European University Institute

DEPARTMENT OF ECONOMICS

# Essays on Financial Macroeconomics and Inequality

Ignacio Gonzalez

Thesis submitted for assessment with a view to obtaining the degree of Doctor of Economics of the European University Institute

Florence, 07 September 2016

European University Institute
**Department of Economics**

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**Examining Board**

Prof. Evi Pappa, EUI, Supervisor
Prof. Árpád Ábrahám, EUI
Prof. Alexis Anagnostopoulos, Stony Brook University
Prof. Antonia Díaz, Universidad Carlos III de Madrid

European University Institute

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# *Abstract*

This dissertation is composed of three self-contained chapters on the same topic: the impact of financial markets on inequality.

The first paper investigates the connection between the increase of equity wealth, the rise stock-market returns, the slowdown of corporate investment and the decline of the labor share in the U.S. economy. I use a version of the standard heterogeneous-agent model to explain the connection of these phenomena and I identify three driving forces. In particular, I show that the fall of the average marginal tax on capital income, the reduction of stock-market costs and a higher inclination towards corporate short-termism explain the decrease of investment and the rise of equity prices. This way, the model predicts an endogenous upsurge of equity Tobin's Q and, importantly, the rise of equity returns. The decline of the labor share occurs in response to investment sluggishness when capital and labor are complements, which requires an elasticity of substitution consistent with the values found in the literature. Given the predictions of the model, the paper solves what Joseph Stiglitz has recently called the Piketty puzzle: why has the wealth-output ratio and capital returns increased, while wages have not.

The second paper, which is joint work with Pedro Trivin, extends the previous analysis to a panel of countries. We use a reduced-form framework with wealth in the utility function to obtain an estimable equation and, by using recent panel time-series techniques, we find that the increase in Tobin's Q explain almost 60 per cent of the total decline in the labor share.

The third paper makes a theoretical contribution to recent debate on secular stagnation. I use a growth model with imperfect competition to show that the rise of monopoly rents is consistent with several investment and inequality dynamics that have characterized the post-1980 stagnant era.

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Finally, this thesis is dedicated to my parents, Isabel and Jose Luis, and my sister Elisa, whose unconditional support and endless encouragement have made this possible. This dissertation belongs to them as much as to me.

# Contents

# List of Figures

# List of Tables

# Chapter 1

# Tobin's Q and Inequality


*Abstract*

Corporate physical capital and equity wealth have followed divergent trajectories in the U.S. since the early 1980s. While the equity-wealth-income ratio (Piketty's $\beta$ for the corporate sector) has risen remarkably, the corporate-physical-capital-income ratio has decreased. Accordingly, equity Tobin's Q ratio has experienced a secular growth. During the same period, labor productivity and wages have significantly decoupled from each other, leading to a decline of the U.S. corporate labor share. I use a version of the standard incomplete markets model (in the Bewley-Huggett-Aiyagari tradition) to explain the connection of these phenomena. I show that the steady fall of the average marginal tax on capital income, the reduction of stock market diversification costs and the switch towards higher corporate short-termism explain the decrease of investment flows and the rise of the market value of existing capital. The consequence is an endogenous upsurge of equity Tobin's Q and, importantly, the rise of equity returns, which is also consistent with U.S. data. Wage-productivity decoupling is the natural response to investment sluggishness when capital and labor are complements, a result that is consistent with the values of the elasticity of substitution traditionally found in the literature. The decline of the labor share, in combination with the resulting evolution of corporate returns and equity wealth, triggers inequality, offering a joint explanation for observed changes in the evolution of the factorial and the personal U.S. distribution of income. This paper turns the attention towards capital income taxation, financial markets and corporate behavior to solve what Joseph Stiglitz has recently called the Piketty puzzle: why have the wealth-ouput ratio and the returns to capital increased, while wages have not.



**JEL Codes:** E22, E25, E44

**Keywords**: Equity Wealth, Corporate Capital, Tobin's Q, Inequality.

## 1.1 Introduction

Wealth-income ratios have risen astonishingly since the early 1980s in the major advanced economies, as convincingly shown by Piketty (2014). One of Piketty's main arguments connects the rise of wealth-income ratios with the rise in capital shares. With the standard neoclassical production function, he argues, the only logical explanation for the observed rise in wealth-income ratios and growing capital shares would be abnormally low diminishing returns to capital. In terms of the aggregate production function, this would imply an elasticity of substitution $\sigma$ between capital and labor substantially larger than one.

Piketty's argument has opened a vivid debate in academic circles about the distributional implications of rising wealth-income ratios, the shape of the production function and the concept of wealth itself. Summers (2014), for example, has criticized Piketty's estimate of $\sigma$ (between 1.3 and 1.6) saying that it is not feasible according to the estimates found in the literature. Rognlie (2014) argues that most evidence suggests that diminishing returns are powerful enough to cause a decline in net capital income when more capital is accumulated. More recently, Stiglitz (2014) has pointed out the necessary distinction between capital and wealth, suggesting that Piketty's theory is flawed because he conflates both. Piketty's argument uses worth as synonym of productive capital. Yet, according to Stiglitz, the stagnation of wages and the fact that the marginal product of capital has not gone down would indicate that the accumulation of productive capital, in contrast to worth, has not been so astonishing. Actual capital-income ratios might have declined during the last decades, he adds.

Stiglitz's conclusion is in accordance with the evidence shown by McGrattan (2015). Using U.S. data, McGrattan shows that the standard measure of productive capital $K$ used by macroeconomists, namely fixed assets, follows a pattern very different to capital measured as net worth. In particular, while the fixed assets-income ratio declined between 1980 and the mid-2000s, the net worth-income ratio experienced an impressive rise during the same period, just as Piketty shows. Like McGrattan (2015) states, understanding the difference between the two aggregates is equivalent to understanding movements over time in aggregate Tobin's Q, whose numerator and denominator are net worth and the market value of physical capital respectively:

"One, the numerator, is the market valuation: the going price in the market for exchanging existing assets. The other, the denominator, is the replacement or reproduction cost: the price in the market for the newly produced commodities. We believe that this ratio has considerable macroeconomic significance and usefulness, as the nexus between financial markets and markets for goods and services." (Tobin and Brainard, 1977)

The distinction between net worth and fixed assets turns out to be crucial for the distributional analysis. They are two related concepts, but while the former refers to wealth in hands of the households and, therefore, includes forms of financial wealth, the latter only refers to capital with productive capacity. This distinction becomes even more crucial when the analysis refers to the corporate sector, where the two categories are mutually exclusive: net worth is the market value of corporate equities and fixed assets refer to the market value of physical capital owned by the corporate sector. In order to avoid double counting issues, we should choose which of the two should be the input $K$ in the aggregate production function. [1] And this choice is not a minor matter from a distributional perspective. Since they have evolved differently, the degree of diminishing returns able to explain the evolution of capital and labor share will depend on the definition of capital we are using.[2]

In this paper, I build an incomplete markets model in the Bewley-Huggett-Aiyagari tradition where I distinguish between physical capital (fixed assets) and net-worth. I use the model to explain the recent evolution of these two aggregates for the U.S. corporate sector. In particular, I show that the observed increase in the net worth-income ratio is compatible with the observed decline of the physical-capital-income ratio and, therefore, compatible with the decline (rise) of the labor (capital) share for conventional diminishing returns (i.e. $\sigma < 1$). I show that this has to be the case in an one-sector neoclassical growth model with uninsurable idiosyncratic shocks and incomplete markets where equity Tobin's Q rises over time, as occurred in the United States and in other major advanced economies. As in Anagnostopoulos et al. (2012), I use a version of the Aiyagari model where, in addition to risky labor income, households receive capital income from owning shares. Firms decide on investment and accumulate physical capital. By distinguishing between the

[1]Note that this is not an issue in the simple theoretical model where Tobin's Q is equal to 1. In that case, the market value of assets, which is equal to the expected present value of dividends, is equal to the cost of replacing the physical capital that generates those dividends.

[2]When they infer a positive relation between the capital-output ratio and the capital share, Piketty and Zucman (2014b) use the market value of corporate equities as input K

ownership of financial capital, which is held by households, and the ownership of physical capital, which is held by firms, I can study how changes in either of these two impact the Tobin's Q ratio and how the distributional implications of these changes are.

