration has, thus, increased at both the intensive margin, due to more concentrated sales, and at the extensive margin, due to fewer competitors in the relevant market.

Autor et al. (2017) emphasize that the increase in the price markup spreading from higher concentration could be at the root of the secular downward trend in the labor share of income observed in various countries around the world. Barkai (2016) provides reduced-form empirical evidence that a decline in competition plays a significant role in the decline in the labor share. Edmond et al. (2015) provide an oligopolistic general equilibrium framework with heterogeneous firms and complete markets where markups in the product market correlate positively with firms' market shares. The implications of their model are consistent with the empirical findings in Autor et al. (2017). Edmond et al. (2018) study the welfare costs associated with market power in this setting and find that the welfare costs of markups are large. Eggertsson et al. (2018) and De Loecker et al. (2018) argue that the recent increase in markups could explain both the decrease in the labor share of income and the increase in the dividend share of income.

The main contribution of our paper to this literature is that of providing a general equilibrium model with incomplete markets where the extent of market concentration affects markups, factors' share and stock market returns and, through these channels, impacts on the distribution of income and wealth. With respect to Edmond et al. (2015), Edmond et al. (2018), Eggertsson et al. (2018) and De Loecker et al. (2018), we make the key step of relating the extent of competition in the market for final goods to the degree of wealth and income inequality. Due to heterogeneity across households and incomplete markets, we can study both the aggregate welfare cost associated with market power and how its burden is distributed across households characterized by different wealth and productivity levels.

The remainder of the paper is organized as follows. Section 2 discusses the empirical literature documenting macroeconomic trends (i)-(v), Section 3 spells out the model economy, Section 4 defines the equilibrium concepts used in the analysis, Section 5 calibrates the initial steady state, Section 6 displays the main results, Section 7 concludes.

2 Macroeconomic Trends in the US over the last Thirty years

In this section we describe five macroeconomic trends that have been characterizing the US economy over the last thirty years and are jointly captured by our model.

Recent changes in the U.S. competitive landscape. There has been a structural change in the competitive landscape of U.S. industries in the last thirty years. Grullon et al. (2017) argue that more than 75% of US industries experienced an increase in sales concentration. At the same time, Gao et al. (2013), Doidge et al. (2017), Grullon et al. (2017) and others, show that the number of public firms has significantly declined since the late 1990s. As mentioned above, concentration has, thus, increased at both the intensive margin, due to more concentrated sales, and at the extensive margin, due to fewer competitors in the relevant market.

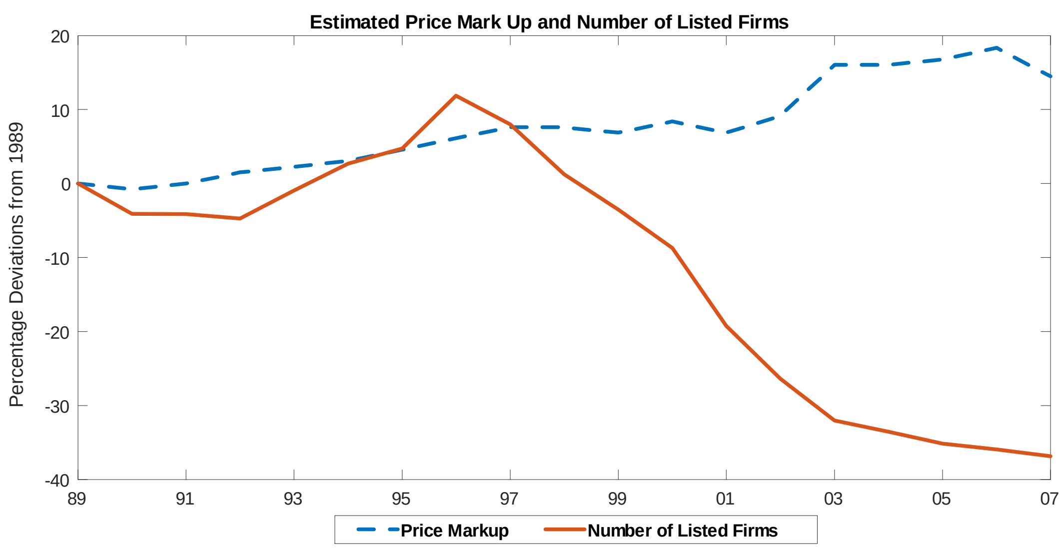

Figure 1: Percentage deviations in the number of listed firms and the price markup estimated by De Loecker et al. (2018). The plotted value in each year represents the deviation from the baseline value, which is that in 1989. Data Source: Number of listed firms: FRED. Price markup: De Loecker et al. (2018).

To give a quantitative flavor of these facts, Figure 1 plots yearly percentage deviations in the number of US-listed firms and the median price markup in US industries estimated by De Loecker et al. (2018). The latter authors estimate firms-level markups using Compustat data on the universe of U.S. publicly traded firms. We report their weighted average markup, across the economy, where weights are based on firm-level sales. Average markups have gone up since the 1980s.[4] Deviations are taken with respect to the values assumed by these variables

[4]Edmond et al. (2018) argue that the overall level of markups is best measured as a cost-weighted average of firm-level markups. While the weighting affects the estimated markups level, both weighting methods suggest an increase in average markups over time.

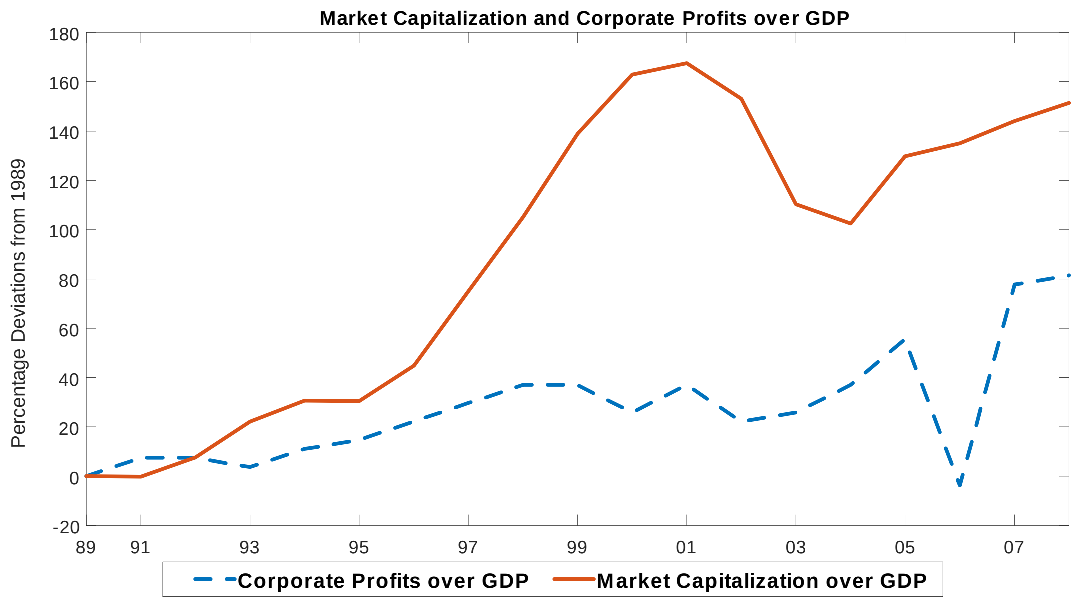

Figure 2: Percentage deviation in corporate profits over GDP and Stock Market Capitalization over GDP. The plotted value in each year represents the deviation from the baseline value, which is that in 1989. Data Source: FRED.

