Competition and Inequality[*][†]

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Abstract

In the last few decades, the vast majority of US industries experienced a broad growth in profit rates, in sales concentration, and in estimated price markups. These trends were accompanied by persistent drops in firm entry rates, in the number of publicly traded firms and in the labor share of income, together with a rising stock market capitalization to GDP ratio. The increase in rents could be one of the reasons behind the surge in inequality documented in the United States over the same period. This paper links the debate concerning the decrease in competitiveness and business dynamism with that on rising inequality. To do so, it builds a quantitative framework with strategic interactions between an endogenous number of firms and incomplete markets. Our analysis makes four contributions: (i) it provides a model that matches the concentration of the US empirical income and wealth distributions; (ii) it jointly explains the trends described above through an increase in entry costs for new firms, which limits the extent of competition; (iii) through those trends it accounts for 25% to 50% of the increase in income inequality observed between 1989 and 2007 and for about 30% of the increase in wealth inequality; (iv) it finds that welfare costs associated with lower competition are large and unevenly distributed across households. Just 3% of the population experiences a welfare gain during the transition from a high to a low competition environment. These households benefit from an increase in the price markup because a large fraction of their income comes from stocks ownership.

Keywords: inequality, entry, oligopoly, markups, incomplete markets.
JEL classifications: D4, E2, L1.

1 Introduction

In the last few decades, the vast majority of US industries experienced a broad growth in profit rates, in sales concentration and in price-cost margins. Those upward trends were accompanied by persistent drops in firm entry rates, in the number of publicly traded firms, and in the labor share of income, together with an increase in the ratio between stock market capitalization and GDP.

These facts suggest that the United States is no longer the dynamic and competitive economy it was thirty years ago, and led to a renewed interest in the macroeconomic effects of market power. Stiglitz (2012) and Baker & Salop (2015) argue that an increase in rents could be one of the reasons behind the increase in income and wealth inequality documented in the United States over the last forty years.

This paper links the debate concerning the decrease in competitiveness and business dynamism in the United States with that on rising inequality. To do so, it builds a quantitative framework with strategic interactions between an endogenous number of firms and incomplete markets. Our analysis makes four contributions. First, it provides a model that matches the concentration of the US empirical income and wealth distributions. Second, it jointly explains the trends described above through an increase in entry costs for new firms, which limits competition. Third, through those trends it explains between a quarter and a half of the actual variation in the Gini index of income concentration over the same period of time and about a third of the increase in wealth inequality.[1] Finally, it quantifies the welfare costs due to the decrease in competition and finds that they are large and unevenly distributed across households. Just 3% of the population enjoys a small welfare gain in response to lower competition. These are either very wealthy agents, or agents with a low productivity relative to their asset holdings. In both cases, financial income represents the main source of receipts for these households, and an increase in markups has a positive impact on their total income and consumption.

The theoretical framework consists of a quantitative, variety-based, general equilibrium model enriched with aspects of industrial organization and characterized by incomplete markets. As in the seminal contributions by Melitz (2003) and Bilbiie et al. (2012), the entry of a new firm into the market amounts to the creation of a new variety of the final good. In our setup, each individual firm produces output using only labor. However, the number of firms that produce in each period can be interpreted as the capital stock of the economy, and the decision of households to finance entry of new firms is akin to the decision to accumulate physical capital in the standard incomplete markets model à la Aiyagari (1994).

Entry takes place subject to sunk costs, which are paid by investors in anticipation of future profits. As in the endogenous growth literature based on expanding varieties, labor is shared between the production of the consumption good and the development of new firms/products. As a result, entry costs are proportional to the real wage. Firms enter into the market up to the point where the value of their newly created product equals its sunk cost.

Market participants compete in an oligopolistic fashion. While our baseline framework features Cournot competition, we show that results do not depend on the specific form of competition by considering Bertrand competition in an extension. Oligopolistic competition establishes a link between the intensity of competition and price markups. Specifically, oligopolistic competition implies that a higher number of market competitors translates into a lower price-cost margin. The level of the price markup, in turn, affects how aggregate income is distributed between labor and profits. The investment in new productive units is financed by households through the accumulation of shares in the portfolio of firms. The stock-market price of this

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[1]As discussed in the next Section, there are some differences in the degree of income inequality, and its evolution over time, across available US surveys. The Survey of Consumer Finances is characterized by a higher degree of income dispersion than that characterizing the Current Population Survey. For this reason, we provide a range, and not a specific number, for the fraction of the change in income inequality explained by our model between 1989 and 2007.

investment changes endogenously in response to changes in competition and it is at the core of our mechanism. Together with the shares' payoff due to oligopolistic profits, it determines the return to investment which in turn affects household saving decisions and the distributions of wealth and income, producers entry, and, thus, the intensity of competition. This contrasts with the standard incomplete markets model, where the price of physical capital is constant absent capital adjustment costs, and the return to investment equals the marginal product of physical capital.

We describe an environment with no aggregate uncertainty and calibrate it to resemble the US economy in 1989. In particular, we calibrate entry costs such that the price markup matches the estimates by De Loecker & Eeckhout (2018) for that year, and solve for the ergodic, or steady state, distribution of the model. In the United States wealth was highly concentrated and very unequally distributed, much more so than income, already in 1989.

The stationary wealth distribution delivered by the model closely resembles the actual US wealth distribution. Specifically, the model captures the fact that households constituting the bottom two quintiles of the wealth distribution hardly have any wealth, but also that the top wealth quintile holds approximately 80% of all net worth in the US economy. This results in a Gini coefficient of about 0.8, as in US data. Given the high concentration of stocks ownership, dividend income benefits disproportionately a restricted group of households. As a result, the oligopolistic framework delivers an income distribution characterized by a Gini coefficient of about 0.5, as that observed in the United States.

With the realistic wealth and income distributions delivered by our model in hand, we study the impact of an increase in entry costs on income inequality. The increase in entry costs is modeled as an increase in the amount of labor required to create a new firm/product. This could be due either to a decrease in the productivity of the R&D sector, or to an increase in regulation, or to a combination of both. Both hypotheses have empirical support and are consistent with our modelling choice. Bloom et al. (2017) present evidence from various industries, products, and firms showing that research effort is rising substantially, while research productivity is declining sharply. This is so even if the analysis is restricted to publicly-listed firms in Compustat that engage in R&D. Gutiérrez & Philippon (2019b) suggest that barriers to entry due to regulation contributed, at least in part, to the decline in business dynamism observed in the United States since the end of the 80s. Further, they find that the correlation between entry rates and the value of incumbent firms turned negative since 2000, suggesting that allocative efficiency has been operating less effectively in recent years.

In our experiment, entry costs increase in order to replicate the dynamics of the average US price markup estimated by De Loecker & Eeckhout (2017) between 1989 and 2007. Higher entry costs lead to a decrease in the rate of entry and to a negative correlation between entry and the value of incumbent firms. The reduction in the number of market competitors limits the extent of competition in the market for final goods and leads to a higher price markup. As a result, the economy transits from the initial steady state, characterized by low entry costs and low market power, to a final, high entry costs and high market power, steady state. The reduction in the number of listed firms implied by the model is comparable to that in the data. A higher price markup translates in a reduction in the labor share of income, and in a rise in both the profit share of income and the ratio between stock market capitalization and GDP. These outcomes impact on income and wealth inequality. Since the increase in the price markup leads to a shift in the distribution of income from the less concentrated labor income to the more concentrated profit income, we observe an increase in income concentration. As mentioned above, the model implies that the decrease in the labor share, together with the mirror increase in dividend income spreading from the rise in the price markup, explains a large fraction of the overall increase in income and wealth inequality between 1989 and 2007 in the United States.[2] This is remarkable

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[2] The literature has suggested other factors, beside a decrease in market competition, that could have contributed to exacerbate income inequality over this period of time. These factors are not included in our analysis, but we discuss them in the next Section.

in light of the fact that the only exogenous input in the model is the series of entry costs.

Finally, we identify the welfare costs resulting from an increase in market power triggered by higher entry costs. We do so by evaluating the welfare costs spreading from the transition from the initial steady state to the final one. We find that welfare costs associated with lower competition are large and unevenly distributed across the population. Just 3% of the households experience a welfare gain during the transition to the final steady state. These are either very wealthy agents, or agents with a low productivity relative to their asset holdings. In both cases, financial income represents the main source of their receipts, and an increase in markups has a positive impact on their total earnings and consumption.[3]

The baseline infinite horizon Bewley-Aiyagari model does not account for the wealth heterogeneity observed in the data. Our model, instead, is successful at matching the US empirical income and wealth distributions. With respect to other mechanisms that have been proposed in the literature to address the degree of empirical wealth concentration, that we briefly review below, our approach is simple and could have various applications in macroeconomics, finance, public finance, and industrial organization.

The remainder of the paper is organized as follows. Section 2 discusses the various branches of the literature related to our work and the stylized facts addressed in our analysis, Section 3 spells out the model economy, Section 4 defines the equilibrium concepts used in the paper, Section 5 calibrates the initial steady state, Section 6 provides the wealth and income distributions in the initial steady state, Section 7 evaluates the macroeconomics and distributional effects of an increase in market power, Section 8 concludes.