The model predicts that the labor income share and the physical-capital-income ratio decreases when Tobin's Q rises. The extent to which this ratio responds to changes in Tobin's Q depends, among other factors, on the strength of the decreasing returns to capital. Moreover, the model is also consistent with an additional striking feature of the post-1980 U.S. economy: equity returns have increased with respect to their historical average (McGrattan and Prescott, 2003). When the market valuation of existing capital rises, shareholders respond by demanding a higher return, which in turn forces firms to cut down on investment to increase the marginal productivity of capital and, thus, the return on equity. Wage-productivity decoupling and the decline of the labor share are the natural response to investment sluggishness when capital and labor are, on average, complements. This implies an elasticity of substitution within the range of estimates found by the literature, which has mostly suggested values below one (Chirinko and Mallick, 2014a).

This result is starkly in contrast to Piketty (2014). When Piketty deals with the corporate sector, he does not distinguish between wealth and capital. In his model, it is net worth what enters into the production function and it is the rise of the net-worth-income ratio what *directly* causes the decline of the labor share after 1980, requiring abnormal values of the elasticity of substitution. This is equivalent to assume that equity Tobin's Q has been equal to one during the whole period considered (see Appendix A.4.2 in Piketty and Zucman (2014a)). Data from his own book, on the contrary, suggest that this is a questionable assumption.[3]

In my model, the rise of the wealth-income ratio occurs simultaneously to the decrease in the capital-income ratio. However, as in any standard growth model, it is capital stock which enters into the production function and what affects the evolution of the factor shares. In this way, the paper not only explains recent movements in equity returns and Tobin's Q ratio, but it also reconciles Piketty's data with standard theory, offering a solution to what Joseph Stiglitz has recently

[3] Piketty (2014) uses aggregate data for the whole economy. His estimate of aggregate wealth simply sums private and government wealth. But the capital stock of the corporate sector is included through the equity holdings of households and the government. This means that, with respect to the corporate sector, the argument that connects the evolution of the factor shares and the wealth-income ratio uses net equity worth and not productive capital.

called the Piketty puzzle: why has the wealth-income ratio increased while the marginal product of capital has gone up and, most importantly, wages have not increased (Stiglitz, 2014).

The distinction of equity wealth and physical capital is not a mere measurement dispute about which should be the input "$K$" in the production function. The evolution of Tobin's Q also gives us hints about the drivers of capital-income ratios, and consequently, about the long-run drivers of factor shares and inequality. In particular, I argue that the post-1980 evolution of the U.S. equity Tobin's Q has been mostly driven by three factors: the steady fall of the average marginal tax on capital income, the reduction of stock-market costs and the switch towards higher corporate short-termism. The first two factors are documented with data. The third factor has been widely discussed in the literature.

Firstly, taxes on corporate distributions (dividends and share buybacks) directly affect Tobin's Q causing low equity valuations. McGrattan and Prescott (2005) find that the large decline in the effective tax rate on U.S. corporate distributions accounts for the high value of equities in the late 1990s relative to the 1960s. They also show that the largest decline in taxes happened in the early 1980s. In their model, however, the tax reduction leaves after-tax equity returns and the capital-income ratio unaffected. The reason is that they use a complete markets environment, in which the supply of capital is completely elastic and the tax burden falls entirely on the firms, leaving the after-tax return unchanged. In my model, like in Anagnostopoulos et al. (2012), the presence of uninsurable idiosyncratic shocks and incomplete markets guarantees an upward sloping supply of capital, which implies that any change in Tobin's Q induced by a lower tax on corporate distributions rises after-tax equity returns and decreases the capital-income ratio.

This mechanism has been amplified by two additional factors. In the first place, the costs of holding a diversified portfolio have dramatically fallen in the U.S. stock market since the early 1980s (McGrattan and Prescott, 2003). In a financial economy where households trade in shares, stock market costs -measured as a percentage of total assets held- are equivalent to a tax on financial wealth. The steady fall of these costs during the last three decades has significantly contributed to the rise of equity Tobin's $Q$, having similar -but non linear- effects to the decline of capital income taxes.

Finally, I argue that the U.S. corporate sector is today more short-term oriented, due to a switch towards a more shareholder-oriented corporate model after the early 1980s (Kaplan, 1997). In the context of the model, I show that this switch has also impacted the U.S. economy by lowering the capital-income ratio, increasing the stock market value of the corporate sector and raising the U.S. equity returns. The mechanisms that explain the evolution of the U.S. corporate model are several.[4] Given the difficulty to measure the contribution of each of them, I opt for a reduced-form friction that makes the stochastic discount factor of the firm different to that of shareholders. This friction captures the extent to which the corporate sector maximizes shareholder value by allowing the firm to be more long-term oriented than shareholders. My argument says that, after the 80s, the U.S. corporate sector is more short-term oriented than before. This means that prior to 1980, U.S. firms opted for higher levels of investment and lower payouts to shareholders. This argument has been widely discussed in the recent literature of financialization (Lazonick and Sullivan, 2000; Davis, 2009; Mason, 2015; Stiglitz, 2015). But, to my knowledge, it has never been addressed within a neoclassical growth framework. This reduced-form parameter is calibrated in a residual way: any change in the Tobin's $Q$ not attributable to the evolution of capital income taxation and financial costs is attributed to corporate behavior.

The three factors considered have altered equity Tobin's $Q$ in the same manner: raising the equity wealth-income ratio and lowering the capital-income ratio. I call this mechanism the Tobin's $Q$ channel to the labor share.[5] The rest of the paper is organized as follows. Section 1.2 documents the decline of the U.S. corporate labor share and the growth of U.S. equity Tobin's Q in the post-1980 years. As shown below, equity Tobin's Q has been driven by the divergent evolution of the net equity wealth-income ratio and the corporate physical capital-income ratio. Section 1.3 explains these secular movements using the representation of a capital market that resembles an incomplete markets economy. Section 1.4 provides empirical evidence to justify changes in the key parameters of the model. Section 1.5 presents the

[4]Among the causes that have altered the corporate behavior towards a more shareholder-value oriented model are i) the extensive use of equity-based executive compensation after 1980 (which has aligned the interests of managers and shareholders) as documented by Bivens and Mishel (2013), ii) the takeover activity during the 80s and the 90s and the development of a market for corporate control (Holmstrom and Kaplan, 2001) and iii) the greater involvement of institutional shareholders (Gompers et al., 2003). All these three factors are powerful corporate governance mechanisms that began to play an important role in the early 1980s and that have pushed equity valuation upwards.