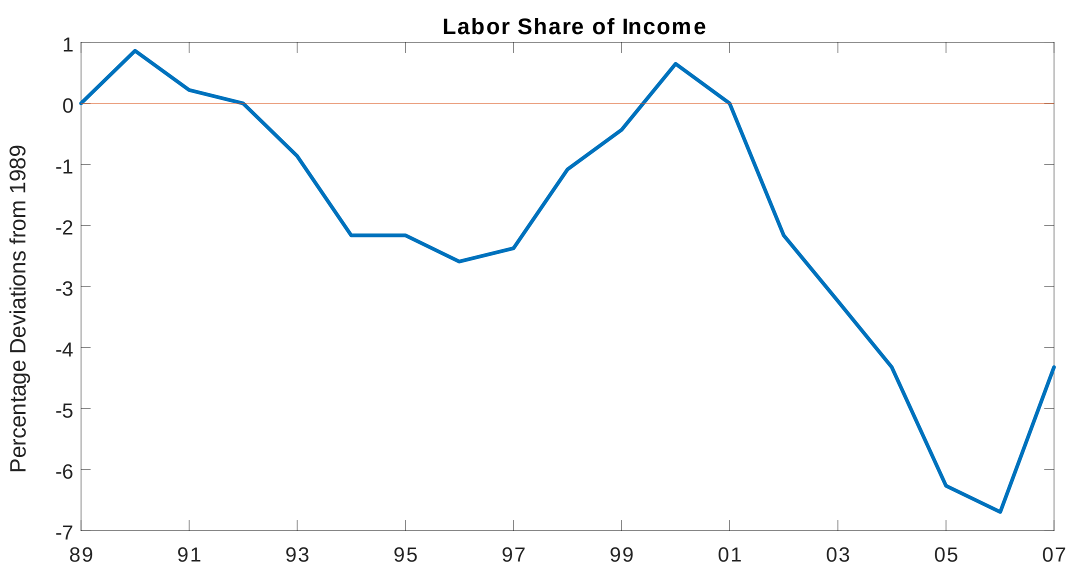

Figure 3: Percentage deviation in the labor share of income. The plotted value in each year represents the deviation from the baseline value, which is that in 1989. Source: FRED.

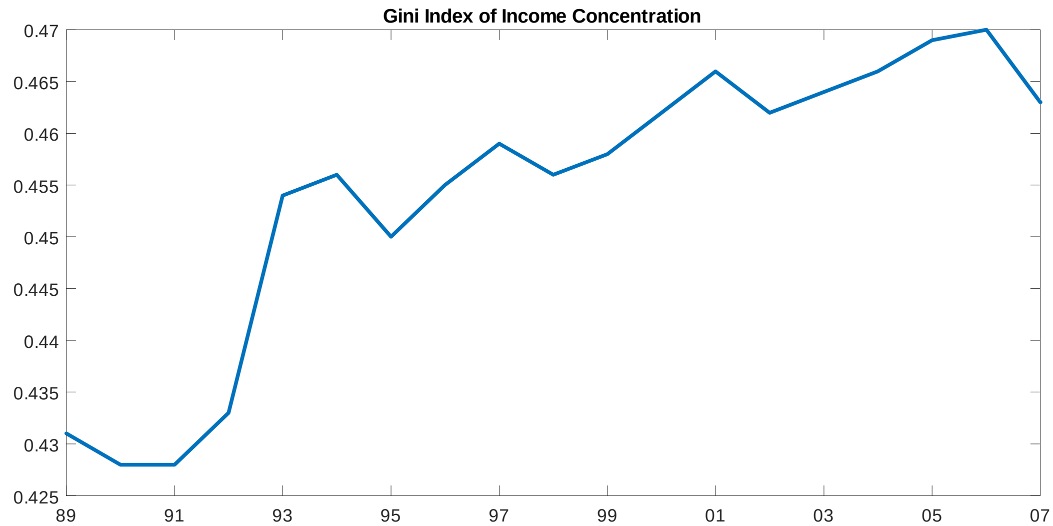

Figure 4: Gini Index of income concentration in the US. Source: US census.

in 1989, which we take as the baseline period in our analysis.

Grullon et al. (2017) examine several possible explanations that could be at the root of the secular increase in market concentration. Among them, they consider an increase in barriers to entry. As argued by Grullon et al. (2017), If technological barriers to entry are an important factor behind the increase in market concentration, then firms in more concentrated markets should hold a stronger patent portfolio. Their findings suggest that, indeed, patent concentration follows a pattern very close to that of sales concentration.

Factors' shares, stock market capitalization and income inequality. Figure 2 displays yearly percentage deviations, from 1989, in corporate profits over GDP and Stock Market Capitalization to GDP for the United States. Figure 3 displays the dynamics of the labor share of income.[5]

Karabarbounis et al. (2014) observe that the share of aggregate income paid as compensation to labor is frequently used as a proxy for income inequality. If capital holdings are very concentrated among high-income individuals, increasing their share of GDP, all else equal, widens the gap with poorer workers. Indeed, another macroeconomic trend over the last three decades in many advanced and developing economies is the rise in income inequality. Figure 4 displays the evolution of the Gini Index for income since 1989 in the U.S.

3 The Model

The economy features a continuum of atomistics sectors, or industries, on the unit interval. Each sector is characterized by different firms producing a good in different varieties and using labor as the only input. In turn, the sectoral goods are imperfect substitutes for each other and are aggregated into a final good. Oligopolistic competition and endogenous firms' entry are modeled at the sectoral level. At the beginning of each period, N^e_{jt} new firms enter into sector $j \in (0, 1)$, while at the end of the period a fraction $\delta \in (0, 1)$ of market participants exits from

[5]Aggregate labor share measures are influenced by the methods used to separate the labor and capital income earned by entrepreneurs, sole proprietors, and unincorporated businesses. The measure we display in figure 3 is given by the ratio between the compensation of all employees in the US and GDP. Data Source: FRED.

the market for exogenous reasons[6]. As a result, the number of firms in a sector N_{jt} follows the equation of motion:

$$N_{jt+1} = (1-\delta)(N_{jt} + N_{jt}^e) \tag{1}$$

where N_{jt}^e is the number of new entrants in sector j at time t. Following Bilbiie et al. (2012), we assume that new entrants at time t will only start producing at time $t+1$ and that the probability of exit from the market, δ, is independent of the period of entry and identical across sectors. The assumption of an exogenous constant exit rate is adopted for tractability but it also has empirical support. Using U.S. annual data on manufacturing, Lee & Mukoyama (2008) find that, although the entry rate is procyclical, annual exit rates are similar across booms and recessions.

Alternative forms of competition between the firms within each sector are considered below. In particular, the focus is on the approach based on oligopolistic competition developed by Jaimovich & Floetotto (2008) and Etro & Colciago (2010). As in Ghironi & Melitz (2005) and Bilbiie et al. (2012), who gave new life to the interesting literature on the role of entry in macroeconomic models, sunk entry costs are introduced to endogenize the number of firms in each sector. The nature and form of the entry costs will be specified below. Households use the final good for consumption purposes, inelastically supply labor to firms, are subject to uninsurable labor income shocks and choose how much to save in the creation of new firms through the stock market.