2   Related Literature and Stylized Facts

Our work is related to several recent strands of the macroeconomic literature. We discuss them in turn.

Market Concentration: Market Power Vs Superstar Firms. There has been a structural change in the competitive landscape of US 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. Haltiwanger et al. (2013) show that the startup rate and other measures of business dynamism, such as the rates of worker and job reallocation, have been decreasing in the non-farm private sector since 1980. Concentration has, thus, increased at both the intensive margin, due to more concentrated sales, and at the extensive margin, due to fewer key competitors in the relevant markets. There are two leading explanations for the increase in concentration. The first one is the super-star firms hypothesis popularized by Autor et al. (2017). According to this view, a restricted group of firms have become increasingly more efficient than other firms in their respective industries. This might explain why their market shares and their profits have grown. In this case, increased concentration should be regarded as good news. The second view argues for an increase in entry costs for new firms which create barriers to entry. According to this view, concentration is bad news and the result of market power. If concentration is due to market power, we should see rising markups, whereas if it is due to superstar firms, we should see advancing productivity among market leaders. As argued by Crouzet & Eberly (2018), these explanations are not mutually exclusive and need not play the same role in every industry. Gutiérrez & Philippon (2019a) find that super-star firms have not become more productive and that their contribution to overall productivity growth has decreased by about 40% over the past 20 years.

The works by De Loecker & Eeckhout (2018), De Loecker & Eeckhout (2017) and Hall (2018) are among the most influential studies in the macro market power literature. These papers find

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[3]To isolate the effects of market power on the distribution of wealth and income, we hold the level of technology constant during the transition from the intial to the final steady state.

that measured markups have grown substantially since the early 1980s, both in the US and in many other countries around the world. Rising markups provide evidence of market power. Several authors argue that market power is on the rise due to an increase in barriers to entry for new firms. As mentioned above, there could be various reasons at the basis of an increase in entry barriers. Gutiérrez & Philippon (2019b) argue in favour of an increase in regulation. Grullon et al. (2017) suggest that if large firms are better able to develop and implement technology, then recent technological advances may create barriers to entry for new firms. They calculate the evolution of patent-based industry concentration by looking at the share of total patent activity by the largest four firms in the industry using the patent database by Kogan et al. (2017), and find that it follows a pattern almost identical to that of the sales-based Herfindahl–Hirschman index. Their results suggest that complex technology also facilitates synergy potentials and increases barriers to entry. A sharp decline in research productivity, as that documented by Bloom et al. (2017), implies a higher research input for the creation of new products and leads, through this channel, to higher entry costs.

Competition and Markups. Syverson (2019) argues that the formally correct concept of market power is given by the ability of a firm to price its products above marginal costs. The empirical works mentioned in the previous paragraph suggest that the rise in concentration has been accompanied by rising markups, though the estimated degree of the increase varies.

Figure 1 plots yearly percentage deviations in the average price markup in US industries estimated by De Loecker & Eeckhout (2017). They estimate firms-level markups using Compustat data on the universe of US-listed firms. We report their weighted average markup, across the economy, where weights are based on firm-level sales.[4] The picture also reports yearly percentage deviations in the number of US-listed firms. Deviations are taken with respect to the values assumed by these variables in 1989, which we take as the baseline period in our analysis. We focus on publicly traded firms because they tend to be much larger than private firms, and are therefore typically the key industry players. In line with this approach, our theoretical framework features publicly listed firms. Figure 1 suggests that competition at the extensive margin and price markups are indeed negatively correlated as one would expect. Grullon et al. (2017) go one step further and provide direct evidence that a lower number of peers in the relevant market positively affects profit margins. Early works in the New Empirical Industrial Organization literature starting with Bresnahan et al. (1987) and more recent research by Manuszak (2002), Manuszak & Moul (2008) and others, have provided evidence in support of a causal negative relationship between the number of competitors and price markups, which is the key transmission mechanism in our framework.

Macroeconomics Effects of Market Power. Bilbiie et al. (2019) study distortions related to endogenous product creation and variety under monopolistic competition. They argue that those distortions entail large welfare costs and that appropriate taxation schemes can restore optimality if they preserve entry incentives. Colciago (2016) studies the distortions caused by oligopoly on firms and product creation. He finds that the optimal dividend income tax is higher in market structures characterized by competition in quantities rather than those characterized by price competition. Edmond et al. (2018) study the welfare costs of markups in a dynamic model with heterogeneous firms and endogenously variable markups. They find that the welfare costs of aggregate markups are large, while those associated to markup dispersion are low. Eggertsson et al. (2018), demonstrate that a neoclassical model augmented with monopolistic competition and a declining natural rate of interest can quantitatively mimic observed trends in markups, asset prices, and factor income in response to a change in agent preferences. De Loecker & Eeckhout (2018) show that an increase in price markups can explain the declining labor and capital shares as well as the decrease in labor market dynamism observed in the last thirty years. Edmond et al. (2015) provide an open-economy model with oligopolistic competition and

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[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.

variable markups. Parametrizing their model using Taiwanese data, they show that opening up to trade reduces markup distortions in half. Carvalho & Grassi (2019) and Grassi (2017) build multi-sector heterogeneous-firms, general equilibrium models characterized by oligopolistic competition and an input-output network. They show that, by affecting price markups, firms level productivity shocks have aggregate effects.

Factors' shares and stock market capitalization. Figure 2 displays yearly percentage deviations, from 1989, in corporate profits over GDP and Stock Market Capitalization to GDP for the United States. Both ratios display a positive trend during the period considered.

Figure 3 reports the dynamics of the labor share of income.[5]. As pointed out by various observers as Karabarbounis & Neiman (2013), Elsby et al. (2013) and Karabarbounis et al. (2014), the labor's share of income in the United States has trended downward over the past quarter century. 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. Autor et al. (2017) find that the fall in the labor share is explained by a composition shift towards establishments with low labor shares. Barkai (2016) provides evidence suggesting that the decline in the shares of labor and capital are due to a decline in competition. His results, consistently with our story, support the view that the decline in the labor share is not an efficient outcome.

Evolution of Income and Wealth Inequality. Over the last 30 years, income and wealth inequality in the United States have increased substantially. This has been documented, *inter alia*, by Saez & Zucman (2016) using income tax data, and by Kuhn & Rios-Rull (2016) using the Survey of Consumer Finance (SCF). Panel a) of Figure 4 displays the Gini coefficient of wealth inequality computed by Kuhn & Rios-Rull (2016) on the basis of the SCF, which runs every three years. Panel b) of the same Figure reports the Gini coefficient of income inequality published by the US Census Bureau and that computed by Kuhn & Rios-Rull (2016) on the basis of the SCF.[6] The solid line represents the time series of the Census's Gini Index. The circles represent the values of the Gini index extrapolated from the SCF. The dashed line, instead, is the linear time trend fitted through those points, and has the purpose to highlight the time pattern followed by income inequality in the SCF. Both measures are characterized by an upward trend. The difference in value between the two Gini coefficients of income concentration is likely due to a different definition of the units of observation in the two surveys.[7] This paper is among the few studying the potential drivers of income and wealth inequality over time in a general equilibrium quantitative framework. Acemoglu & Restrepo (2018) study income inequality in a model where high-skill labor has a comparative advantage in new tasks relative to low-skilled labor. In this case, automation increases income inequality in the short run. In Favilukis (2013) the stock market plays a major role at explaining the increase in inequality in both income and wealth. Other factors that contributed to an increase in income inequality over recent decades are the increased wage inequality documented by Katz & Murphy (1992), job polarization as in Autor et al. (2003) and Siu & Jaimovich (2015). Moll et al. (2019) argue that automation could lead to higher wealth inequality, Hubmer et al. (2016) find that the main driver of the increase in wealth inequality observed in the US over the recent decades is the decrease in tax progressivity. Higher wealth inequality leads to a more concentrated capital income and could,

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[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. The data source is FRED.

[6] The Census figures are based on the Current Population Survey (CPS), sponsored jointly by the US Census Bureau and the US Bureau of Labor Statistics (BLS).

[7] Kuhn et al. (2018) point out that the unit of analysis in the SCF is the primary economic unit (PEU), that contains persons in a household who share finances. The Census household definition deviates slightly from that of a PEU as it groups people living together in a housing unit. In some cases, this definition may include several PEUs living together. However, the two concepts should lead to identical units of observation in the vast majority of cases.

through this channel, increase income inequality. Our work emphasizes that a rise in entry costs for new firms, through its impact on competition and on the labor share of income, is an additional driver of inequality.

Quantitative Models of Wealth Inequality. The infinite horizon Bewley-Aiyagari model does not account for the wealth heterogeneity observed in the data. Quadrini & Ríos-Rull (2015) and De Nardi & Fella (2017) argue that the baseline version of the model comes nowhere near to matching the Gini coefficient, let alone the degree of wealth concentrated in the hands of the top quintile of the wealth distribution. Castaneda et al. (2003) and De Nardi & Fella (2017) provide a quantitative assessment of the mechanisms which could lead to a concentrated wealth distribution in Bewley-Aiyagari models. These mechanisms aim at providing agents with additional reasons to save besides the, standard, precautionary motive associated with income uncertainty. These motives are the inter-generational transmission of bequests and human capital, preference heterogeneity, as in Krusell & Smith (1998), complex earning dynamics, only partially insured medical expenditure shocks in old age, entrepreneurship as in Quadrini (2000) and Cagetti & De Nardi (2006), idiosyncratic shocks to investment opportunities or its returns, as in Benhabib et al. (2011), and life cycle aspects as in Huggett (1996).