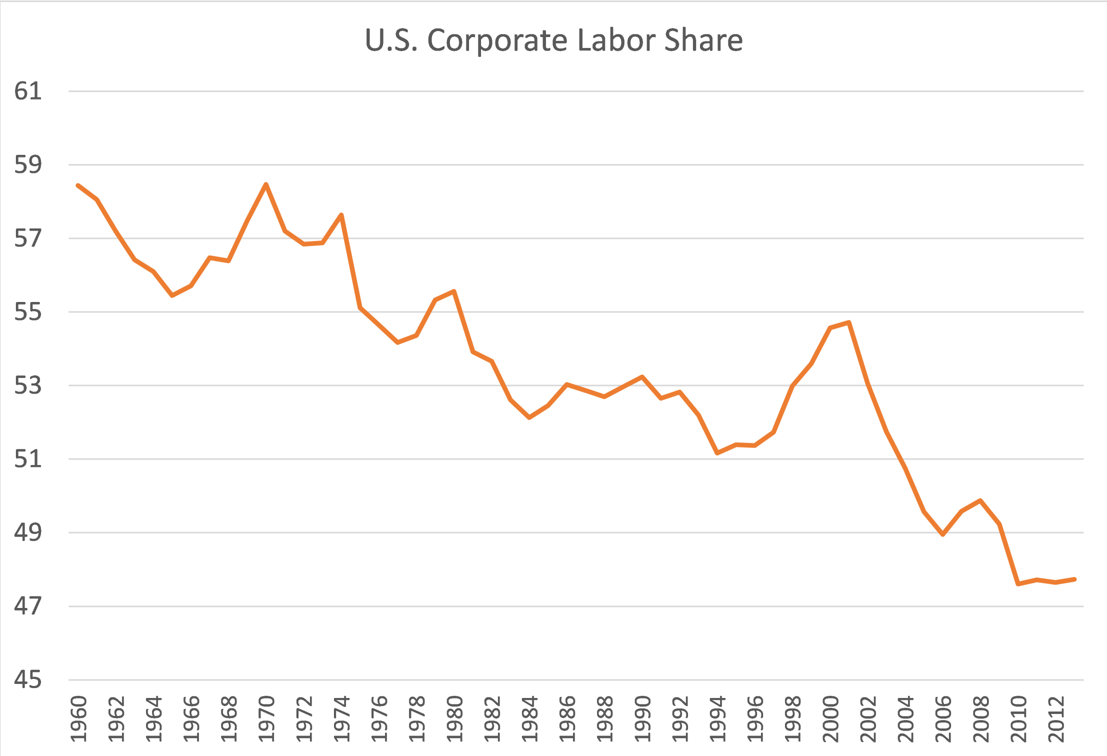
[5]The model can also confront this channel with the recent theory of the labor share proposed by Karabarbounis and Neiman (2014). They argue that the observed decrease in the relative price of investment goods has induced firms to shift away from labor and towards capital, reducing the share of labor income. I show, using the approach of Greenwood et al. (1997), that the mechanism of Karabarbounis and Neiman (2014) can easily be embedded into a general equilibrium model like the one presented in this paper. However I leave the computational calculation of the contribution of this channel for a future version of the paper.

model. Section ?? presents the calibration of the model to U.S. data and the quantitative analysis. Section ?? summarizes and concludes.

## 1.2 Trends in Tobin's $Q$ and the corporate labor share

Figure 1.1 shows the evolution of the U.S. corporate labor share of income. The aggregate corporate labor share equals total compensation of labor across all the corporate sector divided by the corporate value added, or $\frac{w^c L^c}{Y^c}$, where $w^c$ equals the average wage and $L^c$ equals total hours worked in the corporate sector. Gross corporate value added $Y^c$ equals the sum of compensation paid to workers $w^c L^c$, taxes on production (net of subsidies) and the gross operating surplus, which captures all the payments to the capital factor, including the consumption of fixed capital (NIPA Table 1.14). Figure 1.1 shows a secular decline during the last decades. In particular, the U.S. corporate labor share has declined by 8 percentage points (which implies an actual decline of 14, 4 %) between 1980 and 2013.

FIGURE 1.1: U.S. Corporate Labor Share



I focus on the labor share in the corporate sector for two reasons. Firstly because, as it has been remarked in Karabarbounis and Neiman (2012), labor share measured within the corporate sector is not biased by the statistical imputation of wages from the combined capital and labor income earned by self-employees. This imputation would be problematic for a consistent measurement of the labor share. Secondly, the corporate sector is the natural environment to propose a theory that connects the labor share with the evolution of Tobin's $Q$. Only within the corporate sector we have a clear distinction between wealth and capital because we can easily distinguish between equity-net-worth and corporate-physical capital. Therefore, we can study the impact that changes in the evaluation ratio $Q$ have on corporate investment, equity returns and the factor shares. Furthermore, the mechanisms that alter the Tobin's $Q$ and I study here (taxes on corporate distributions, financial intermediation costs and changes in corporate behavior) can only operate through the corporate sector. This is because they always alter the relation between the physical capital owned by the firm and the financial wealth owned by the shareholders.