3.1 Firms and Technology

The final good is produced according to the function

$$Y_t = \left[\int_0^1 Y_{jt}^{\frac{\omega-1}{\omega}} dj \right]^{\frac{\omega}{\omega-1}} \tag{2}$$

where Y_{jt} denotes the output of sector j and ω is the elasticity of substitution between any two different sectoral goods. The final good producer behaves competitively. In each sector j, there are $N_{jt} > 1$ firms producing differentiated goods that are aggregated into a sectoral good by a CES (constant elasticity of substitution) aggregating function defined as

$$Y_{jt} = \left[\sum_{i=1}^{N_{jt}} y_{jt}(i)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{3}$$

where $y_{jt}(i)$ is the production of good i in sector j and $\theta > 1$ is the elasticity of substitution between sectoral goods. As in Etro & Colciago (2010), a unit elasticity of substitution between goods belonging to different sectors is assumed. This allows realistic separation of limited substitutability at the aggregate level and high substitutability at the disaggregate level. Each firm i in sector j produces a differentiated good with the following production function

$$y_{jt}(i) = A h_{jt}^c(i) \tag{4}$$

where A represents technology that is common across sectors and remains constant over time, while $h_{jt}^c(i)$ is the labour input used by the individual firm for the production of the final good. The unit intersectoral elasticity of substitution implies that nominal expenditure, EXP_t, is identical across sectors. Thus, the final producer's demand for each sectoral good is

$$P_{jt} Y_{jt} = P_t Y_t = EXP_t. \tag{5}$$

[6] As discussed in BGM (2012), if macroeconomic shocks are small enough, $N_{j,t}^e$ is positive in every period. New entrants finance their entry on the stock market.

where P_{jt} and faced by the producer of each variant is

$$y_{jt}(i) = \left(\frac{p_{jt}}{P_{jt}}\right)^{-\theta} Y_{jt} \tag{6}$$

where P_{jt} is defined as

$$P_{jt} = \left[\sum_{i=1}^{N_{jt}} (p_{jt}(i))^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{7}$$

Using (6) and (5), the individual demand of good i can be written as a function of aggregate expenditure,

$$y_{jt}(i) = \frac{p_{jt}^{-\theta}}{P_{jt}^{1-\theta}} EXP_t \tag{8}$$

As technology, the entry cost and the exit probability are identical across sectors, in what follows the index j is disregarded to consider a representative sector.

3.2 Households

Households have unit mass and are infinitely lived. Household i has expected utility given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{C(i)_t^{1-\gamma}}{1-\gamma} \tag{9}$$

where $\beta \in (0,1)$ is the, common across households, discount factor, $C_t(i)$ is the consumption of the final good, and γ is the coefficient of relative risk aversion. The household inelastically supplies one unit of labor and it is subject to idiosyncratic labor productivity risk as in Aiyagari (1994). A households' labor productivity, z_{it}, follows an AR(1) process in log given by $\log(z_t(i)) = \rho \log(z_{t-1}(i)) + \varepsilon_t$. Households enjoy labor and dividend income. The household maximizes (9) by choosing how much to consume and how much to invest in stocks. The timing of investment in the stock market is as in BGM (2012) and Chugh & Ghironi (2011). At the beginning of period t, household i owns $s_t(i)$ shares of a mutual fund of the N_t firms that produce in that period, each of which pays a dividend d_t. Denoting the value of a firm with V_t, it follows that the value of the portfolio held by the household is $s_t(i) V_t N_t$. During period t, the household purchases $s_{t+1}(i)$ shares in a fund of these N_t firms as well as the N_t^e new firms created during period t, to be carried into period $t+1$. Total stock market purchases are thus $s_{t+1}(i) V_t(N_t + N_t^e)$. At the very end of period t, a fraction of these firms disappears from the market.[7] Following the production and sales of the N_t varieties in the imperfectly competitive goods markets, firms distribute the dividend d_t to households. The household's total dividend income is thus $D_t = s_t(i) d_t N_t$. Households' labor income is composed by the real wage per efficiency unit w_t times the idiosyncratic productivity level $z_{i,t}$.

The flow budget constraint of the household is

$$V_t(N_t + N_t^e) s_{t+1}(i) + C_t(i) = (d_t + V_t) N_t s_t(i) + z_t(i) w_t \tag{10}$$

where we impose the no short-selling constraint

$$s(i)_{t+1} \geq 0$$

First order conditions for utility maximization with respect to $s_{t+1}(i)$ reads as

[7] Due to the Poisson nature of exit shocks, the household does not know which firms will disappear from the market, so it finances the continued operations of all incumbent firms as well as those of the new entrants.

$$U_c(C(i)_t) \geq \beta E_t \frac{(V_{t+1} + d_{t+1}) N_{t+1}}{V_t (N_t + N_t^e)} U_c(C(i)_{t+1}) \tag{11}$$

The latter holds with equality when $s_{t+1}(i) > 0$.

3.3 Endogenous Entry

Upon entry, firms face a sunk cost, defined as $f_t = \eta / A_t$ units of labor, with $\eta > 0$. Note that under this specification, the level of technology affecting the productivity of the workers that produce goods is identical to that of the workers that create new businesses. As such A is the aggregate level of technology. In each period entry is determined endogenously to equate the value of firms to the entry costs.

3.4 Strategic Interactions

In each period, the same expenditure for each sector EXP_t is allocated across the available goods according to the standard direct demand function derived from the expenditure minimization problem of households. It follows that the direct individual demand faced by a firm, $y_t(i)$, can be written as

$$y_t(i) = Y_t \left(\frac{p_t(i)}{P_t} \right)^{-\theta} = \frac{p_t(i)^{-\theta}}{P_t^{1-\theta}} Y_t P_t = \frac{p_t(i)^{-\theta} EXP_t}{P_t^{1-\theta}} \qquad i = 1, 2, ..., N_t \tag{12}$$

Inverting the direct demand functions, the system of inverse demand functions can be derived:

$$p_t(i) = \frac{y_t(i)^{-\frac{1}{\theta}} EXP_t}{\sum_{i=1}^{N_t} y_t(i)^{\frac{\theta-1}{\theta}}} \qquad i = 1, 2, ..., N_t \tag{13}$$

which will be useful in the remainder of the analysis. Firms cannot credibly commit to a sequence of strategies, therefore their behavior is equivalent to maximize current profits in each period taking as given the strategies of the other firms. A main interest of this study is in the evaluation of the income and wealth long-run distribution delivered by popular forms of competition between firms, such as competition in prices and quantities. Firms take as given their marginal cost of production and the aggregate nominal expenditure.[8] Under different forms of competition, we obtain equilibrium relative prices satisfying

$$p_t(i) = \mu(\theta, N_t) \frac{w_t}{A_t} \tag{14}$$

where $\frac{w_t}{A_t}$ is the real marginal cost and $\mu(\theta, N_t) > 1$ is the markup function. In the next sections, the markup functions under alternative forms of market competition are characterized.

3.4.1 Price Competition

Consider competition in prices. In each period, the gross profits of firm i can be expressed as:

$$\Pi_t [p_t(i)] = \frac{\left[p_t(i) - \frac{W_t}{A_t} \right] p_t(i)^{-\theta} EXP_t}{\left[\sum_{j=1}^{N_t} p_t(j)^{1-\theta} \right]} \tag{15}$$

[8] Of course, both of them are endogenous in general equilibrium but it is reasonable to assume that firms do not perceive marginal costs and aggregate expenditure as being affected by their choices.

Firms compete by choosing their prices. We consider two alternative approaches to this problem. The first one is the traditional monopolistic competition approach, which neglects strategic interactions between firms. The second one is the Bertrand approach, where strategic interactions are taken into consideration. The outcome of profit maximization under monopolistic competition is well known. Each firm i chooses the price $p_t(i)$ to maximize profit taking as given the price of the other firms, neglecting the effect of their price choice on the sectoral price index. The symmetric equilibrium price is $p_t = \mu^{MC}(\theta) W_t/A_t$, which is associated with the constant price markup $\mu^{MC}(\theta) = \frac{\theta}{(\theta-1)}$. The latter does not depend on the extent of competition but just on the elasticity of substitution between goods. Under Bertrand competition, each firm i chooses the price $p_t(i)$ to maximize profit taking as given the price of other firms. The first-order condition for any firm i is:

$$p_t(i)^{-\theta} - \theta \left(p_t(i) - \frac{W_t}{A_t} \right) p_t(i)^{-\theta-1} = \frac{(1-\theta) p_t(i)^{-\theta} \left(p_t(i) - \frac{W_t}{A_t} \right) p_t(i)^{-\theta}}{\sum_{i=1}^{N_t} p_t(i)^{1-\theta}}$$

Note that the term on the right-hand side is the effect of the price strategy of a firm on the price index: higher prices reduce overall demand, therefore firms tend to set higher markups compared to monopolistic competition. The symmetric equilibrium price p_t must satisfy

$$p_t = \mu^B(\theta, N_t) \frac{W_t}{A_t}$$

where the markup reads as

$$\mu^B(\theta, N_t) = \frac{1+\theta(N_t-1)}{(\theta-1)(N_t-1)} \tag{16}$$

As discussed in more detail in Etro & Colciago (2010), the markup is decreasing in the degree of substitutability between products θ and in the number of firms. Importantly, when $N_t \to \infty$ the markup tends to $\mu^{MC}(\theta)$, the standard one under monopolistic competition[9].