The performance of our model at matching the US empirical wealth distribution is essentially identical to that achieved by more sophisticated frameworks, such as that proposed by Krueger et al. (2016). The latter features a life cycle structure, heterogeneous discount factors, cyclical unemployment and an unemployment insurance policy.

The models in the papers mentioned so far maintain the assumption of perfect competition in the goods markets with a finite number of varieties. Notable exceptions are Brun & González (2017) and Boar & Midrigan (2019), who provide incomplete markets models with monopolistic competition. With respect to them, we explicitly model strategic interactions between an endogenous number of firms and study the interaction between the trends in the labor share of income, the profits share and the ratio of wealth to GDP and income and wealth inequality.

Our work suggests that oligopolistic competition with endogenous varieties in infinite horizon Bewley-Aiyagari models is successful at matching concentration facts. At the basis of this result is the inverse relationship between the price markup and the intensity of competition together with the endogeneity of the stock-market price and the shares' payoff due to oligopolistic profits.

Models with Endogenous Markups. Atkeson & Burstein (2008) Jaimovich & Floetotto (2008) and Etro & Colciago (2010) provide models where oligopolistic competition leads to an inverse relationship between the extent of competition and the level of the price markup. The literature proposed alternative strategies, beside oligopolistic competition, to achieve a negative relationship between markups and competition. These could be as successful as the one we propose at addressing the facts analyzed in this paper. Bilbiie et al. (2012) and Bilbiie et al. (2019) consider a framework with monopolistic competition and endogenous variety. In their setting, a negative relationship between price markups and competition spreads from translog preferences, where the elasticity of substitution across varieties is decreasing in the number of varieties. Edmond et al. (2015) consider monopolistic competition between heterogenous firms and show a negative relationship between price markups and competition under Kimball-style preferences, where the elasticity of substitution between a given variety and others is decreasing in the relative quantity consumed of the varieties. Edmond & Veldkamp (2009) link the cyclicality of the price markup to the degree of income dispersion. Specifically, they develop a framework where a higher degree of income dispersion, as that observed during recessions, lowers the price elasticity of demand, and increases imperfectly competitive firms' optimal markups. Bertoletti & Etro (2016) consider monopolistic competition with non-homothetic preferences. Specifically, they consider monopolistic competition in the case of an indirect utility that is additively separable. In this case, the relative demand of two goods does not depend on the price of other goods, but it generally depends on income. They show that higher income and productivity increase price markups in the long run, consistently with the evidence that markups tend to be higher in richer countries.

3 The Model

The economy features a continuum of atomistics sectors, or industries, on the unit interval. Each sector is characterized by a limited number of 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_{jt}^e 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 the market for exogenous reasons. As a result, the number of firms in a sector N_{jt} follows the equation of motion:

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

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 US annual data on manufacturing, Lee & Mukoyama (2008) find that, although the entry rate is procyclical, annual exit rates are similar across booms and recessions.

We consider the oligopolistic competition approach developed by Jaimovich & Floetotto (2008) and Etro & Colciago (2010). As in Ghironi & Melitz (2005) and Bilbiie et al. (2012), 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

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

where A represents technology that is common across sectors and remains constant over time, while $l_{jt}^c(i)$ is the labor 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

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

where P_{jt} is defined as

$$P_{jt} = \left[\sum_{i=1}^{N_{jt}} (p_{jt}(i))^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{6}$$

and the demand faced by the producer of each variety is

$$y_{jt}(i) = \left(\frac{p_{jt}(i)}{P_{jt}}\right)^{-\theta} Y_{jt}. \tag{7}$$

Using (7) and (5), the individual demand of good i can be written as a function of aggregate expenditure,

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

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. Each household has expected utility given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma} \tag{9}$$

where $\beta \in (0,1)$ is the, common across households, discount factor, c_t 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 household's idiosyncratic labor productivity, z_t, follows an AR(1) process in log given by $\log(z_t) = \rho \log(z_{t-1}) + \varepsilon_t$, where ε_t is a mean zero *i.i.d.* shock.

Households enjoy labor and dividend income. The household maximizes (9) by choosing how much to consume, $c_t(s_t, z_t)$, and how much to invest in stocks, $s_{t+1}(s_t, z_t)$. Consumption and investment choices depend on the current value of the idiosyncratic states: wealth (s_t) and productivity (z_t). In the remainder, to lighten notation, we will omit dependence on current states whenever possible. The timing of investment in the stock market is as in Bilbiie et al. (2012) and Chugh & Ghironi (2011). At the beginning of period t, each household owns s_t 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 $s_tV_tN_t$. During period t, the household purchases s_{t+1} 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 $V_t(N_t + N_t^e)s_{t+1}$. At the very end of period t, a fraction of these firms disappears from the market.[8] 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 $D_t = s_td_tN_t$. Households' labor income is composed by the real wage per efficiency unit, w_t, times the idiosyncratic productivity level, z_t. The flow budget constraint of the household is

$$V_t(N_t + N_t^e)s_{t+1} + c_t = (d_t + V_t)N_ts_t + z_tw_t \tag{10}$$

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[8]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.

where we impose the no short-selling constraint

$$s_t \geq 0, \ \forall t$$

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

$$U_c(c_t) \geq \beta E_t \frac{(V_{t+1} + d_{t+1}) N_{t+1}}{V_t (N_t + N_t^e)} U_c(c_{t+1}) \tag{11}$$

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

3.3   The Mutual Fund

Following Bilbiie et al. (2012) and Gornemann et al. (2016) we assume that a mutual fund owns all the firms in the economy. The fund collects firms' profits, $d_t N_t$, and distributes them to households according to their individual stock holdings, s_t. The mutual fund has a dual role. On the one hand, it allows each household to invest in a single asset instead of investing in a multiplicity of stocks of identical firms. On the other hand, it suggest a simple and intuitive way to aggregate the heterogeneous stochastic discount factors of households.[9] Households own the fund and for this reason the factor used by the fund to discount future firms' profit is defined as an asset-weighted average of the households' individual stochastic discount factors:

$$\Lambda_{t,t+s} = \int s_{t+s} \left(\beta^s E_t \frac{U'(c_{t+s})}{U'(c_t)} \right) \mathsf{d}\lambda_t(s, z) \qquad s = 0, 1, \dots$$

Where $\lambda_t(s, z)$ defines the measure of households over the possible values of wealth, s, and productivity levels, z, in a given period t. Notice that Favilukis (2013) adopts an identical definition.

3.4   Endogenous Entry

Each firm is the producer of a different variety, and the creation of a new firm amounts to the creation of a new variety. Following Bilbiie et al. (2012) and the endogenous growth literature based on expanding varieties, we assume that the creation of a new firm requires labor. Specifically, we assume that the creation of a new firm requires ϕ_t units of labor. As a result, the sunk entry cost required to create a new firm is $\phi_t w_t$. In each period entry is determined endogenously to equate the value of a firm, V_t, which is given by the expected discounted value of its future profits, to the entry cost, $\phi_t w_t$. Firms will, thus, enter the market up to the point where

$$V_t = \phi_t w_t. \tag{12}$$

3.5   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

$$y_t(i) = Y_t \left(\frac{p_t(i)}{P_t} \right)^{-\theta} = \frac{p_t(i)^{-\theta}}{P_t^{1-\theta}} Y_t P_t = \frac{p_t(i)^{-\theta} EXP_t}{P_t^{1-\theta}} \qquad i = 1, 2, \dots, N_t \tag{13}$$

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[9]Note that households with a positive stocks holding have an identical stochastic discount factor. However, there is a positive mass of constrained households, for whom the Euler Equation does not hold. These households are characterized by heterogeneous stochastic discount factors.

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

$$p_t(i) = \frac{y_t(i)^{-\frac{1}{\theta}} EXP_t}{\sum_{i=1}^{N_t} y_t(i)^{\frac{\theta-1}{\theta}}} \qquad i = 1, 2, ..., N_t. \tag{14}$$

We will use the latter to characterize the Cournot equilibrium. 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. We take Cournot competition as our baseline competitive framework, but also consider Bertrand competition in an extension.

Under both competitive frameworks, firms take as given their marginal cost of production and the aggregate nominal expenditure.[10] We obtain equilibrium relative prices satisfying

$$\rho_t(i) = \mu(\theta, N_t)\frac{w_t}{A} \tag{15}$$

where $\frac{w_t}{A}$ is the real marginal cost and $\mu(\theta, N_t) > 1$ is the markup function. In the next section, we characterize the markup function under Cournot competition.