FIGURE 1.2: Equity-Wealth-Output and Corporate-Capital-Output ratios

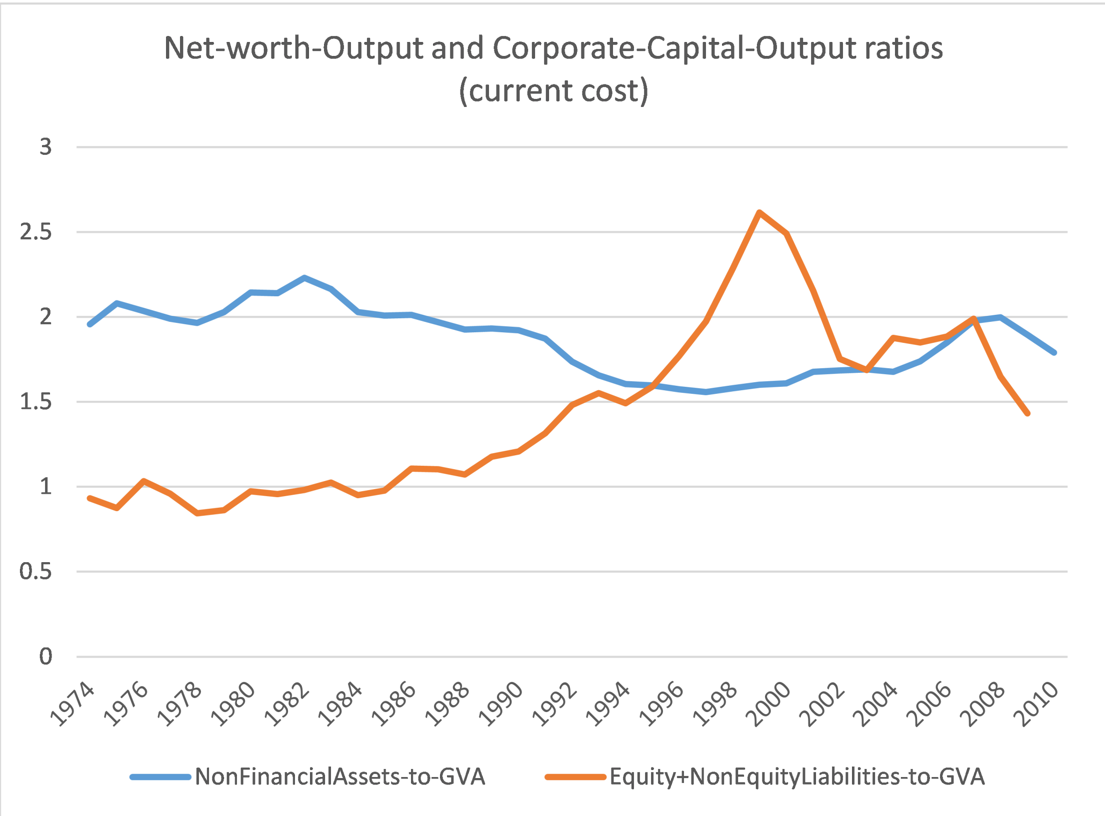


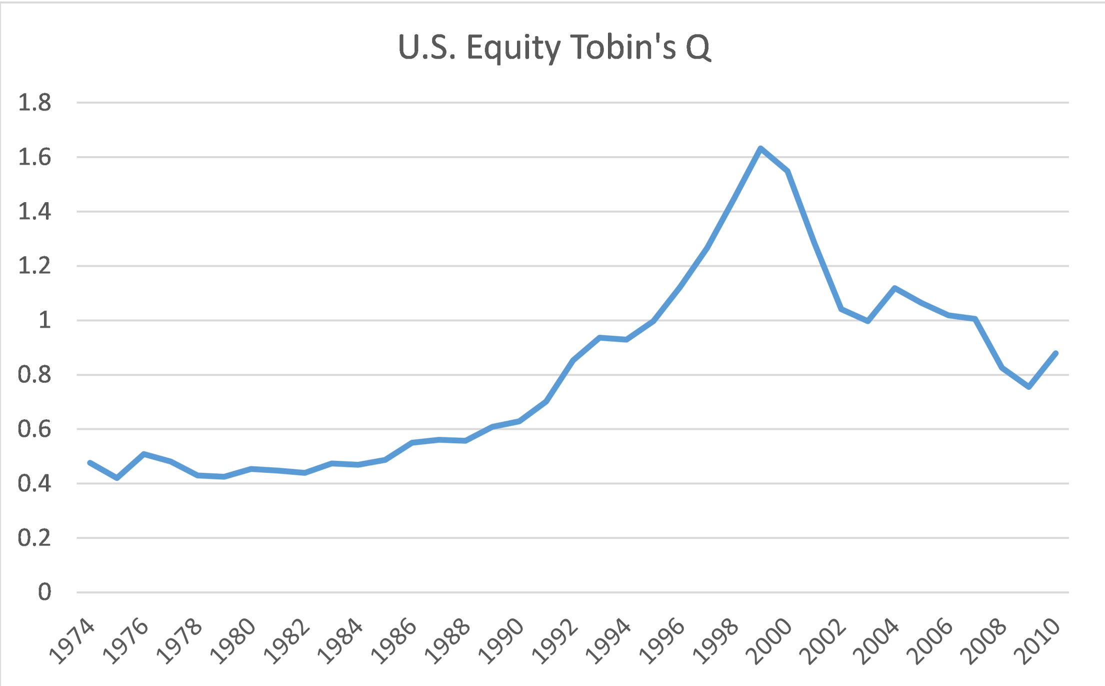
Figure 1.2 shows the evolution of the corporate-capital-output ratio and the evolution of the equity-wealth-output ratio. The measure of corporate capital sums all the nonfinancial assets (produced tangible capital, non-produced tangible capital, and intangible capital) of the whole corporate sector (financial and non-financial sectors). I use the series "Nonfinancial assets" in the corporate sector from Piketty and Zucman (2014a) database. Net-worth sums the market value of equities and the net-non-equity liabilities (which is the difference between non-equity liabilities and financial assets). Note that for notational convenience sometimes I use the term equity-wealth to denote net-worth, which apart from equity wealth also includes net-non-equity liabilities. This is because the model presented below abstracts from corporate debt and financial assets owned by the firms. This simplification is not problematic. The aggregate "net-non-equity liabilities" is just another form of financial wealth in hands of the households which is conceptually similar to equity wealth. Finally, corporate output is the gross corporate value added from NIPA table 1.14.

In figure 1.2, we observe that, since the early 1980s, the U.S. corporate sector has been reducing the corporate-capital-output ratio. Meanwhile, the ratio net-worth-to-output has risen remarkably. Importantly, the corporate-capital-output ratios seems to show a slight increase since the late 90s. But this is just the effect of the increase in the market value of capital (in particular, the increase in the price of structures during the last decade). Figure 1.8 in the appendix shows that the evolution of the corporate-capital-output ratio in real terms presents a clear downward trend since the early 80s, which is not reverted by an upward trend in the late 90s. Nevertheless, the declining trend has ceased in the early 2000s.

The distinction between the nominal and the real value of the capital-output ratio is important for two reasons. Firstly, to calculate Tobin's $Q$ we need a measure of the replacement cost of capital, which is, by definition, a measure of the capital stock in nominal terms. This is also implied by the model presented below where, in absence of frictions, Tobin's $Q$ equals one because the nominal value of capital and the stock market value of the corporate sector are the same. The second reason has to do with the factorial distribution of income. When we use the aggregate production function to get a relation between the factor shares and the capital-output ratio, we are using the real value of capital stock, which is always the way capital enters into the production function. This relation is shown below (equation 1.7). The fact that we input the real value and not the nominal value is sometimes ignored in standard macro models because they usually assume that the price of capital goods is not different to the price of consumption goods.

Equity Tobin's $Q$ is simply the ratio between the two ratios shown in figure 1.2. In figure 1.3 we observe that in the years before the early 1980s, the U.S. corporate sector had a relatively stable equity Tobin's $Q$ below one, which started to grow to values close to one from the mid-1990s to the early 2010s. Note that the concern of this paper is the secular movement of Tobin's Q during the last decades, but not its short-run fluctuations, like the one observed in the early 2000s, presumably due to the dot.com bubble in the stock market.[6]

FIGURE 1.3: Tobin's Q




## 1.3 Theoretical Analysis

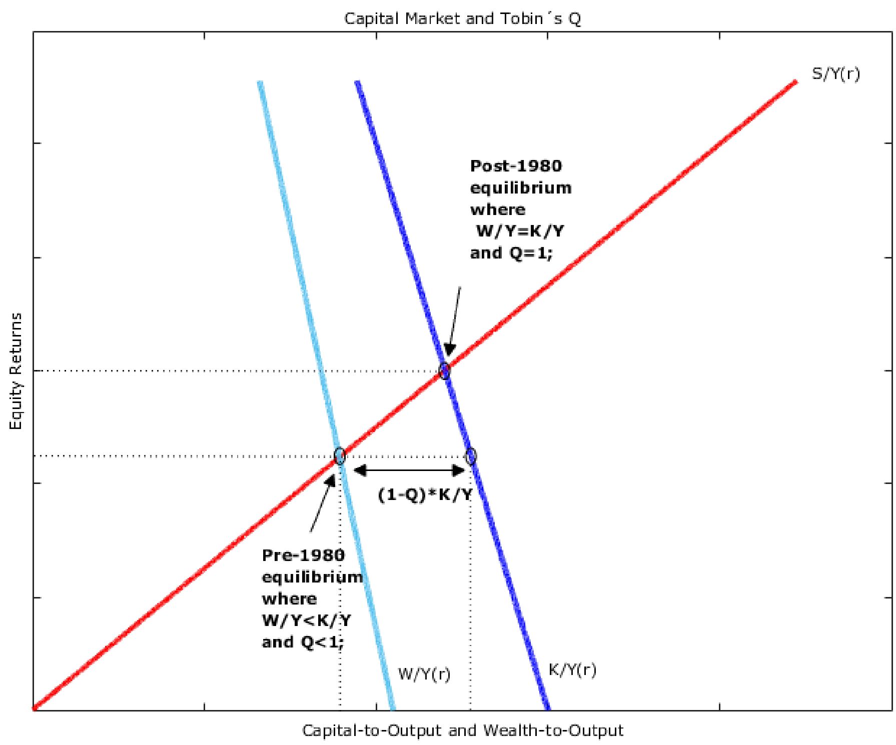
A key result of this paper is that an increase in the wealth-income ratio is compatible with a decline of the labor share for standard estimates of the elasticity

[6] Piketty and Zucman (2014a) calculate Tobin's "equity" Q as $\left(\frac{Market\,value\,of\,equities}{Total\,assets - NonEquity\,Liabilities}\right)$ (see their Appendix pag. 28). I prefer to opt for the traditional form $\left(\frac{Market\,value\,of\,equities + NonEquityLiabilities - Financial\,assets}{NonFinancial\,assets}\right)$ for two reasons. Firstly, because this is ratio I get when I extend my model and introduce corporate debt and financial assets owned by the firm. Therefore, the model is consistent with this definition. Secondly, because I am interested in the divergent evolution of financial wealth and physical wealth. That is why I choose to isolate physical capital in the denominator and gather all the forms of financial wealth in the numerator. In any case, both forms display a similar evolution.

of substitution. This section explains graphically why this has to be the case in a neoclassical growth model with incomplete markets where equity Tobin's Q rises over time. I follow Anagnostopoulos et al. (2012) closely in the explanation they provide about the 2003 capital income tax reform.

To understand the historical movements in Tobin's Q and in the capital-output and wealth-output ratios shown above, I use a graphical representation of the capital market (figure 1.4). Note that the demand of capital $K^d(r)$ is standard and is simply represented by a monotonically decreasing function of the net return to capital $r$. With a standard neoclassical production function, like a CES production function, this negative relation also holds for the capital-output ratio $\frac{K^d}{Y}(r)$. This relation is represented in figure 1.4 by the dark blue curve.

FIGURE 1.4: Capital Market




The supply of capital is given by the aggregate demand for assets or the stock of savings $S(r)$. In an economy where households accumulate capital and rent it to firms, like in the standard Aiyagari model, the market equilibrium is achieved where the supply of capital intersects the demand of physical capital (intersection A in figure 1.4). This is not the case in a financial economy where households accumulate financial assets and firms accumulate capital. In this type of economy, what matters for households is the market value of shares (i.e. the supply of equity wealth), which I denote here by $W$, and not the market value of the existing capital stock. In this context, the market equilibrium is achieved when the supply of equity wealth $W(r)$ intersects the aggregate demand for assets $S(r)$.