3.4.2 Quantity Competition

Consider now competition in quantities in the form of Cournot competition. Using the inverse demand function (13), the profit function of a firm i can be expressed as a function of its output $y_t(i)$ and the output of all the other firms:

$$\begin{aligned} \Pi_t [y_t(i)] &= \left[p_t(i) - \frac{W_t}{A_t} \right] y(i) = \\ &= \frac{y_t(i)^{\frac{\theta-1}{\theta}} EXP_t}{\sum_{j=1}^{N_t} y_t(j)^{\frac{\theta-1}{\theta}}} - \frac{W_t y_t(i)}{A_t} \end{aligned} \tag{17}$$

Assume now that each firm chooses its production $y_t(i)$ taking as given the production of the other firms. The first-order conditions:

$$\left(\frac{\theta-1}{\theta} \right) \frac{y_t(i)^{-\frac{1}{\theta}} EXP_t}{\sum_i y_t(i)^{\frac{\theta-1}{\theta}}} - \left(\frac{\theta-1}{\theta} \right) \frac{y_t(i)^{\frac{\theta-2}{\theta}} EXP_t}{\left[\sum_i y_t(i)^{\frac{\theta-1}{\theta}} \right]^2} = \frac{W_t}{A_t}$$

[9] Since total expenditure EXP_t is equalized between sectors, we assume that it is also perceived as given by the firms.

for all firms $i = 1, 2, ..., N_t$ can be simplified imposing the symmetry of the Cournot equilibrium. This generates the individual output:

$$y_t = \frac{(\theta - 1)(N_t - 1)A_t EXP_t}{\theta N_t^2 W_t} \tag{18}$$

Substituting into the inverse price, one obtains the equilibrium price $p_t = \mu^C(\theta, N_t)\frac{W_t}{A_t}$, where

$$\mu^C(\theta, N_t) = \frac{\theta N_t}{(\theta - 1)(N_t - 1)} \tag{19}$$

is the markup under competition in quantities. For a given number of firms, the markup under competition in quantities is always larger than the one obtained before under competition in prices, as is well known for models of product differentiation Vives (1999, see, for instance). Note that the markup is decreasing in the degree of substitutability between products θ and in the number of competitors. Finally, only when $N_t \to \infty$ the markup tends to $\mu^{MC}(\theta)$, the markup under monopolistic competition.

3.5 Aggregation and Market Clearing

Let $\lambda_t(s, z)$ define the distribution of households across wealth and productivity levels in a given period t. Aggregate supply of labour reads as $L_t^s = \int z_t(i)l_t(i)d\lambda_t = 1$. Aggregate labor demand is, instead, the sum between labor used for production purposes $L_t^c = N_t l_t^c$, and that used to create new firms $L_t^e = N_t^e \frac{\phi}{A_t}$. As a result, labor market clearing requires

$$L^c + L^e = 1.$$

Equilibrium in the stock market reads as $\int s_t(i)d\lambda_t = 1$. Finally, aggregating the individual household budget constraint in equation 10 and imposing the clearing of labor and asset markets we obtain the aggregate accounting relationship

$$C_t + V_t N_t^e = w_t L_t + d_t N_t$$

where $C_t = \int C_t(i)\, d\lambda$ is aggregate consumption. Notice that $V_t N_t^e$ represents the value of total investment. The aggregate accounting relationship states that the sum between consumption and investment must equal GDP, that is the sum between labor and dividend income.

4 Equilibrium Concepts

Given a deterministic sequence of entry costs $\{\phi_t\}_{t=0}^{\infty}$ and the initial distribution of agents λ_0 a recursive stationary equilibrium is characterized by a sequence of policy functions $\{g_t^s, g_t^c\}_{t=0}^{\infty}$, aggregate variables $\Omega_t = \{N_t,\ N_t^e,\ V_t,\ \mu_t,\ \pi_t,\ Y_t,\ w_t,\ L_t^c,\ L_t^e\}_{t=0}^{\infty}$ and distributions $\{\lambda_t\}_{t=0}^{\infty}$ such that in every period t:

1. Given the aggregate quantities Ω_t, the policy functions $g_t^s(s, z)$ and $g_t^c(s, z)$ solve the households' problem in equations 11 and 10
2. Aggregate variables in Ω_t satisfy firms optimality conditions
3. Markets clear
4. the distribution λ_t evolves according to $\lambda_{t+1} = P\ \lambda_t$ where P is a transition function defined by the saving policy function g_t^s together with the exogenous transition matrix for the productivity process Π.

4.1 Stationary Equilibrium

The stationary equilibrium is characterized by policy functions $g^s(s,z)$ and $g^c(s,z)$, a set of aggregate variables $\Omega = \{N,\ N^e,\ V,\ \mu,\ \pi,\ Y,\ w,\ L^c,\ L^e\}$[10] and a distribution of agents $\lambda(s,z)$ such that:

1. Given the aggregate variables in Ω, the policy functions $g^s(s,z)$ and $g^c(s,z)$ solve the households' problem in equations 11 and 10
2. Aggregate variables in Ω satisfy firms optimality conditions
3. Markets clear

The distribution $\lambda(s,z)$ is the ergodic distribution implied by the exogenous transition matrix for labor productivity Π and the policy function $g^s(s,z)$. This distribution gives two information at the same time: on the cross-sectional dimension it indicates the fraction of agents in each state while, on the time series dimension, it gives the share of time each agent spends in each state.

4.2 Recursive Equilibrium

To assess the aggregate and distributional implications of a rise in barriers to entry, we simulate a deterministic transition from the initial stationary equilibrium to a final one characterized by a higher sunk entry cost. Timing is as follows: at time $t=0$ the economy is in the initial steady state (denoted by ^{I}) and the end of the period the entry cost increases. From $t=1$ the economy transit to the final steady state (indicated by ^{F}). Given a deterministic sequence of entry costs $\{\phi_t\}_{t=0}^{\infty}$ and the initial distribution of agents λ^I a recursive stationary equilibrium is characterized by a sequence of policy functions $\{g_t^s, g_t^c\}_{t=0}^{\infty}$, aggregate variables $\{\Omega_t\}_{t=0}^{\infty}$ and distributions $\{\lambda_t\}_{t=0}^{\infty}$ such that in every period t:[11]

1. given Ω_t, the decision rules g_t^s and g_t^c solve the individual problems
2. Ω_t is consistent with firms optimality conditions
3. markets clear
4. the distribution λ_t evolves according to $\lambda_{t+1} = \mathcal{P}\ \lambda_t$ where $\mathcal{P}$ is a transition function defined by the saving policy function g_t^s together with the exogenous transition matrix for the productivity process Π.

5 Calibration

The model is solved numerically using a discretization of the state space. Specifically, the households' problem is solved adopting the Endogenous Grid Method developed by Carroll (2006) and by approximating the policy functions through linear splines. Our solution algorithm, described in detail in the Appendix, takes non-linearities and uncertainty in idiosyncratic dynamics into account.

[10] Note that, as common in the literature, we drop the time index and denote future variables with the $'$ subscript.

[11] The dependance of the distribution and the policy functions on the state variables has been neglected just to lighten the notation.

A period corresponds to a year. Standard values are chosen for the discount factor $\beta = 0.96$, the intrasectoral elasticity of substitution $\theta = 6$ and the risk aversion parameter in the utility function $\gamma = 1.5$. The exit probability, δ, is set to 0.1 as in BGM (2012). Consistently with the no-short selling constraint, the minimum individual amount of shares is 0. The maximum (which is equal to 25) is such that it is never binding in any state of the world. To approximate the policy functions, we use 500 exponentially spaced nodes in this interval, while the grid used for the distribution is equispaced and finer (5000 nodes).