3.5.1 Cournot Competition

Consider competition in quantities in the form of Cournot competition. Using the inverse demand function (14), the nominal profit function of firm i can be expressed as a function of its output $y_t(i)$ and the output of all the other firms:

$$\begin{aligned}
\Pi_t[y_t(i)] &= \left[p_t(i) - \frac{W_t}{A}\right]y(i) = \\
&= \frac{y_t(i)^{\frac{\theta-1}{\theta}} EXP_t}{\sum_{j=1}^{N_t} y_t(j)^{\frac{\theta-1}{\theta}}} - \frac{W_t y_t(i)}{A}
\end{aligned} \tag{16}$$

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

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

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

$$y_t = \frac{(\theta-1)(N_t-1) \ A \ EXP_t}{\theta N_t^2 W_t} \tag{17}$$

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

$$\mu^C(\theta, N_t) = \frac{\theta N_t}{(\theta-1)(N_t-1)} \tag{18}$$

is the markup under Cournot competition. For a given number of firms, the markup under Cournot is always larger than the one obtained under Bertrand, as is well known for models of product differentiation since Vives (2001). 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 $\mu^{MC}(\theta) = \frac{\theta}{(\theta-1)}$, the markup under monopolistic competition (MC).

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[10]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.

3.6 Aggregation and Market Clearing

Aggregate supply of labour reads as $L_t^s = \int z_t l_t \mathrm{d}\lambda_t = 1$, where $l_t = 1$, for all households and in any t. Aggregate labor demand is, instead, the sum between labor used for production purposes $L_t^c = N_t l_t^c$, where we imposed symmetry among firms' labor demand, and that used to create new firms $L_t^e = N_t^e \phi_t$. As a result, labor market clearing requires

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

Equilibrium in the stock market reads as $\int s_t \mathrm{d}\lambda_t = 1$. Finally, aggregating the individual household budget constraints defined 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 $C_t = \int c_t \mathrm{d}\lambda_t$ 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

The definition of equilibrium slightly changes according to whether we consider the stationary equilibrium or a transition path.

A *stationary equilibrium* is characterized by two time invariant policy functions, $g^s(s,z)$ and $g^c(s,z)$, a set of constant aggregate variables $\Omega = \{N,\ N^e,\ V,\ \mu,\ \pi,\ Y,\ w,\ L^c,\ L^e\}$, 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 defined by equations 11 and 10.

2. Aggregate variables in Ω satisfy firms optimality conditions

3. Markets clear and the entry condition 12 is satisfied.

The distribution $\lambda(s,z)$ is the ergodic distribution implied by the exogenous transition matrix for labor productivity Ψ and the policy function $g^s(s,z)$. Distribution $\lambda(s,z)$ contains the fraction of agents in each wealth-productivity state along the cross-sectional dimension, while it gives the share of time each agent spends in each state along the time series dimension.

To assess the aggregate and distributional implications of a rise in entry costs, 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, the entry cost increases at the end of the period. At time $t = 1$ the economy starts transiting to the final steady state. Given the deterministic sequence of entry costs $\{\phi_t\}_{t=0}^{\infty}$ and the initial distribution of agents $\lambda_0(s,z)$ a *recursive equilibrium* is characterized by a sequence of policy functions $\{g_t^s(s,z), g_t^c(s,z)\}_{t=0}^{\infty}$, 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 $\{\lambda_t(s,z)\}_{t=0}^{\infty}$ 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 defined by equations 11 and 10

2. Aggregate variables in Ω_t satisfy firms optimality conditions

3. Markets clear and the entry condition 12 is satisfied.

4. the distribution $\lambda_t(s,z)$ evolves according to $\lambda_{t+1}(s,z) = P\ \lambda_t(s,z)$ where P is a transition function defined by the saving policy function $g_t^s(s,z)$ together with the exogenous transition matrix for the productivity process Ψ.

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 Appendix B, takes non-linearities and uncertainty in idiosyncratic dynamics into account.

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 Bilbiie et al. (2012).[11] 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 states 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 pointed out 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 aimed at evaluating the macroeconomic implications of a rise in market power.

We set them such that the endogenous price markup equals the estimate of the average price markup across US industries provided by De Loecker & Eeckhout (2017) in 1989. We then compute the ergodic wealth and income distributions implied by the model. We select 1989 as the initial year because this is the earliest year where the Survey of Consumer Finance (SCF) is publicly available. 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 entry costs. There is no time series concerning the dynamic of entry costs over time, thus we do not have a clear guidance to set them. For this reason, we run two alternative experiments and evaluate the robustness of our results. In the baseline experiment, we assume that entry costs increased gradually over time between 1989 and 2007 in order to match the trend in the estimated price markup over the same time period. In the alternative experiment we assume that entry costs jump once and for all in 1989 in order to match the estimated price markup in 2007.

The baseline experiment is designed as follows. We consider the estimates of the price markup for the US in 1989 and 2007 by De Loecker & Eeckhout (2017). The estimated average

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[11] The value of the long-run real interest rate under the baseline calibration is lower than that one would obtain under the benchmark Aiyagari model with the same parameterization of the discount factor. For this reason, we experimented with an alternative calibration strategy where we fix the discount factor in order to obtain the same long run interest which spreads from the model in Aiyagari (1994). This requires setting $\beta = 0.949$. Under this parameterization, the implied differences in the wealth and income distributions with respect to those under our baseline calibration are quantitatively minor.

[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.

price markup in 1989 is 1.369, while it is 1.464 in 2007. We assume that the price markup grew linearly over time between these two points. We then design a gradual increase in entry costs aimed at matching the linear time trend in the price markup starting from 1989.[13] The second experiment features a single jump in entry costs in 1989 in order to match the price markup estimated by De Loecker & Eeckhout (2017) in 2007. The two experiments feature the same price markups in 1989 and 2007. In this case, the distributions of wealth and income are identical in those two years and do not depend on the dynamics of the entry costs.

In the main text, we discuss the results concerning the baseline experiment - where entry costs increase gradually - and report in Appendix A the alternative experiment where entry costs jump in 1989. The main difference between the two exercises is constituted by the evolution of the ratio between the stock market capitalization and GDP. In the baseline experiment this increases gradually over time, as in the data, whereas in the alternative one it jumps on impact after the shock to gradually decrease to its new higher long-run level over time.[14]

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 macroeconomic, distributional and welfare implications of a rise in entry costs.

The main analysis is carried out under Cournot competition. Notice that, for a given price markup, Bertrand and Cournot deliver the same distributions of wealth and income. Appendix C shows that, holding fixed the entry costs across market structures, the price markup will be lower under Bertrand, which is a more competitive market structure with respect to Cournot.[15]

6   Income and Wealth Distributions

In this section, we evaluate the extent to which our model can match the US empirical distributions of wealth and income in 1989. Tables 2 and 3 report, respectively, the wealth and income distributions under Cournot and compare them to the empirical ones provided by Kuhn & Rios-Rull (2016), which are based on the SCF in 1989. We report the fraction of net worth and of income held by the five quintiles, and more detailed information about the top of the distributions. Finally, in both tables we report Gini concentration coefficients for the whole distribution under analysis (Gini All), and for the bottom 99% (Gini 99%).

As argued in Section 2, matching the empirical wealth distribution and its concentration in Bewley-Aiyagary models is challenging. The Cournot model matches essentially the wealth concentration of the bottom 99% of the US wealth distribution and the large fraction of total wealth in the hands of the richest 5%. It misses to explain the fraction of wealth held by the top 1%. In the data, households in the top 1% hold about 30% of the overall net worth, whereas the corresponding figure in the model is 13.2%. Recall, however, that the SCF oversamples rich households. Turning to income, the model matches the distribution of income both at the bottom and at the top. Households constituting the bottom three quintiles of the income distribution earn about 30% of total income, while the top quintile earns a fraction equal to 49.5%. The Cournot framework 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%.

Importantly, neither the concentration of the distribution of wealth nor that of income are

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[13] We simulate a shock to the entry cost parameter every 3 years - i.e. at the end of 1989, end of 1992, end of 1995 and so forth. The shocks are such that the endogenous markup reaches the value predicted by the linear trend three years after the shock. We cannot match the trend in the price markup every year since the model features state variables that require time to adjust after a shock.

[14] We thank Virgiliu Midrigan for suggesting that a gradual increase in entry costs would lead to a gradual increase in the ratio between stock market capitalization and GDP.

[15] Vives (1999) provides the following intuitive explanation to support this view. In Cournot competition, each firm expects the others to cut prices in response to price cuts, while in Bertrand competition the firm expects the others to maintain their prices; therefore Cournot penalises price cutting more.

targets of the calibration procedure. Krueger et al. (2016) develop a state-of-the-art incomplete markets model characterized by heterogeneity in preferences, a life-cycle structure, cyclical unemployment and unemployment insurance. We obtain, under the parametrization of the earning process that they estimate, a wealth distribution essentially identical to theirs. For this reason, and given the simplicity of our approach, we regard the performance of our model at matching the US empirical wealth and income distribution as a success, and believe that endogenous variety in oligopoly should be added to the list of mechanisms which lead to an empirically consistent concentration of the wealth and income distributions.

In the next Section, we assess the macroeconomic, distributional and welfare effects of an increase in entry costs which limits the extent of competition.