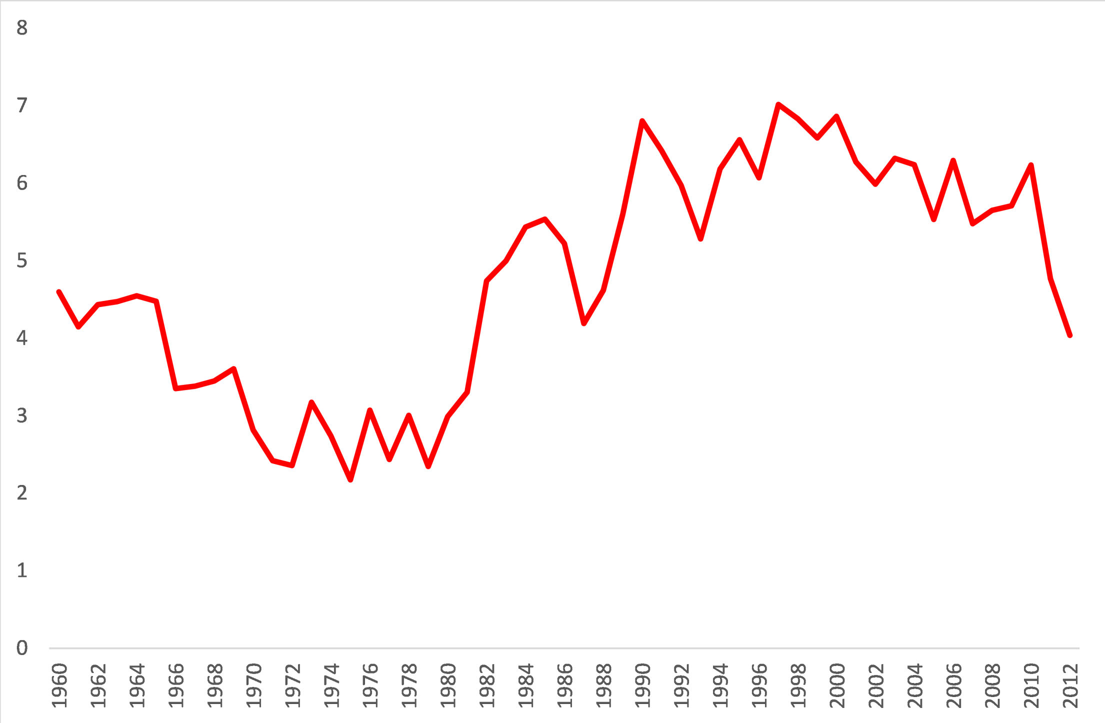
In a frictionless financial economy where firms maximize standard shareholder-value, the stock market value of the corporate sector $W$ would be equal to the market value of the corporate capital stock $K$ (see the model below). Therefore, Tobin's $Q$, which is the ratio between the two, would equal one. In this simple case, the two curves $\frac{K}{Y}(r)$ and $\frac{W}{Y}(r)$ would overlap and the capital market equilibrium would resemble the equilibrium in a standard Aiyagari economy.

In an economy where equity Tobin's Q is lower than one, as we observed historically for the U.S. economy, the situation is very different. In that case, the market price of corporate capital $K$ is larger than the stock market value $W$. Therefore, $\frac{K}{Y}(r)$ and $\frac{W}{Y}(r)$ do not overlap and the curve $\frac{W}{Y}(r)$ is shifted to the left. The size of the wedge between $\frac{K}{Y}(r)$ and $\frac{W}{Y}(r)$ is given by the magnitude of Tobin's $Q$ and equals $(1-Q) * \frac{K}{Y}$. Since households only care about the stock market wealth and not about the replacement cost of corporate capital, the new equilibrium is achieved at the intersection between the supply of savings $\frac{S}{Y}(r)$ and the stock market wealth $\frac{W}{Y}(r)$. Note, however, that the level of capital corresponding to this equilibrium remains given by the curve $\frac{K}{Y}(r)$ at the corresponding equilibrium equity return. This level is larger than the level achieved in the frictionless equilibrium.

In this paper, following the evidence presented in section 1.2, I argue that the U.S. economy has transitioned from a pre-1980 equilibrium where $Q < 1$ to a post-1980 equilibrium where $Q = 1$. Note that when this happens, the economy transits from an "higher capital-output" equilibrium to a "lower capital-output" equilibrium. During the transition, the wedge between $\frac{K}{Y}(r)$ and $\frac{W}{Y}(r)$ closes, and the economy increases the wealth-output ratio $\frac{W}{Y}$ and decreases the capital-output ratio $\frac{K}{Y}$. The magnitude of the decrease in the capital-output ratio depends on the slope of the capital demand curve, which in turn depends on the elasticity of substitution $\sigma$ between capital and labor.

Importantly, note that in this type of transition the return to equity increases. This has been precisely the case for the U.S. since the early 80s. Figure 1.5 shows that U.S. equity returns, adjusted for inflation, taxes and diversification costs, have increased with respect to their historical average and have fluctuated around 6% in the post-1980 period.[7] The model below is also able to explain this increase.

FIGURE 1.5: Equity Returns adjusted for Inflation, Taxes and Costs (%), 1960-2012




Apart from the slope of the demand of capital, the elasticity of substitution $\sigma$ also determines the extent to which the labor share responds to capital-output ratio movements. Note that with an aggregate CES production function, the labor share is an one-to-one function of the capital-output ratio:

$$ls = 1 - \alpha \left(\frac{K}{Y}\right)^{\frac{\sigma-1}{\sigma}} \tag{1.1}$$

where $\sigma$ is the elasticity of substitution and $\alpha$ is the standard distributional parameter of a CES production function. The impact of $\frac{K}{Y}$ on the labor share $ls$ depends on $\sigma$. If $\sigma < 1$, any raise in $\frac{K}{Y}$ increases the labor share, because diminishing returns to capital are sufficiently high and $r$ does adjust sufficiently downwards when there is more capital accumulation. The opposite happens when $\sigma > 1$. Here

[7] Ibbotson (2013) provide data for nominal before-tax returns. The following calculation is done to adjust for taxes, diversification costs and inflation: $1 + r_t = \frac{1+r^{Ib} - \tau^d y^{Ib}}{\frac{\pi_{t+1}}{\pi_t}(1+\kappa)}$ where $r^{Ib}$ is nominal before-tax total return and $y^{Ib}$ is the income part of total return (which is also provided by Ibbotson (2013)).

is where the distinction between stock market wealth and physical capital turns out to be crucial to understand the impact they have on the factor shares. Piketty (2014) uses capital and wealth as synonyms. Moreover, he uses the stock market value of the corporate sector as his measure of corporate capital. This means that, with respect to the corporate sector, Piketty's wealth-income ratio $\beta$ is given by

$$\frac{W}{Y} = Q\frac{K}{Y} \tag{1.2}$$

where he abstracts from any valuation effect and assumes that $Q$ has been constant and equal to 1. Given his finding that $\beta = \frac{W}{Y}$ has increased in recent decades, he therefore assumes the same for $\frac{K}{Y}$ and concludes that the only plausible explanation for the observed rise in wealth-income ratios and capital shares under the neoclassical model would be an elasticity of substitution larger than one.

However, evidence shown above indicates that $\frac{K}{Y}$ has been falling in the U.S. since the early 80s. This is also what Piketty and Zucman (2014a) find when they simulate U.S. wealth-income ratios in the absence of capital gains.[8] Piketty's data shows large increases in the valuation ratio during the period considered but, surprisingly, his theory of inequality ignores it.

In my model, the return to equity $r$ and the ratios $\frac{K}{Y}$ and $\frac{W}{Y}$ move as in figure 1.4 and it is capital stock what enters into the production function. Since $\frac{K}{Y}$ has been falling during the period considered, my theory requires a value of the elasticity of substitution below one, just like the literature has traditionally estimated.

In the next two sections, I examine the causes that are behind the evolution of equity Tobin's Q. I provide empirical evidence and a theoretical framework to show that the wedge between equity wealth and corporate capital has been reduced by the actual decline of capital income taxes, the decline of financial diversification costs and the switch towards a short-term oriented corporate model.