Parameters characterizing the AR(1) process for (the log of) labor productivity[12] are those estimated by Krueger et al. (2016) using PSID data. The autoregressive coefficient is $\rho = 0.9695$ and the variance of the earnings process equals $\sigma^2 = 0.0384$. We choose Rouwenhorst method to discretize the stochastic process for productivity. As stated by Kopecky & Suen (2010), this method is more robust than the more often used Tauchen method, in particular for very persistent processes.

Special care must be devoted to the calibration of the entry costs as they are one of the main determinants of the degree of market power and become the forcing variable in our experiment concerning the macroeconomic implications of a rise in market power.

We set them as follows. We take the Cournot model as the benchmark model and set the entry cost such that the endogenous price markup equals the estimate of the median price markup across US industries provided by De Loecker et al. (2018) in 1989. We then compute the ergodic wealth and income distributions implied by the model. Holding fixed the value of the entry cost we run the same exercise under Bertrand competition.[13]

We select 1989 as the initial year because this is the earliest year available of the Survey of Consumer Finance (SCF). The SCF is a special survey, conducted by the National Opinion Research Center at the University of Chicago. As discussed by Kuhn & Rios-Rull (2016), its sample size of over 6,000 households is appreciably smaller than that of other surveys such as the Current Population Survey (CPS), which has a sample size of 60,000 households.

Despite its small sample size, the SCF is particularly careful to represent the upper tail of the wealth distribution by oversampling rich households. This unique sampling scheme makes the SCF particularly well suited for discussing the earnings, income, and wealth concentration at the top. We take income and wealth distributions, together with concentration indexes, from the analysis of the SCF conducted by Kuhn & Rios-Rull (2016).

As mentioned above, we then simulate an increase in sunk technological entry costs which lead to higher market power. Specifically, we increase the entry costs in Cournot up to the point where the price markup equals the value of the median price markup across US industries estimated by De Loecker et al. (2018) in 2007. Again we compute, for this implied entry cost, the distribution of income and wealth under both Cournot and Bertrand. Table 1 reports the baseline calibration.

[12] In the model the wage per efficiency unit is the same for everybody and the supply of labor is inelastic, thus the process for earnings and that for labor productivity have the same persistence and variance.

[13] We believe that the models should be compared holding parameter fixed. Given the entry cost, Bertrand leads to a lower equilibrium number of firms and to a lower price markup with respect to Cournot.

Parameter	*Description*	*Value(annual)*
β	discount factor	0.96
γ	relative risk aversion	1.5
θ	intrasectoral elasticity of substitution	6
δ	exit probability	0.1
ρ	persistence of the productivity process	0.9695
σ^2	variance of the productivity process	0.0384
ϕ^I	entry cost in the initial SS Cournot	0.19
ϕ^F	post-reform entry cost Cournot	0.57

Table 1: Model Parameters. One period corresponds to an year

In the next section, we will evaluate the ability of our model at matching the distributions of wealth and income observed in 1989 in the US. Then we will run our experiment and assess the distributional implications of a rise in barriers to entry. In the remainder, we will refer to the intial calibration as to the 89-calibration, while to the calibration characterizing the high concentration equilibrium as to the 07-calibration.

6 Results

6.1 Income and Wealth Distributions Under Alternative Market Structures

In this section, we evaluate the extent to which our model can match the empirical distributions of wealth and income in 1989. Tables 2 and 3 report, respectively, the implied wealth and income distributions under Bertrand and Cournot, we also report statistics for the monopolistically competitive case, and compare them to the empirical ones provided by Kuhn & Rios-Rull (2016), which are based on the SCF in 1989. Table 2 (Table 3) displays the wealth (income) distribution and compares it to that in the data. We report the fraction of wealth (income) held by each quintile of the distribution, together with the fraction of wealth (income) held by the top 10%, the top 5%, and the top 1%. Finally, in both tables we report Gini coefficients for the whole distribution under analysis (Gini All), and for the bottom 99% (Gini 99%).

Quantiles	*SCF* 89	*Cournot*	*Bertrand*	*Mon.Comp.*
Q1	-0.2	0	0	0
Q2	1.2	0.3	0.1	0.1
Q3	5.2	3.3	2.3	2
Q4	13	15.3	13.8	13.3
Q5	80.7	81.1	83.7	84.7
90-95	12.9	19.2	19.7	19.8
95-99	24.3	27.2	28.6	29.1
T1%	29.9	13.7	14.9	15.4
Gini All	0.79	0.78	0.80	0.80
Gini 99%	0.72	0.76	0.78	0.79

Table 2: 89-calibaration. Wealth distribution under alternative market structures. Comparison with data.

Quantiles	*SCF* 89	*Cournot*	*Bertrand*	*Mon.Comp.*
Q1	7.2,	4.6	4.8	4.8
Q2	10.7	9.7	9.8	9.8
Q3	14.6	13.9	14.1	14.2
Q4	20.2	22.6	22.8	22.9
Q5	47.3	49.2	48.5	48.3
90-95	8.8	12.2	12.1	12
95-99	12.1	13.9	13.6	13.5
T1%	13.1	5.7	5.6	5.6
Gini All	0.53	0.47	0.46	0.46
Gini 99%	0.46	0.46	0.45	0.45

Table 3: 89-calibaration. Income distribution under alternative market structures. Comparison with data.

As mentioned in the Introduction, matching the empirical wealth distribution and its concentration in Bewley-Aiyagary models is challenging. Both the Cournot and Bertrand models, as well as the monopolistic competitive framework, essentially match the US wealth distribution. Notice that the concentration of the distribution of wealth is not matched by construction in the calibration procedure. Notice also that, as in the data, the wealth distribution is more concentrated than the income distribution.

At the basis of this result is the direct link between investment and economic profits in EMSs incomplete markets models. Households hold assets for precautionary reasons. Assets holders are entitled to a share of aggregate profits. For this reason, the income of wealth-rich households is, to a large extent, constituted by dividend income. There is thus a feedback mechanism for which asset-rich households also have higher income, which, in turn, feeds back into more asset holdings. The model underestimates the fraction of income accruing to the top 1% of the income distribution, but it exactly matches the Gini coefficient relative to the bottom 99%.[14] In the next sections, we assess the effects of an increase in technological entry costs on market power on some key macroeconomic variables, on the wealth and income distributions, and on welfare.

6.2 The Implications of a Rise in Market Power

6.2.1 Macroeconomic trends

In this section, we evaluate whether in response to an increase in technological entry costs our model can account for the macroeconomic trends described in Section 2. Namely, whether it can explain a decrease in the number of firms together with an increase in price markups, an increase in the value of stock market capitalization and aggregate profits with respect to GDP, a decrease in the labor share and an increase in income inequality.

We also compare the wealth an income distributions implied by our model in 2007, namely eighteen periods after the increase in entry costs, to the empirical ones in 2007 in the US (See Table 4). Consider that, starting from the 89-calibration, the new ergodic income and wealth distributions implied by the 07-calibration requires about forty periods to be reached. For this reason, we regard the ergodic distributions under the 07-calibration as describing the long-run implications of our model for income and wealth distributions.

We report results for the Cournot and Bertrand framework. Under monopolistic competition the change in entry costs does not affect the price markup. This implies that the allocation of

[14] In this respect, introducing a fraction of super-productive workers as in Nakajima (2012) could help addressing the evidence.