7 The Macroeconomic Effects of an Increase in Entry Costs

7.1 Macroeconomic Variables

With the realistic wealth and income distributions described in the previous Section, we now evaluate whether in response to an increase in entry costs our model can account for the trends described in Section 2. Further, we evaluate the effects of those trends on income and wealth inequality. We focus mainly on the period 1989-2007, but also evaluate long run effects.

Figures 5-7 are the model-equivalent of Figures 1-3, relative to US data, reported in Section 2. The Figures show that 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 oligopolistic competition, the price markup increases. This, in turn, leads to a lower labor share of income and to a higher profit share of income. Higher future profits lead to a persistent rise in stock market capitalization with respect to GDP. Since the number of listed firms decreases, this is due to an increase in the stock market value of incumbent firms. Thus, in line with the empirical evidence presented by Gutiérrez & Philippon (2019b), during our transitional experiment entry rates decrease as the value of incumbent firms increases.[16]

7.2 Distributional Effects

In this section we evaluate the distributional effects of our transitional experiment. We do that by considering the evolution of wealth and income inequality between 1989 and 2007 and by reporting the long-run distributions implied by the model in response to the change in entry costs.

The dynamics of the value of the Gini coefficient of wealth inequality during the transition between 1989 and 2007 are reported in Panel a) of Figure 8. Table 4 shows the distribution of wealth implied by the model in 2007, and compares it to that extracted by Kuhn & Rios-Rull (2016) from SCF data in the same year. In 2007 the fraction of wealth in the hand of the richest 5% of the population increased with respect to that in 1989. This lead to an increase in the Gini coefficient from 0.79 to 0.82. In response to higher markups the model correctly implies an increase in the fraction of wealth held by the richest 5% and by the top 1%, however it falls short of explaining quantitatively the overall increase in wealth inequality. Notice that an increase in wealth concentration also implies an increase in the concentration of the financial income that spreads from it.

Panel b) of Figure 8 shows the dynamics of the Gini coefficient of income inequality between 1989 and 2007, while Table 5 reports the distribution of income in 2007 and compares it to that in the SFC in the same year. The shift of the distribution of GDP from labor to dividend income, together with the increase in the concentration of dividend income, lead to a permanent increase in the Gini coefficient of income inequality.

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[16]A lower entry rate is implied by the decrease in the number of firms, together with a constant exit rate.

Figure 9 reports, for several variables of interest, the percentage of the total variation between 1989 and 2007 explained by the model in the aftermath of an increase in entry costs. The Cournot framework explains more than 80% of the total change in the number of firms and the entire change in the labor share of income. Recall that we match by construction the variation in the price markup estimated by De Loecker & Eeckhout (2017) between 1989 and 2007. This result suggests a close connection between the variation in the price markup and that in the labor share of income. The model falls short of explaining the change in stock market capitalization and the profit share of income. Nevertheless, it explains 26.7% of the total variation in the Gini coefficient of income inequality reported by the Census and 52.6% of that reported by the SCF. The model also account for 30% of the total change in the Gini coefficient of wealth inequality. This is remarkable in light of the fact that the only exogenous input in the model is the series of entry costs.

Table 6 shows the long run distributions of wealth and income assuming that entry costs remain constant at the level that allowed to match the estimated price markup in 2007. The implied price markup in the long run is 1.49. Under this calibration, the increase in income inequality described between 1989 and 2007 will be permanent, while the degree of wealth concentration would reverse below that observed in the initial steady state. This is so since a permanently higher price markup implies a higher stock market return with respect to the one in 1989. In the long run, this promotes financial market participation and a more equal wealth distribution.

7.3 Welfare effects

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

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

$$V\left[c_t(s,z)\right]_{t=0}^{\infty} = E_0 \sum_{t=0}^{\infty} \beta^t u\left[c_t(s,z)\right]$$

The consumption path is conditional on the agent's states (wealth, s, and productivity, z). We denote the values assumed by variables in the initial steady state with the superscript 89, to emphasize that they are relative to the 89 calibration of entry costs; 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 $\omega(s,z)$ that solves:

$$E_0 \sum_{t=0}^{\infty} \beta^t u((1+\omega(s,z))c^{89}(s,z)) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^{tr}(s,z))$$

The constant $\omega(s,z)$ 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 $\omega(s,z)$ implies that the rise in market power leads to a welfare gain for that particular individual and vice-versa. The value of $\omega(s,z)$ 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.

The main result is that the vast majority of households, independently of their initial productivity and wealth, lose during the transition to the high market power steady state associated

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to higher entry costs. Just 3% of the population enjoys a welfare gain in response to lower competition. These are households for whom financial income represents the main source of income, thus an increase in rents has a sizeable impact on their total income and consumption. Figure 10 reports the distribution of CEVs in the productivity-stock holdings space. The vertical axis measures the number of shares (s) held by each individual in the initial steady state, while the horizontal axis reports productivity levels (z). Hence, each point in this space identifies an agent-type. The space is divided in four areas. The areas in grey include agents who suffer a welfare loss. The area denoted by the marker (*) contains, instead, agents who enjoy a welfare gain. The darker the shade of grey the larger the loss. For the agents included in the darkest area the transition costs up to 8% of the initial steady state consumption. Although this area extends along a small portion of the productivity-wealth space, it contains more than 60% of the population. The large area denoted by the markers includes agents for whom the transition is beneficial. While this area represents a large portion of the productivity-wealth space, it contains just 3% of the population. These agents enjoy a positive CEV up to 8% of their initial consumption. They are either very wealthy agents, or agents with a low productivity relative to their asset holdings. In both cases financial income represents the main source of income for these households, thus an increase in financial income has a sizeable impact on their total income and consumption.

An indicator of the effect of the increased market power on the economy as a whole is given by the *utilitarian social welfare gain,* denoted by 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 position in the asset-productivity space. The utilitarian social welfare gain is the value of ω^u which solves

$$\int E_0 V \left(\{(1 + \omega^u) c_t (s,z)\}_{t=0}^{\infty} \right) \mathrm{d}\lambda(s,z) = \int E_0 V \left(\{(c_t^{tr} (s,z)\}_{t=0}^{\infty} \right) \mathrm{d}\lambda(s,z)$$

Notice that in the expression above $\int E_0 V \left(\{c_t (s,z)\}_{t=0}^{\infty} \right) \mathrm{d}\lambda(s,z)$ 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 attached to our experiment equals -5.8% of aggregate consumption.

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 $(\bar{c}(s,z))$. This value is such that $V \left(\{\bar{c} (s,z)\}_{t=0}^{\infty} \right) = E_0 V \left(\{c_t (s,z)\}_{t=0}^{\infty} \right)$. It represents the constant amount that an agent 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, $c_t (s,z)$ to the certainty equivalent, $\bar{c}(s,z)$. 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. The level 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

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[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.

composition of income in favor of financial income leads to a more unequal distribution of resources due to the highly concentrated stock ownership. The overall negative welfare 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.

8 Conclusions

This paper studies the interaction between the extent of competition in the goods market and income and wealth inequality. To this end, we develop a quantitative model of firms dynamics enriched with aspects of industrial organization and incomplete markets. The number of producers in each period can be interpreted as the capital stock of the economy, and the decision of households to finance entry of new firms is akin to the decision to accumulate physical capital in the standard incomplete markets model à la Aiyagari (1994). The resulting framework matches the US income and wealth distributions.

An increase in entry costs, of the form recently documented in the empirical literature, dampens the entry of new firms and leads to a higher price markup, a lower labor share of income and to an increase in the profits share of income. The dynamics of these variables implied by the model in response to the increase in entry costs are broadly consistent with those observed in US data between 1989 and 2007. The increase in rents and the decrease in the labor share of income explain more than 50% of the increase in income inequality and 30% of that in wealth inequality observed over the same time period. We find that lower market competition entails large welfare losses which are unevenly distributed across households. Just 3% of the population enjoys a welfare gain in response to lower in competition. Appropriate fiscal policies, as those considered by Boar & Midrigan (2019) and Mechelli (2019), could reduce the distortions spreading from market power and decrease inequality.

During the analysis we focused on the extensive margin of competition, which is related to the number of competitors in the market. In ongoing research we extend the framework to account for firms' heterogeneity, and in particular for large firms. This allows to disentangle the effects of variations in the intensive and extensive margins of competition on the distributions of income and wealth.

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Appendix A: Alternative Transition Experiment

This Appendix displays the dynamics of the variables of interest in response to a once an for all increase in entry costs in 1989. Recall that in the baseline experiment reported in the main text we assumed that entry costs increase gradually over time between 1989 and 2007 in order to match the trend in the estimated price markup over the same time period. In this Appendix, we assume that entry costs jump once and for all in 1989 in order to match the price markup estimated by De Loecker & Eeckhout (2017) in 2007. The two experiments feature the same price markups in 1989 and 2007. In this case, the distributions of wealth and income are identical in those two years and do not depend on the dynamics of the entry costs. Wealth and income distributions in 89 and 07 are reported in the main text.