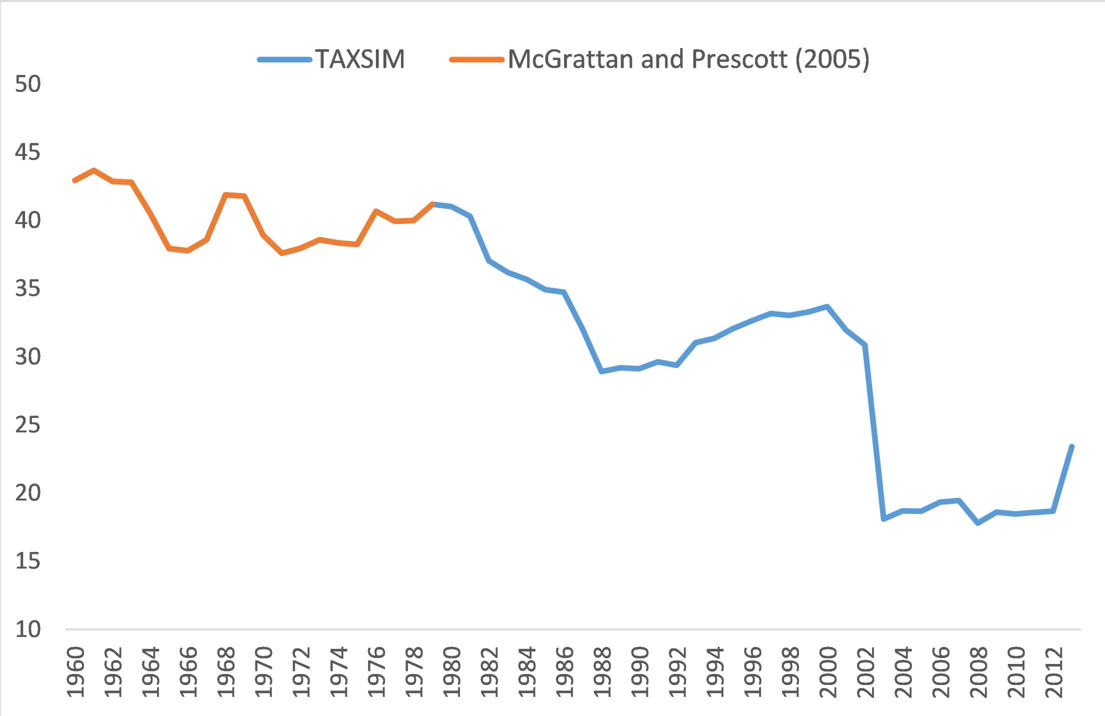
I build an incomplete markets model to explain how these factors have changed equity wealth, corporate capital, equity returns and the labor share after 1980. Markets incompleteness is an appropiate assumption because when markets are incomplete the aggregate demand for assets $S(r)$ is increasing in $r$ (indeed, $S$ is concave and tends to infinity as $r$ approaches $\frac{1}{\beta} - 1$ due to the precautionary

[8] Piketty and Zucman (2014a), appendix figure A131

motive). And an increasing $\frac{S}{Y}(r)$ curve is needed to obtain the observed movements in $\frac{K}{Y}$ and $r$ when Tobin's Q rises. [9]

## 1.4 Stock Market Costs and Capital Income Taxes

FIGURE 1.6: Average Marginal Tax Rate on U.S. Dividend Income (%), 1960-2014

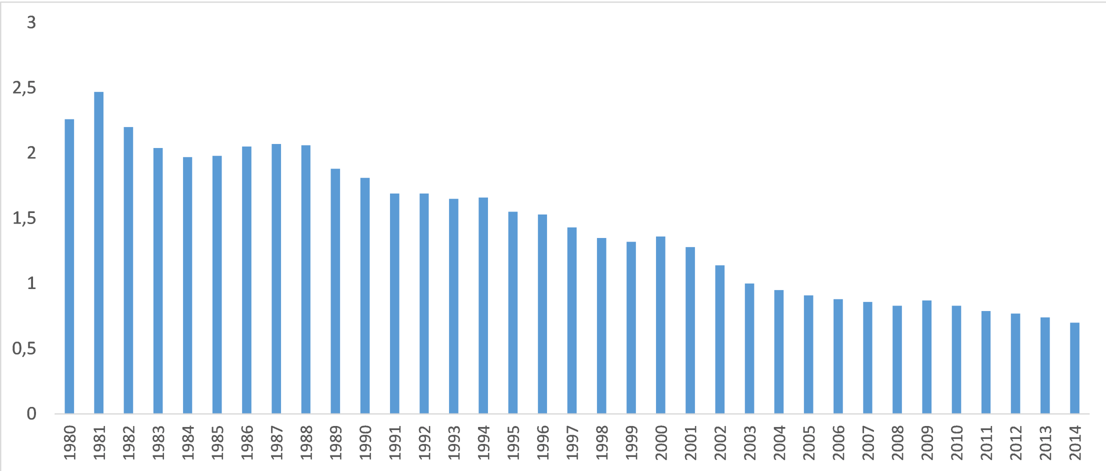



In figure 1.6 I plot estimates of the average marginal tax on divend income for years 1960 to 2012. For the period 1979-2012 I use average marginal taxes calculated by NBER TAXSIM model with micro data from the Statistics of Income Distribution of the Internal Revenue Service. For the period 1960-1979, I use average marginal

[9]Note that in presence of complete markets, however, the stationary demand for assets would be given by the Euler equation of the representative household evaluated at the steady state. This would give a steady state demand for assets completely elastic and stuck at $r = \frac{1}{\beta} - 1$. In that case, the equilibrium characterized by $Q < 1$ would still occur at the intersection between $\frac{S}{Y}(r)$ and $\frac{W}{Y}(r)$, but now the economy would not transition towards $Q = 1$ by lowering $\frac{K}{Y}$ and increasing $r$. It would simply close the gap between $\frac{K}{Y}(r)$ and $\frac{W}{Y}(r)$ by increasing $\frac{W}{Y}$, leaving $r$ and $\frac{K}{Y}$ unchanged, which is at odds with what we observe for the U.S. economy. Anagnostopoulos et al. (2012) provide a detailed explanation about the difference between assuming complete or incomplete markets

taxes calculated by McGrattan and Prescott (2005) using the SOI (Statistics of Income) data.

FIGURE 1.7: Equity Mutual Fund Costs (% of Assets), 1980-2014




In figure 1.7 I plot the sum of mutual fund costs and annuitized sales loads relative to the sum of fund assets. Data are from the Investment Company Institute (ICI). As in McGrattan and Prescott (2005), I use these data as an estimate of the costs paid by shareholders to hold a diversified portfolio. Note that the costs are expressed as a percentage of total assets helds and, therefore, they are conceptually equivalent to a tax on financial wealth. Both, the average marginal tax rate on dividend income and the equity mutual fund costs play important roles in the model explained below. In particular, they lead to a Tobin's $Q$ lower than one. Their decline during the post-1980 have contributed to the rise of Tobin's $Q$.

## 1.5 The Model

The model assumes an infinite horizon economy with endogenous production and uninsurable labor income risk. The economy is populated by a continuum (measure 1) of infinitely lived households indexed by $i$ that trade in stocks to insure against idiosyncratic risk, a representative firm and a government that maintains a balanced budget. Time is discrete and denoted by $t = 0, 1, 2....$ The enviroment is similar to Anagnostopoulos et al. (2012).

### 1.5.1 Households

Households' have identical preferences over sequences of consumption described by the expected utility function

$$U(c_i) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_{it})$$

where $\beta \in (0,1)$ is the subjective discount factor,$\mathbb{E}_0$ denotes the expectation conditional on information at date $t = 0$ and $c_{it}$ denotes personal consumption. The utility function $u(\cdot) : R_+ \to R$ is assumed to be strictly increasing, strictly concave, continuously differentiable and satisfies the Inada conditions. Households can only save in stocks of the firm to insure against idiosyncratic labor income risk. I denote $s_{it}$ the number of stocks held by the subject $i$ at the begining of period $t$. Stocks can be traded between households every period at a competitive price $p_t$ and they entitle shareholders to a dividend per share of $d_t$. There is no aggregate uncertainty which implies that the amount of dividends, the price of stocks and hence the return on the stocks before taxes and costs $r_t^{bef} = \frac{d_t + p_t - p_{t-1}}{p_{t-1}}$ are known for the households.