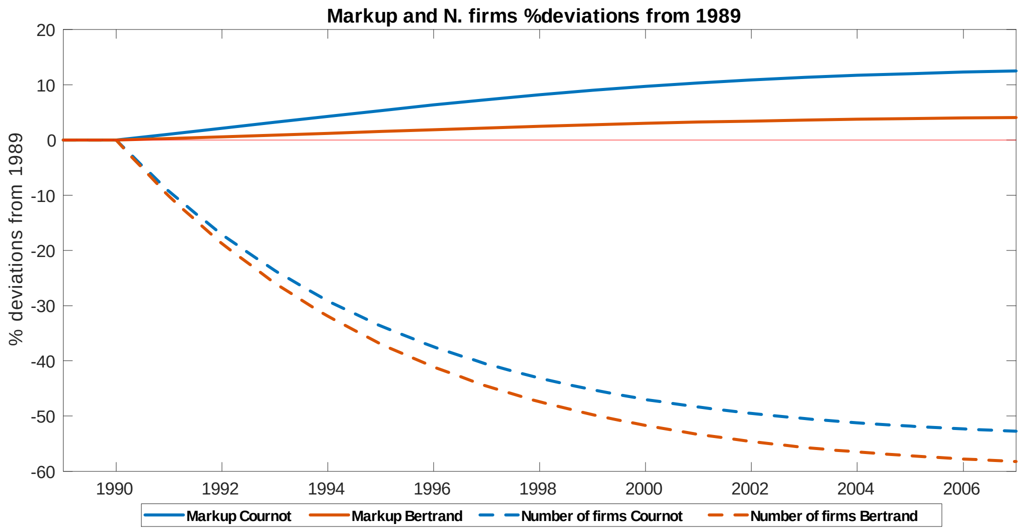

Figure 5: Dynamic of the number of firms and the price markup between 1989 and 2007 Under Bertrand and Cournot. Percentage deviations from 1989.

income between capital and labor is unaffected. In other words the labor share of income remains unchanged in the aftermath of the increase in sunk entry costs and concentration. The same holds for the wealth and income distributions. This highlights that the increase in the price markup which follows an increase in concentration and the resulting decrease in the labor share of income are key ingredients to explain the increase in income concentration observed in the US in the last decades. Figures 5-7 are the model-equivalent of Figures 1-3, relative to US data, reported in Section 2.

The model successfully reproduces the pattern of the variables of interest. An increase in entry costs leads to fewer competitors in the market. Due to EMSs, this leads to an increase in the price markup. Remarkably we obtain a relative pattern between capitalization over GDP and profits over GDP which is very close to that in the data, also in terms of quantitative variations, under both Bertrand and Cournot. The magnitude of the reduction in the labor share of income is also comparable to that in the data. The reduction in the labor share of income is closer to that observed in the data under Cournot competition. This is due to the larger increase in the price markup observed under Cournot, which is close to that reported by De Loecker et al. (2018). The latter is due to the higher elasticity of the price markup with respect to the number of competitors implied by Cournot competition with respect to Bertrand.

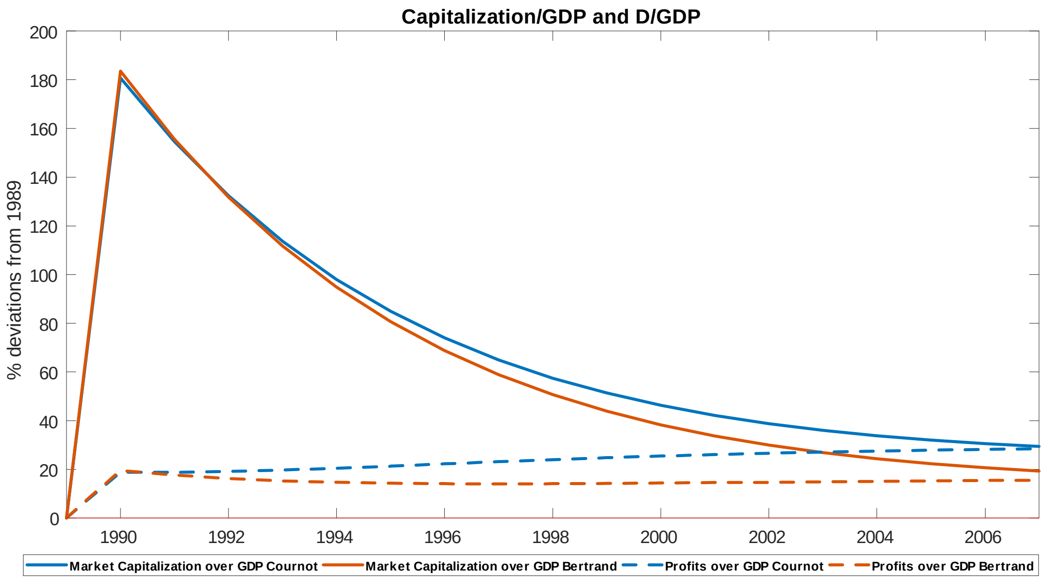

Figure 6: Dynamic of capitalization over GDP and profits over GDP between 1989 and 2007 under both Bertrand and Cournot. Percentage deviations from 1989.

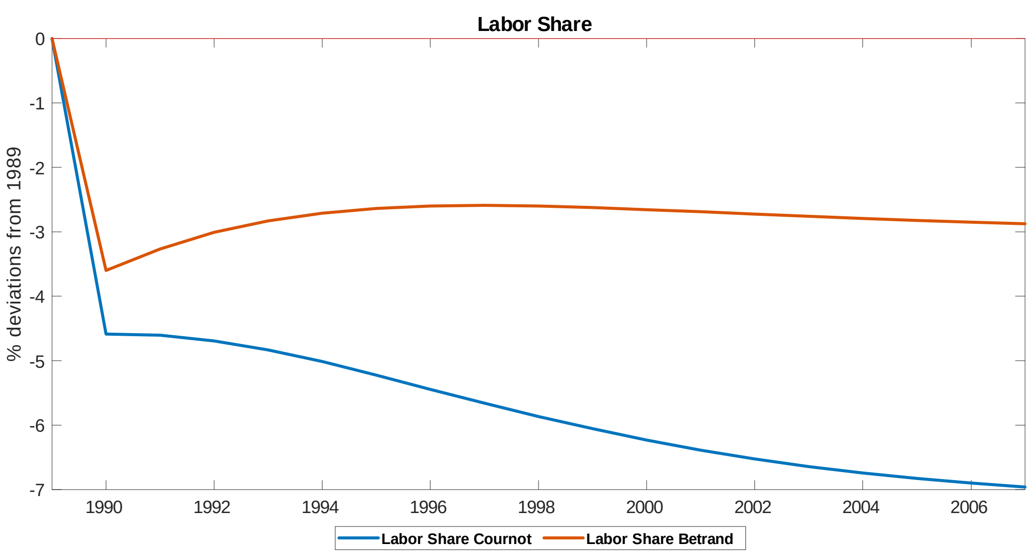

Figure 7: The labor share of Income between 1989 and 2007 udner both Bertrand and Cournot. Percentage deviations from 1989.

Quintiles	*SCF* 89	*Cournot* 89	*Bertrand* 89	*SCF* 07	*Cournot* 07	*Bertrand* 07
Q1	-0.2	0	0	-0.2	0	0
Q2	1.2	0.3	0.1	1.1	0.2	0.1
Q3	5.2	3.3	2.3	4.5	3.3	2
Q4	13	15.3	13.8	11.2	14.8	12.5
Q5	80.7	81.1	83.7	83.4	81.7	85.5
90-95	12.9	19.2	19.7	11.1	19.1	19.5
95-99	24.3	27.2	28.6	26.7	27.8	29.9
Top 1%	29.9	13.7	14.9	33.6	13.9	15.7
Gini All	0.79	0.78	0.80	0.82	0.79	0.81
Gini 99%	0.72	0.76	0.78	0.74	0.77	0.79

Table 4: Wealth distributions under Cournot and Bertrand in 2007. Comparison with data

Table 4 shows the distribution of wealth implied by the model in 2007, and compares it with the SCF data provided by Kuhn & Rios-Rull (2016) for the same year. Table 5 shows the distribution of income. The fraction of wealth in the hands of the top quintile increases under both frameworks. Although with a lower extent with respect to that in the data, our models match the increase in wealth concentration. We, instead, match quantitatively the change in the Gini index relative to income. In our model, in line with the empirical evidence in Kuhn & Rios-Rull (2016), financial income is the key driver of the increase in income inequality.