The dynamics of the price markup and of the number of listed firms reported in Figure A1 is essentially identical to that in the main text. Also the labor share of income, in Figure A3, shows a similar decreasing pattern as that obtained in the baseline experiment. As in the main text there is a permanent increase in the value of stock market capitalization to GDP, displayed in Figure A2, but the dynamic is different. In particular, in response to a once and for all jump in entry costs that variable increases on impact and then gradually reverts to the final steady state. This stays in contrast with the gradual increase observed in the data. The Gini indexes on wealth and income concentration, reported, respectively, in Panel a) and Panel b) of Figure A4, show dynamics similar to those observed in the main text. However, a noteworthy difference is in the persistency in the increase in the Gini index of wealth concentration, which is higher in the baseline experiment and it is due to the different dynamics of stock market capitalization to GDP obtained under the two scenarios.

Appendix B: 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 Ψ. For the asset space, we choose exponentially spaced nodes. The tensor product of the two set of nodes $(z \otimes s)$ is the fix grid used in the algorithm.

2. After guessing a value for N one can 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 close 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 fix 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 Ψ.

    (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 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 Ψ, 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 $\mathcal{P}_{ij} \equiv \Pr\left((s^j z^j) \mid (s^i z^i) \right) = \Pr\left(s^j \mid (s^i z^i)\right) \ x \ \Pr(z^j | z^i)$. In the formula, $\Pr(z^j | z^i)$ simply indicates the exogenous transition matrix Ψ, while $\Pr\left(s^j \mid (s^i z^i)\right)$ refers to the policy function: if $s_k < g_s(s, z) < s_{k+1}$ then $\Pr\left(s_k \mid (s^i z^i)\right) = \frac{s_{k+1} - g_s(s, z)}{s_{k+1} - s_k}$, $\Pr\left(s_{k+1} \mid (s^i z^i)\right) = \frac{g_s(s, z) - s_k}{s_{k+1} - s_k}$ and it is zero everywhere else[19]. The ergodic distribution

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

[19] Note that if the policy function takes exactly the values on the assets grid there will be only one value for each row of the transition matrix describing it.

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.

Appendix C: Bertrand Competition

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

$$\Pi_t\left[p_t(i)\right] = \frac{\left[p_t(i) - \frac{W_t}{A}\right]p_t(i)^{-\theta}EXP_t}{\left[\displaystyle\sum_{j=1}^{N_t}p_t(j)^{1-\theta}\right]} \tag{19}$$

Under Bertrand competition, each firm i chooses the price $p_t(i)$ to maximize profits, taking as given the price of other firms. The first-order condition for any firm i is:

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

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

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

where the markup reads as

$$\mu^B(\theta, N_t) = \frac{1 + \theta(N_t - 1)}{(\theta - 1)(N_t - 1)} \tag{20}$$

For a given price markup, Cournot and Bertrand imply the same steady state distributions of wealth and income. For given entry cost, instead, Bertrand leads to a lower equilibrium number of firms and to a lower price markup with respect to Cournot. This is so since Bertrand is a more competitive market structure with respect to Cournot.

Table 8 reports the income and wealth distributions under Bertrand, assuming the same entry costs we calibrated in 1989 under Cournot competition. These distributions should, thus, be compared to the empirical ones in 1989.

The performance of the Bertrand model at matching the empirical wealth and income distribution in 1989 is similar to that of the Cournot model. Bertrand, for given entry cost, implies a lower markup with respect to Cournot. This implies a lower return from asset holdings, which in turn leads to a lower financial market participation. For this reason the fraction of wealth in the hand of the top 1% of the wealth distribution is slightly larger under Bertrand with respect to Cournot. The lower price markup implies a lower dividend income and thus a lower fraction of income accruing to the top of the income distribution with respect to Cournot.

We do not report the dynamics of the main macroeconomic variables and the welfare analysis in response to an increase in entry costs under Bertrand since results are qualitatively and quantitatively similar to those obtained earlier under Cournot.

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Tables

Parameter	Description	Value
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 one year

Wealth	Quintiles					Top		Concentration	
	Q1	Q2	Q3	Q4	Q5	95-99%	1%	Gini 99	Gini All
SCF 89	-0.2	1.2	5.2	13	80.7	24.3	29.9	0.72	0.79
Model 89	0	0.4	3.7	15.9	80	26.7	13.2	0.75	0.77

Table 2: Wealth distribution in 1989. Cournot competition and US data. The empirical distribution is based on the SCF in 1989.

Income	Quintiles					Top		Concentration	
	Q1	Q2	Q3	Q4	Q5	95-99%	1%	Gini 99	Gini All
SCF 89	2.6	7	12.5	20	57.8	15	17.1	0.46	0.53
Model 89	4.5	9.6	13.9	22.5	49.5	14	5.8	0.46	0.48

Table 3: Income distribution in 1989. Cournot competition and US data. The empirical distribution is based on the SCF in 1989.

Wealth	Quintiles					Top		Concentration	
	Q1	Q2	Q3	Q4	Q5	95-99%	1%	Gini 99	Gini All
SCF 07	-0.2	1.1	4.5	11.2	83.4	26.7	33.6	0.74	0.82
Model 07	0	0.2	3.3	15.3	81.2	27.3	13.6	0.76	0.78

Table 4: Wealth Distribution in 2007. Cournot competition and US data. The empirical distribution is based on the SCF in 2007.

Income	Quintiles					Top		Concentration	
	Q1	Q2	Q3	Q4	Q5	95-99%	1%	Gini 99	Gini All
SCF 07	6.6	9.7	13.6	17.7	52.5	16.4	16.1	0.47	0.55
Model 07	4.3	9.5	13.8	22.2	50.2	14.4	5.9	0.47	0.49

Table 5: Income distribution in 2007. Cournot competition and US data. The empirical distribution is based on the SCF in 2007.

Long Run		Quintiles				Top		Concentration	
	Q1	Q2	Q3	Q4	Q5	95-99%	1%	Gini 99	Gini All
Income	4.4	9.4	13.8	22.4	50.1	14.2	5.8	0.47	0.48
Wealth	0	0.6	4.5	17	77.9	25.6	12.3	0.74	0.75

Table 6: Long-run income and wealth distributions under Cournot competition

	Decomposition of the average welfare gain		
Average welfare Gain ω^u	Level ω_{lev}	Inequality ω_{inc}	Uncertainty ω_{unc}
-0.058	-0.083	-0.018	0.045

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

Bertrand		Quintiles				Top		Concentration	
	Q1	Q2	Q3	Q4	Q5	95-99%	1%	Gini 99	Gini All
Wealth	0	0.2	2.5	14.1	83.3	28.3	14.7	0.79	0.78
Income	4.7	9.8	14.1	22.7	48.6	13.6	5.6	0.47	0.45