In addition to stock returns, household $i$ earns labor income. I assume that labor supply is fixed for every households (normalized to one) but their productivity, $\epsilon_{it}$, is $i.i.d$ across households and follows a Markov process with transition matrix $\prod(\epsilon' \mid \epsilon)$ where $\epsilon$ is derived from a set $S_\epsilon$ of possible values. Individual labor earnings per period are thus equal to $w_t \epsilon_{it}$ where $w_t$ is the aggregate wage rate. The governement levies proportional taxes on capital income at rate of $\tau_d$. Households have to pay stock markets costs which are expressed as a fraction $\kappa$ of total assets owned. Since there is a single financial asset in the economy, I abstract from indiosyncratic risk in assets and, consequently, these costs can be conceived as costs of holding a diversified equity portfolio, like in McGrattan and Prescott (2003). Furthermore, because they are expressed as a fraction of total assets held, from shareholders' pespective they are conceptually equivalent to a tax on financial wealth.

Households use their labor income and their after-tax capital income to purchase consumption goods, to purchase additional stocks and to pay the diversification costs. Therefore, household $i$'s budget contraint is:

$$c_{it} + p_t s_{it+1}(1 + \kappa) = w_t \epsilon_{it} + ((1 - \tau_d) d_t + p_t) s_t \tag{1.3}$$

At each period, hosehold $i$ also faces a no short-selling constraint on stocks:

$$s_{it+1} \geq 0 \tag{1.4}$$

As it is shown in Coen-Pirani and Carceles-Poveda (2009), in presence of constant returns to scale in the production function and a no short-selling condition like 1.4, unconstrained shareholders will unanimously agree on the optimal level of investment and dividends despite the existence of incomplete markets. Note that perfect unanimity across unconstrained households on shareholder value maximization implies that any deviation from this objective comes exclusively from the problem of the firm, and not from a dispute among shareholders with different objectives.[10] This deviation, modelled later in the problem of the firm, can be understood as resulting from divergent intertemporal preferences between managers and shareholders.

Households choose how much to consume and how many stocks to buy in each period given their idiosyncratic labor income, the price of stocks and the level dividends. Given the absence of aggregate uncertainty, the optimal choice of stocks by an unconstrained household $i$ requires the following Euler equation to hold:

$$\frac{u_{c,it}}{\beta \mathbb{E}_t u_{c,it+1}} = \frac{[(1-\tau_d)\, d_{t+1} + p_{t+1}]}{p_t(1+\kappa)} = 1 + r_t \tag{1.5}$$

where $u_{c,it}$ denotes the marginal utility of agent $i$. The expected intertemporal marginal rates of substitution for all uncostrained shareholders are equal to the reciprocal rate of the gross return from the stock market between $t$ and $t+1$. Note that what matters for the households decision is the after tax return $1 + r_t$, but not $p_t$, $p_{t+1}$ and $d_{t+1}$ separately.

Using the Euler equation and the transversality condition, the stock price at period $t$ can be written as a function of the stream of future dividends:

$$p_t = \sum_{j=1}^{\infty} \left( \Pi_{h=0}^{j-1} \frac{1}{(1 + r_{t+h})\,(1+\kappa)} \right) [(1-\tau_d)\, d_{t+j}] \tag{1.6}$$

[10]This is also implied by the fact that constrained shareholders have zero assets, which allow us to assume null decisional power

### 1.5.2 Recursive Formulation of the Firm's Problem

The representative firm accumulates capital stock $K_t$, hires labor $L_t$ and uses a $CES$ technology to produce output $Y_t$:

$$F(K_t, L_t) = \left(\phi K_t^{\theta} + (1-\phi) L_t^{\theta}\right)^{\frac{1}{\theta}}$$

where $\phi$ and $\theta$ are technological parameters. The elasticity of substitution between capital and labor is given by $\sigma = \frac{1}{1-\theta}$. Note that according to this formulation, the labor share of income and the capital-income ratio, key variables in the subsequent discussion, have an one-to-one relationship whose sign depends on the value of $\sigma$ :

$$ls_t = 1 - \alpha(k_t)^{\frac{\sigma-1}{\sigma}} \tag{1.7}$$

where $ls$ denotes the labor share and $k = \frac{K}{Y}$. If $\sigma > 1$ diminishing returns to capital are very low and the capital-to-output ratio and the labor share of income are negatively related. If $\sigma < 1$, diminishing returns are high enough to reduce the capital share as investment increases, which implies a positive relation between the labor share and the capital-income ratio. It turns out that $\sigma$ is not only crucial to understand the dynamics of the factor shares, but also the impact of the aggregate capital stock on aggregate welfare since a large proportion of households in this economy will rely mostly on labor income, which positively depends on $K$.

The total number of stocks is normalized to one and no other source of external finance is assumed, namely, there is not new equity or debt issuance. Investment, the total wage bill and payouts to shareholders have to be financed using only internal funds.[11] The firm's flow and funds constraint is:

$$F(K_t, L_t) = d_t + \gamma(K_{t+1} - (1-\delta)K_t) + w_t L_t \tag{1.8}$$

where $\gamma$ is the relative price of investment goods. As in Greenwood et al. (1997), $\gamma$ is intended to measure investment-specific technological change. Note that $\gamma$ is the key explanatory variable in Karabarbounis and Neiman (2014): as the relative price of investment goods falls, the economy becomes more capital-intensive, the capital-income ratio rises and -they argue- the labor share declines for $\sigma > 1$.

[11] I do not allow firms to use share repurchases to distribute corporate profits. Dividends are the only form of corporate payouts

The optimization problem of the firm is

$$V\left(K\right)=max_{d,\,K',\,L}\left\{d\left(1-\tau_{d}\right)+m'V\left(K'\right)\right\} \tag{1.9}$$

subject to

$$d=F\left(K,L\right)-\gamma\left(K'-\left(1-\delta\right)K\right)-wL \tag{1.10}$$

where $m'$ is the discount factor of the firm, which equals $m'=\xi\frac{\beta\mathbb{E}_{t}u_{c,it+1}}{u_{c,it}}$ and $\xi\in[1,1+r)$ by assumption.

Note that under this formulation and due to the presence of parameter $\xi$, the optimization of the firm is not consistent with shareholders' optimization. The firm discounts future cash flows like shareholders would do only when $\xi=1$. Therefore, the extent to which the firm maximizes shareholder value is given by the value of $\xi$. When $\xi=1$, the firm maximizes standard shareholder value and the model collapses to the standard neoclassical model. When $\xi\in(1,1+r)$, the firm deviates from the standard shareholder value maximization and overaccumulates capital. Consequently, the parameter $\xi$ should be interpreted as a reduced-form mean of capturing divergences between the firm's and shareholders' objectives, where $\xi\in(1,1+r)$ may arise from a managers' taste for empire-building or a preference for investment projects that lead to a "quite life".[12] I argue that post-1980s institutional changes like the extensive use of equity-based executive compensation and the development of a market for corporate control have made corporations more short-term oriented, leading to a lower $\xi$ in post-1980 years. Importantly, a higher $\xi$ increases firm's capital stock and, in equilibrium, pushes the market value down, leading to a lower Tobin's $Q$. This is because a higher value of $\xi$ makes the firm more patient than shareholders' and, hence, it has a preference for higher investment and lower return to capital.

Given the difficulty of measuring $\xi$, it plays a residual role in explaining the secular movements of Tobin's $Q$. This implies that any movement in Tobin's $Q$ not attributable to capital income taxes and diversification costs will be attributed to $\xi$.

[12]This is a simple way to model the "control rights valuation" story discussed by Piketty and Zucman (2014a) (see Appendix A.4.3), which provides an explanation of why countries with stronger shareholders rights have a higher Tobin's $Q$ and why anglo-saxon economies have evolved towards a higher Tobin's $Q$ during the last decades.