Quintiles	*SCF* 89	*Cournot* 89	*Bertrand* 89	*SCF* 07	*Cournot* 07	*Bertrand* 07
Q1	7.2	4.6	4.8	6.6	4.3	4.6
Q2	10.7	9.7	9.8	9.7	9.3	9.7
Q3	14.6	13.9	14.1	13.6	13.7	14.0
Q4	20.2	22.6	22.8	17.7	22.4	22.9
Q5	47.3	49.2	48.5	52.5	50.3	48.7
90-95	8.8	12.2	12.1	8.3	12.2	11.8
95-99	12.1	13.9	13.6	16.4	14.5	13.9
Top 1%	13.1	5.7	5.6	16.1	5.9	5.5
Gini All	0.53	0.47	0.46	0.55	0.49	0.47
Gini 99%	0.46	0.46	0.45	0.47	0.47	0.46

Table 5: Income distributions under Cournot and Bertrand in 2007. Comparison with data.

The last table reports the model implied wealth and income distributions in the final stationary distribution.[15] In both the Bertrand and Cournot frameworks, income concentration increases permanently in response to a permanent increase in market concentration. This is not the case under monopolistic competition where both the income and wealth distributions are unchanged with respect to the initial ones.

[15] This is the stationary distibution implied by the 07-calibration.

	Cournot		*Bertrand*		*Mon.Comp.*	
Quintiles	*Wealth*	*Income*	*Wealth*	*Income*	*Wealth*	*Income*
Q1	0	4.4	0	4.7	0	4.8
Q2	0.6	9.3	0.2	9.7	0.1	9.8
Q3	4.6	13.8	2.9	14.0	2	14.2
Q4	17.1	22.4	14.8	22.7	13.3	22.9
Q5	77.8	50.1	82.1	49.0	84.7	48.3
90-95	18.6	12.4	19.3	12.2	19.8	12
95-99	25.6	14.2	27.7	13.8	29.1	13.5
Top 1%	12.3	5.8	14.1	5.7	15.4	5.6
Gini All	0.75	0.48	0.78	0.47	0.80	0.46
Gini 99%	0.74	0.47	0.77	0.46	0.79	0.45

Table 6: Wealth and income distributions under Cournot and Bertrand in the Final steady state, 07-calibration.

6.2.2 Welfare effects

It this section, we asses who gains and who loses, in welfare terms, in the aftermath of the increase in market power characterized in the previous section. To do so we compute the individual welfare changes, and their distribution across the population, and the welfare change experienced by society as a whole during the transition from the initial steady state to the final one.

The welfare level of agent i at time t is measured by her expected lifetime utility, defined as:

$$V(c_{it})_{t=0}^{\infty} = E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_{it}\right)$$

The subscript i indicates that the consumption path is conditional on agents' initial states (wealth, s, and productivity, z). We denote values assumed by variables in the initial steady state with the superscript 89, to emphasize that they are relative to the 89-calibration; we denote, instead, the values that variables assume during the transition to the new stationary state with the superscript tr, which stands for "transition".

Following Floden (2001) and Domeij & Heathcote (2004), we express the individual welfare change in terms of Consumption Equivalent Variation (CEV), defined as the value of ω_i that solves:

$$E_0 \sum_{t=0}^{\infty} \beta^t u((1+\omega_i)c_{it}^{89}) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}^{tr})$$

The constant ω_i measures the percentage change in lifetime consumption that makes an agent indifferent between remaining in the initial steady state forever or moving to the final steady state. A positive value of ω_i implies that the rise in market power leads to a welfare gain for that particular individual and vice-versa.

The value of ω_i is conditional on the initial states, as such we compute a consumption equivalent for each type of agent and we obtain a cross-sectional distribution of CEVs.

Figure 8 displays the distributions of welfare losses.[16] The left-panel refers to Cournot competition, while the right panel to Bertrand. The Figure reports individual wealth levels on the horizontal axis (s) and productivity levels on the vertical axis (z). Hence, each point in

[16] We report just welfare losses, and not also the gains because it simplifies the reading of the Figure.

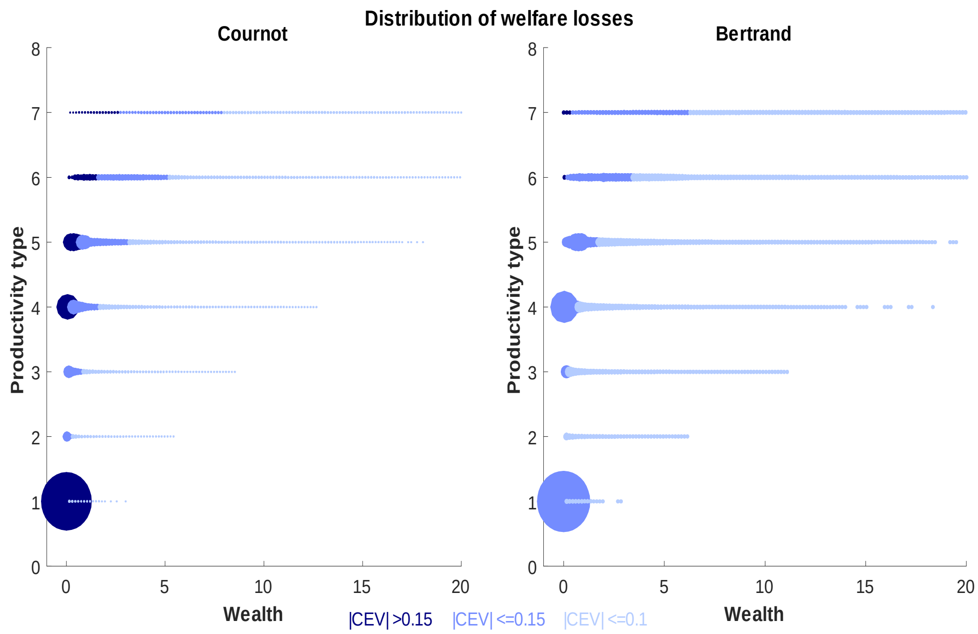

Figure 8: Distributions of consumption equivalent variations under Cournot and Bertrand. Just absolute values of negative CEVs are reported.

this space identifies an agent-type. The size of each circle is proportional to the share of the population that experience the identified welfare loss. The general message of the Figure is that agents who lose are those for whom labor income represents the majority of total income. This is so for wealth-poor agents, independently of their productivity, but also for highly productive agents, independently of their wealth. For these agents, the increase in financial income does not compensate for the loss in labor income spreading from the higher markup. Just 23% of households in Cournot and 25% in Bertrand and Monopolistic Competition enjoy a welfare gain, which implies that higher market concentration makes the vast majority of the population worse off.

An indicator of the effect of the increased market power on the economy as a whole is given by the *utilitarian social welfare gain* ω^u. This represents the average welfare gain in the economy, but it can also be interpreted as the ex-ante welfare gain, that is the welfare gain of a newborn who does not yet know her type, hence her position in the asset-productivity space. The utilitarian social welfare gain is the value of ω^u which solves

$$\int E_0 V\left(\left\{(1+\omega^u)c_{it}^I\right\}_{t=0}^{\infty}\right) d\lambda^I = \int E_0 V\left(\left\{(c_{it}^{tr}\right\}_{t=0}^{\infty}\right) d\lambda^I$$

Notice that in the expression above $\int E_0 V\left(\{c_{it}\}_{t=0}^{\infty}\right) d\lambda$ represents the utilitarian social welfare, i.e. the average expected lifetime utility computed assigning to each agent the same weight. As additional evidence that an increase in market power is not beneficial for the economy, the social welfare variation in Cournot equals -16% of aggregate consumption, while it rises to -13% in Bertrand and to -12% in Monopolistic Competition. The variation in the extent of competition among firms affects contemporaneously the level of aggregate consumption, the distribution of income among households, and the ability of individuals to self-insure against earning shocks through savings. For this reason we follow Floden (2001) and decompose the utilitarian social welfare variation in three components: an aggregate (or level) component ω_{lev}, an an inequality component, ω_{ine}, and an uncertainty component, ω_{unc}.