Table 8: Income and wealth distributions under Bertrand competition

Figures
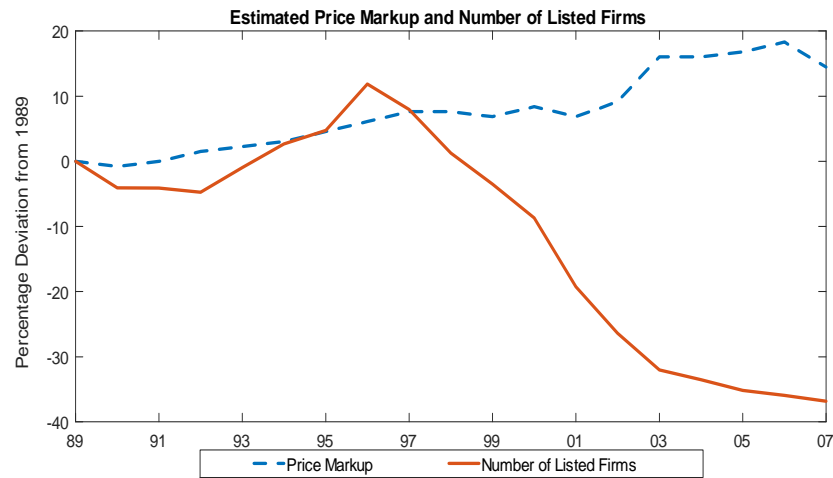
Figure 1: Number of listed firms and the price markup estimated by De Loecker & Eeckhout (2017) between 1989 and 2007. Percentage deviations from 1989. Data Source: Number of listed firms: FRED. Price markup: De Loecker & Eeckhout (2017).
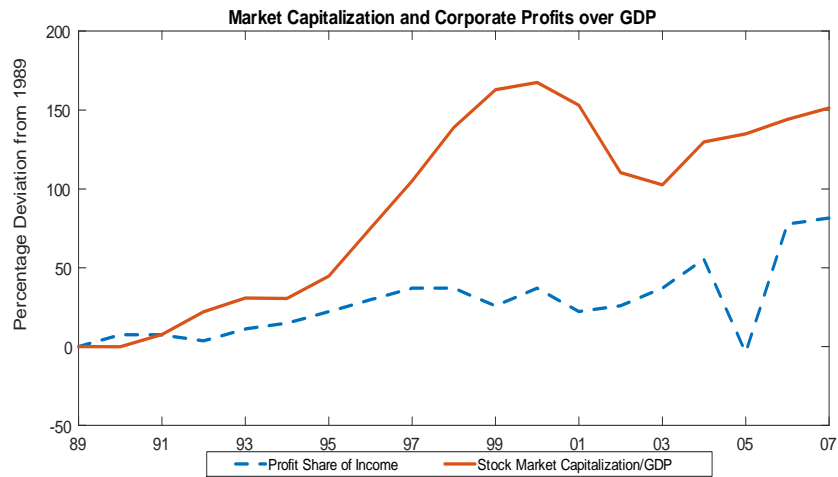
Figure 2: Profit Share of Income (ratio between corporate profits and GDP) and ratio between Stock Market Capitalization and GDP between 1989 and 2007. Percentage deviations from 1989. Data Source: FRED.
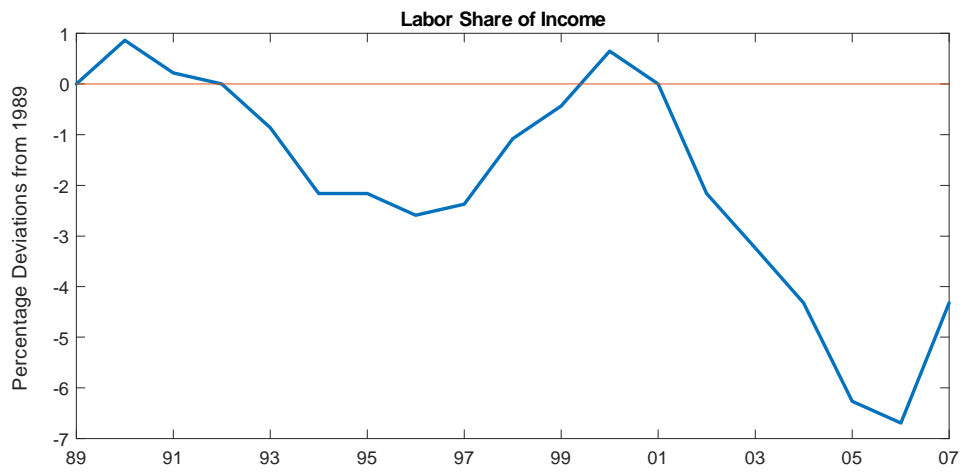
Figure 3: Labor share of income between 1989 and 2007. Percentage deviations from 1989. Source: FRED.
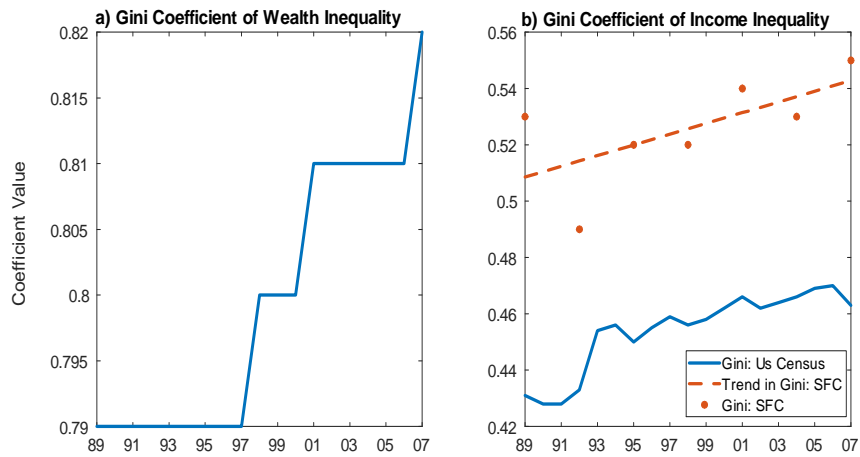
Figure 4: Panel a): Gini coefficient of wealth inequality based on the SCF. Source: Kuhn & Rios-Rull (2016) . Panel b): Gini coefficient of income inequality. Circles: actual values based on SCF; Dashed line: linear trends based on SCF; Solid line: actual values based on Census Data.
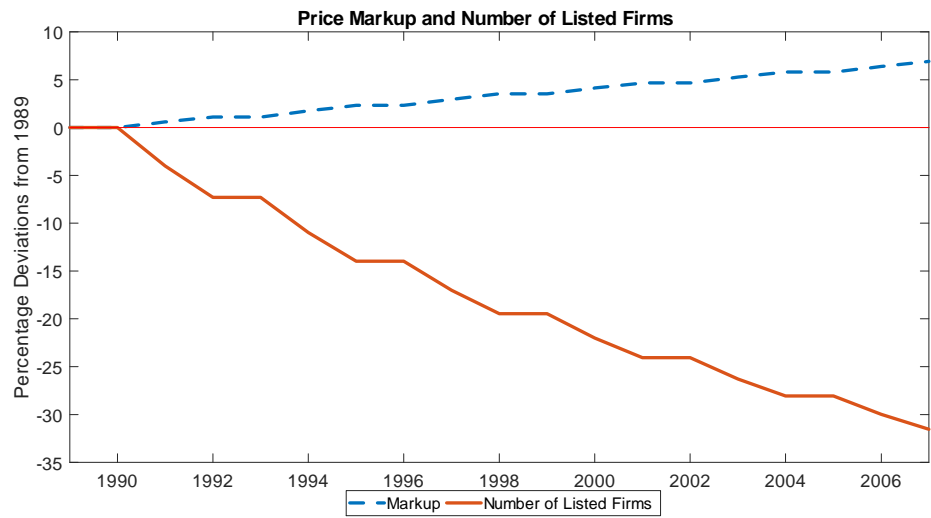
Figure 5: Number of listed firms and the price markup between 1989 and 2007. Percentage deviations from 1989. Gradual increase in entry costs.
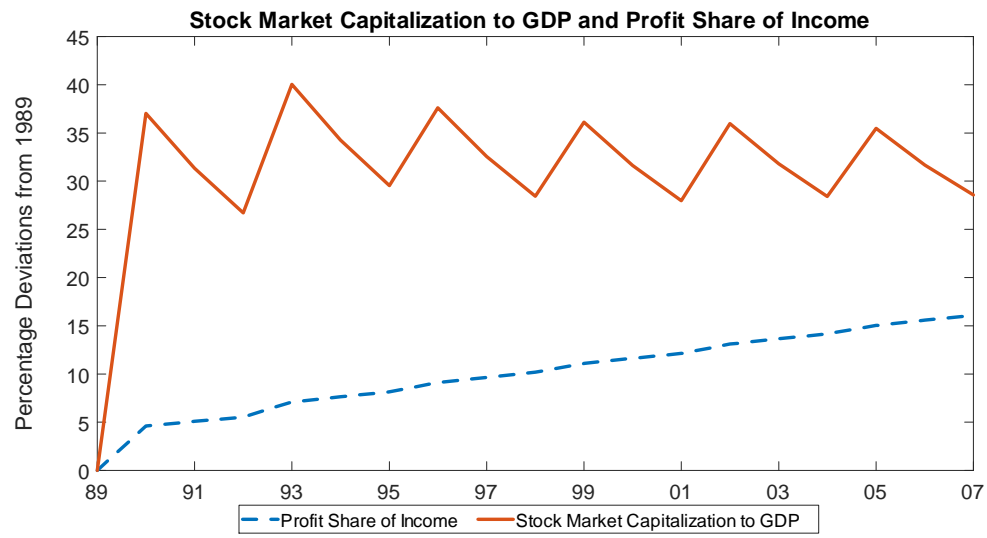
Figure 6: Stock market capitalization to GDP and profits share of income between 1989 and 2007. Percentage deviations from 1989. Gradual increase in entry costs.
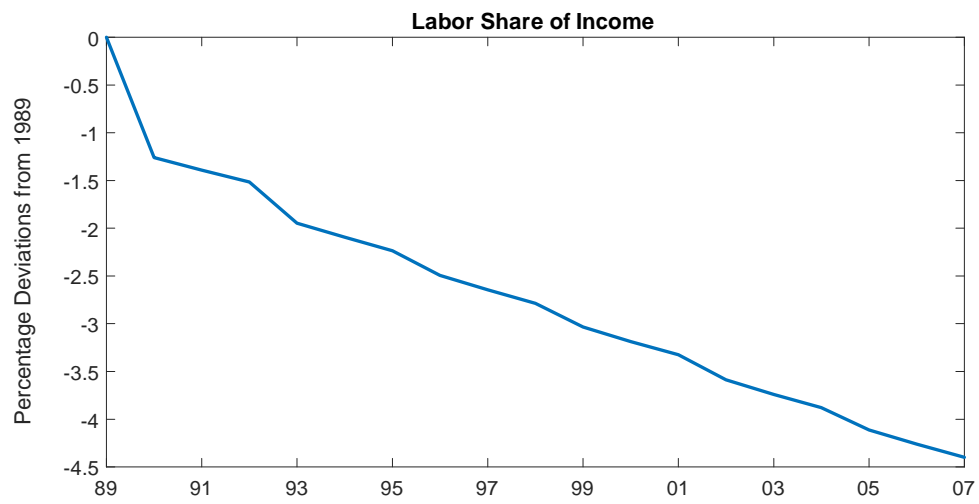
Figure 7: Labor share of income between 1989 and 2007. Percentage deviations from 1989. Gradual increase in entry costs.
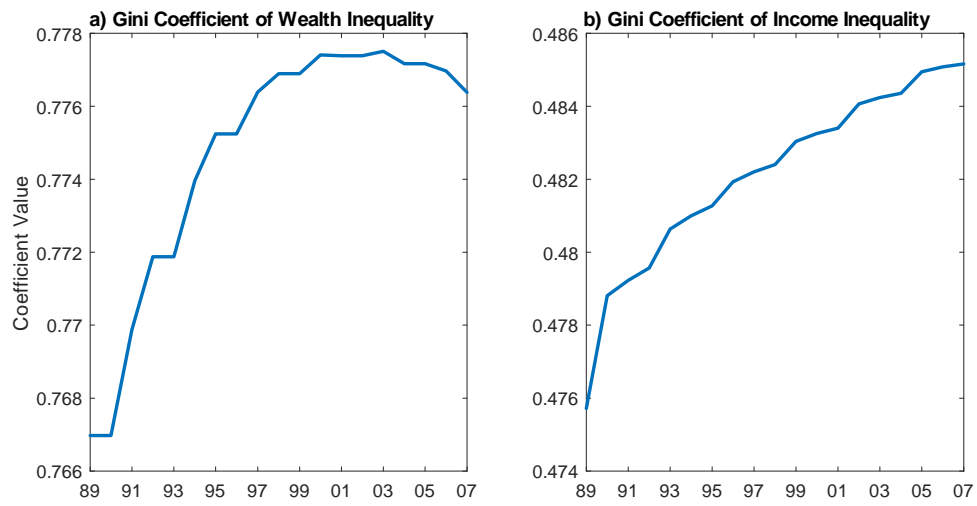
Figure 8: Gini coefficients of inequality between 1989 and 2007. Panel a): wealth; Panel b): income. Gradual increase in entry costs.