To disentangle the three components one must compute individual certainty-equivalent consumption ($\bar{c}_i$). This value is such that $V\left(\{\bar{c}_i\}_{t=0}^{\infty}\right) = E_0 V\left(\{c_{it}\}_{t=0}^{\infty}\right)$. It represents the constant amount that agent i should consume in each period from t onwards in order to have the same expected utility as she gets during the transition to the final steady state. The uncertainty component is then measured comparing actual consumption during the transition, c_{it} to the certainty equivalent, $\bar{c}_i$. The inequality component comes from the distribution of the certainty-equivalent across agents. Floden (2001) shows that, for separable utility functions, the following relationship between ω^u and the three components described above holds:[17]

$$1 + \omega^u = (1 + \omega_{lev})(1 + \omega_{unc})(1 + \omega_{inc}).$$

Table 7 displays the decomposition of ω^u in our model

	Cournot	*Bertrand*	*Mon.Comp.*
Average ω	-16.2	-13.1	-12.3
Level ω_{lev}	-14.7	-11.7	-10.7
Inequality ω_{inc}	-2.6	-1.9	-1.5
Uncertainty ω_{unc}	9.3	0.4	0.3

Table 7: Decomposition of the utilitarian social welfare change. Each component is expressed in percentage of consumption

The aggregate welfare effect of the rise in market power is negative: there are fewer firms, aggregate output is lower and so are aggregate consumption and social welfare. The inequality component is also negative: the shift in the composition of income in favor of financial income leads to a more unequal distribution of resources due to the highly concentrated stock ownership. The negative average effect is, however, partially mitigated by the positive effect coming from the reduction in consumption uncertainty. Financial income is not subject to risk in our framework. As a result, asset holders experience a reduction in the uncertainty of their overall income and consumption. Under Cournot competition, the effects are quantitatively more sizeable with respect to other market structures due to a larger variation in the price markup in response to the change in the extent of competition. A higher price markup leads to a stronger reduction in aggregate consumption, but to a higher financial income which at the same time increases inequality and reduces income uncertainty.

7 Conclusions

This paper provides a model with incomplete financial markets where agents are subject to uninsurable earning shocks. The markets for final goods are characterized by alternative, imperfectly competitive, endogenous market structures. The degree of market power, as measured by the price markup, depends endogenously on the form of competition, on the degree of substitutability between goods and on the equilibrium number of firms.

The interaction between incomplete markets and EMSs delivers long run ergodic distribution of wealth and income which are consistent with those in US data. Further, when we simulate the effects of an increase in technological barriers to entry for new firms we obtain an increase in price markups, a decrease in the labor share of income and an increase in income concentration which are broadly consistent with those observed in the data between 1989 and 2007. Our results suggest that a decline in the labor share of income leads to higher income inequality if

[17] Since in our model agents do not enjoy utility form leisure, the aggregate effect can also be computed directly comparing the utilitarian social welfare in 1989 to the utilitarian social welfare associated with the transition.

wealth is unequally distributed, as in the US. The welfare analysis shows that the vast majority of the population suffers a welfare loss in the aftermath of an increase in market concentration.

This work suggests that a relatively straightforward extension of the Bewley-Aiyagari model, namely oligopolistic competition with endogenous firms dynamics, is successful at reproducing concentration facts and their evolution over the last 30 years. Notice that we focus on the extensive margin of competition, which is related to the number of competitors in the market. Edmond et al. (2015) address contemporaneously both the extensive and the intensive margin, the one which spreads from heterogeneity in market shares across firms. We are currently extending our framework to account for firms heterogeneity and disentangle the effects of both margins of competition on the distributions of income and wealth.

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8 Appendix

8.1 Steady State Solution Method

1. We start by setting parameters and discretizing the state-space. We obtain 7 nodes for the exogenous labor productivity process $z = \{z_1, ..., z_7\}$ and the associated transition matrix Π. For the asset space, we choose exponentially spaced nodes. The tensor product of the two set of nodes $(s \otimes z)$ is the fixed grid used in the algorithm.

2. Guessing a value for N it is possible to compute all the other aggregate variables in $\Omega = \{N,\ N^e,\ V,\ \mu,\ \pi,\ Y,\ w,\ L^c,\ L^e\}$ through the optimality conditions of the firms and the equilibrium conditions implied by the entry process.

3. Given Ω,the households' problem can be solved. We use the "Endogenous Grid Method" developed by Carroll (2006) and we approximate the policy function through linear splines. If the model is not too complicated this method allows for a closed form expression of the current variables in function of future ones avoiding in this way the use of a non-linear equation solver.

    (a) Guess a policy function $g_c(s', z')$ on the fixed grid. This is used for tomorrow assets and allows us to calculate the value of the right-hand side (RHS) of the Euler Equation (EE) $RHS = \beta E\left(\frac{U_c(c')(V'+d')N'}{V(N+N^e)}\right)$. The expectation is over z' and is computed using the exogenous transition matrix Π.

    (b) Exploiting the left-hand side (LHS) of the EE, retrieve current consumption $c = U_c^{-1}(RHS)$. Now, using the budget constraint compute the current asset holding s^*. These are the values of stocks today that lead to s' as the future optimal choice, conditional on current productivity level. This new grid for shares changes at each iteration and it is *endogenous*. Note that s_0^* is the maximum value of shares today that leads to a binding constraint tomorrow.

    (c) Check whether the *endogenous* grid covers the entire assets domain. If s_0^* is greater than s_{min} add (at least) a point $s^* = s_{min}$ that by construction implies s_{min} as optimal choice tomorrow.

    (d) To obtain $g_c(s, z)$ is necessary to interpolate c, defined on the endogenous grid, on the original fix grid.

    (e) Compare the policy function with the initial guess and iterate points a-d until convergence. Once convergence is achieved, compute the policy function for stocks $g_s(s, z)$ from the budget constraint.

4. With the policy function $g_s(s, z)$ and the exogenous transition matrix of the idiosyncratic shock Π, it is possible to compute the ergodic distribution of agents over the state space. This is done exploiting the grid method developed by Young (2010). The distribution is represented as a histogram over a uniform grid[18]. The distribution at time t is described by a vector of masses for each type $\{s, z\}$ on the grid. To obtain the distribution at time $t+1$ the probability of transiting from a generic state $\{s, z\}$ to state $\left\{s', z^{'}\right\}$ must be found. These probabilities, represented by a big transition matrix $\mathcal{P}$, can be computed as $\mathcal{P}_{ij} \equiv \Pr(\ (s^j z^j)\ |\ (s^i z^i)\ ) = \Pr\left(s^j |\ (s^i z^i)\right)\ x\ \Pr(z^j | z^i)$. In the formula, $\Pr(z^j | z^i)$ simply indicates the exogenous transition matrix Π, while $\Pr\left(s^j |\ (s^i z^i)\right)$ refers to the policy function: if $s_k < g_s(s, z) < s_{k+1}$ then $\Pr\left(s_k |\ (s^i z^i)\right) = \frac{s_{k+1} - g_s(s,z)}{s_{k+1} - s_k}$, $\Pr\left(s_{k+1} |\ (s^i z^i)\right) = \frac{g_s(s,z) - s_k}{s_{k+1} - s_k}$ and it is zero everywhere else. The ergodic distribution implied by $\mathcal{P}$ is $\lambda(s, z) = \mathcal{P}\ \lambda(s, z)$ and can be found iterating on this equation starting from any arbitrary initial distribution λ.

5. Finally, using the distribution of agents it is possible to check the stock market clearing condition. If it does not hold, the number of firms is updated and the procedure is repeated from point 2. The new N is chosen through the bisection method according to the sign of the excess demand. If it is positive, there is an excess demand of shares so N has to increase, otherwise, it has to diminish.

[18] To compute the distribution of agents a finer (and equispaced) grid than the one used to obtain the policy functions is adopted.