Fraction of Actual Change in Main Variables Explained by the Model: 1989-2007
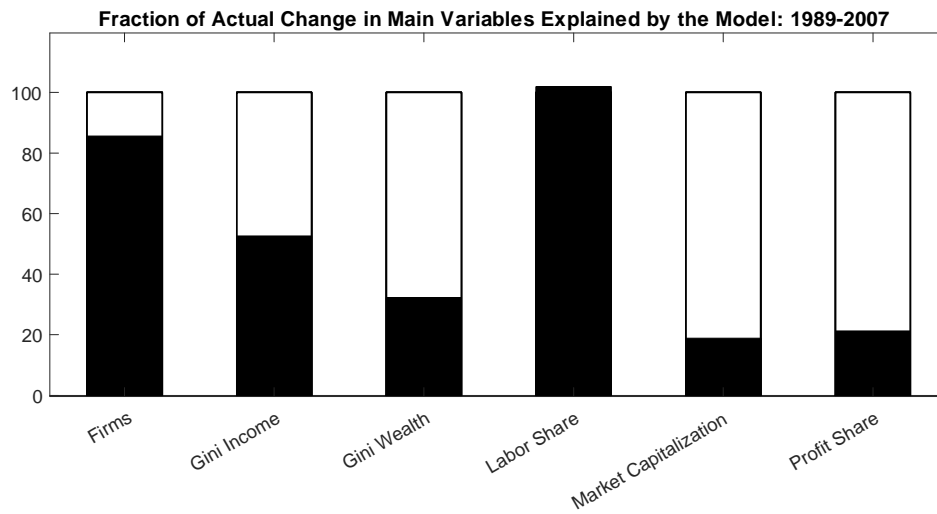
Figure 9: The black area in each istogram represents the percentage of the actual variation undertaken by the corresponding variable between 1989 and 2007 exlained by our model in response to a gradual increase in entry costs.
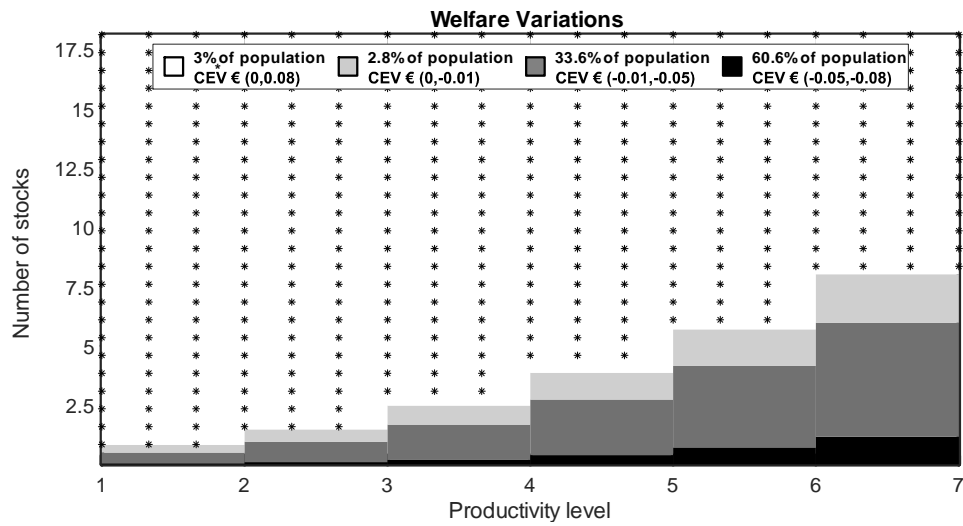
Figure 10: Distribution of CEVs. Productivity levels on the horizontal axis, stock holdings on the vertical one. The white area marked with asterisks includes all agents that experience a welfare gain. The gray-shaded areas, instead, contain agents which suffer a welfare loss: the darker the shade the higher the welfare loss.
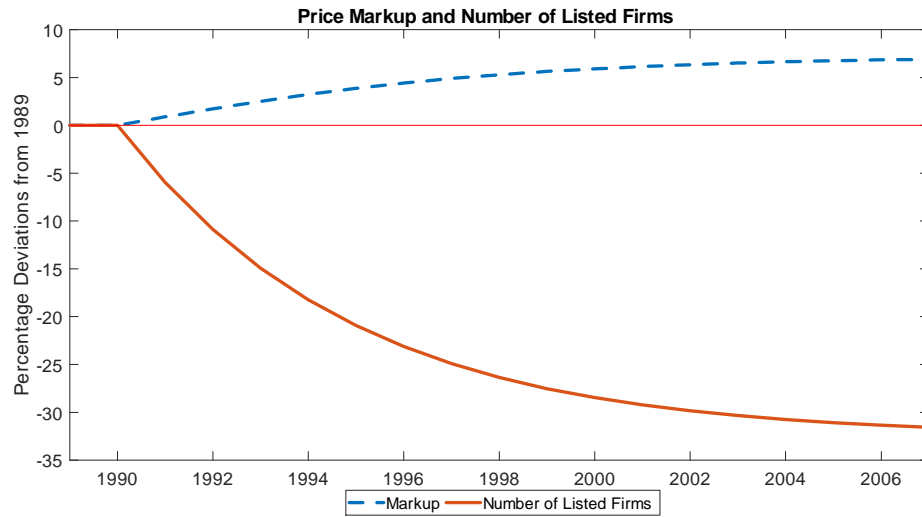
Figures Appendix A

Figure A1: Number of listed firms and price markup. Deviations from 1989. Once and for all increase in entry costs in 1989.
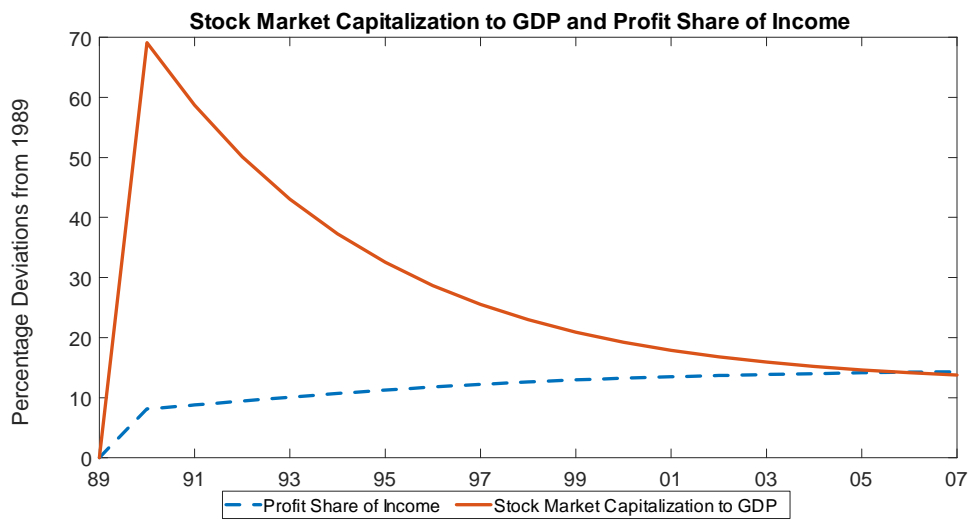
Figure A2: Stock market capitalization to GDP and profit share of Income. Deviations form 1989. Once and for all increase in entry costs in 1989.

Figure A3: Labor share of income. Deviations from 1989. Once and for all increase in entry costs in 1989.

Figure A4: Gini coefficients of inequality between 1989 and 2007. Panel a): wealth; Panel b): income. Once and for all increase in entry costs in 1989.