Labor demand is standard and given by the first order condition with respect to $L$:

$$F_L(K, L) = w \tag{1.11}$$

Capital accumulation is given by the capital Euler equation

$$\gamma\left(1-\tau_d\right) = \frac{1}{1+r}\xi\left(1-\tau_d\right)\left[F_K\left(K',\, L'\right)+\gamma\left(1-\delta\right)\right] \tag{1.12}$$

which results in a demand of capital equal to:

$$\frac{1+r}{\xi} = \frac{F_k\left(K',\, L'\right)}{\gamma} + \left(1-\delta\right) \tag{1.13}$$

In equation 1.12, multiplying both sides by $K'$ and substituting the one-period ahead financing constraint into the capital Euler equation gives the following relation for $K'$ :

$$\gamma K' = \frac{d' + \gamma K''}{\frac{(1+r)}{\xi}} \tag{1.14}$$

Using forward substitution and imposing the transversality condition, gives:

$$\gamma K_{t+1} = \sum_{j=0}^{\infty} \frac{d_{t+1+j}}{\prod_{h=0}^{j-1}\left(\frac{1+r_{t+h}}{\xi}\right)} \tag{1.15}$$

Note that 1.15 gives a formula for the market value of physical capital (i.e. the replacement cost of capital), which in a frictionless economy is equal to the stock market value of the firm given by 1.6. The divergence between the two variables arises due to the presence of capital income taxation ($\tau^d > 0$), costly financial markets ($\kappa > 0$) and deviation from standard shareholder value maximization ($\xi \in (1, 1+r)$). Crucially for the results of this paper, changes in any of these parameters will cause opposite movements in equilibrium total wealth held by households and in equilibrium capital stock. This will affect households differently depending on their amount of wealth held. Those holding a large proportion of assets will benefit from a rise in wealth, even if this growth is at expense of a decline in the capital stock and the corresponding decline in wages. However, those holding very little assets will benefit from a rise in capital stock even if this growth is at the expense of a decline in wealth, since their earnings mainly rely on labor income.

### 1.5.3 Government

In each period $t$, the government consumes an exogenous amount $G$ and taxes capital income to finance it. Its balanced budget contraint is simply given by $G = \tau^d d \int s(\epsilon,\, s) d\Psi(\epsilon,\, s)$.

### 1.5.4 Recursive equilibrium

Let $\Psi$ be the cross sectional distribution of households over the state $(\epsilon,\, s)$. This distribution follows the law of motion $\Psi'' = \Gamma\left(\Psi'\right)$. The stationary distribution can be used to calculate the aggregate consumption demand $\int c(\epsilon,\, s) d\Psi(\epsilon,\, s)$ and the aggregate demand for stock holdings $\int s(\epsilon,\, s) d\Psi(\epsilon,\, s)$. Aggregate capital demand and aggregate labor demand are given by equations 1.13 and 1.11 respectively.

**Definition:** Given the transition matrix $\prod$, a stationary rcursive competitive equilibrium relative to the triple $\left(\tau^d,\, \kappa\,,\xi\right)$ consist of a law of motion $\Gamma$, a stationary distribution $\Psi$, prices $w$ and $p$, return $r$ and decision rules for households $c(\epsilon,\, s)$ and $s'\left(\epsilon,\, s\right)$, the associated households' value function $v\left(\epsilon,\, s\right)$ such that:

- Given prices $w$ and $r$ and aggregates, the individual policy functions $c(\epsilon,\, s)$, $s'\left(\epsilon,\, s\right)$ and the value function $v\left(\epsilon,\, s\right)$, solve the problem of the households.
- Given prices $w$ and $r$, aggregate $K$ and $L$ solve the problem of the firm.
- The price of stocks is equal to

$$p = \frac{\left(1 - \tau_d\right) d}{r + \kappa} \tag{1.16}$$

and the level of dividends $d$ is given by the flow and funds constraint of the firm at the steady state

$$d = F(K, L) - F_L(K, L)L - \gamma\delta K \tag{1.17}$$

- Government spending equals goverment revenue $G = \tau^d d \int s(\epsilon,\, s) d\Psi(\epsilon,\, s)$.
- Prices are such that all markets clear:

$$\int s(\epsilon,\, s) d\Psi(\epsilon,\, s) = 1 \tag{1.18}$$

$$\int \epsilon d\Psi(\epsilon,\, s) = L(K) \tag{1.19}$$

$$\int c(\epsilon,\, s) d\Psi(\epsilon,\, s) + \gamma\left(K' - (1-\delta)K\right) + G = F(K, L(K)) \tag{1.20}$$

**Proposition 1.1.** *In a recursive competitive equilibrium, equity Tobin's Q satisfies*

$$Q = \frac{(1-\tau_d)\left(\frac{1+r}{\xi} - 1\right)}{(r+\kappa)} \tag{1.21}$$

*Proof.* This follows from the definition of Tobin's $Q = \frac{p\int s(\epsilon,\, s)d\Psi(\epsilon,\, s)}{\gamma K}$, the steady state condition 1.16, the market clearing condition 1.18, and the fact that the replacement cost of capital at the steady state is $\gamma K = \frac{d}{\frac{1+r}{\xi}-1}$. □

When $\xi = 1$ (standard sharehoder value maximization), $\kappa = 0$ (zero stock market diversification costs) and $\tau_d = 0$ (no capital income taxes), Tobin's $Q$ is equal to one, and the model collapses to the standard neoclassical growth model with a corporate sector and trading of shares.

In absence of capital income taxes and stock market costs, Tobin's $Q$ equals $\frac{(\frac{1}{\xi}+\frac{r}{\xi}-1)}{r}$. When this is the case and $\xi \in (1, 1+r)$, Tobin's $Q$ is lower than one. By assumption, $\xi$ cannot be equal to $1+r$ because this would imply no-discounting in the problem of the firm and the steady state replacement cost of capital $\gamma K$ would tend to infinite. Interestingly, note that nothing prevents $\xi$ to be lower than one. From an economic point of view, this would mean that managers are more "short-term" oriented than shareholders. This is not an implausible situation and, indeed, the tendency to short-termism in current corporate governance has been an issue of concern in recent policy debates (see for example Martin (2015)). Results below also suggests that this is a very plausible scenario.

## 1.6 Calibration

This section uses a calibrated version of the model for the U.S. economy to study the distributional effects of the rise in Tobin's Q during the post-1980 period due to the steady fall of the average marginal tax on capital income, the reduction of stock market diversification costs and the switch towards a shareholder-oriented corporate model.

The time period is assumed to be one year. Households preferences are of the CRRA class, $U(c_i) = \frac{c^{1-\mu}-1}{1-\mu}$ with a risk aversion of $\mu = 2$. The production function is CES, $Y_t = A\left(\phi K_t^{\theta} + (1-\phi) L_t^{\theta}\right)^{\frac{1}{\theta}}$, where $\phi$ is a distributional parameter with value $\phi = 0.32$ and $A$ and $\theta$ are technological parameter. The elasticity of substitution between capital and labor is given by $\sigma = \frac{1}{1-\theta}$ and equals $\sigma = 0.7$. Note that this value of $\sigma$ guarantees complementarity between capital and labor. Therefore, labor share declines when the physical-capital-output ratio declines. Nevertheless, this estimate is a conservative value of the elasticity of substitution because the range of values that the literature has estimated for $\sigma$ is well below $\sigma = 0.7$ (Chirinko and Mallick, 2014a).

| | Value |
|---|---|
| $\mu$ | 2 |
| $\alpha$ | 0.32 |
| $\beta$ | 0.93 |
| $\delta$ | 0.103 |
| $\epsilon$ | $\begin{bmatrix} 1 & 5.29 & 46.55 \end{bmatrix}$ |
| $\prod^*$ | $\begin{bmatrix} 0.498 & 0.443 & 0.059 \end{bmatrix}$ |
| $\prod(\epsilon' \mid \epsilon)$ | $\begin{bmatrix} 0.992 & 0.008 & 0.00 \\ 0.009 & 0.980 & 0.011 \\ 0.00 & 0.083 & 0.917 \end{bmatrix}$ |

Table 1.1: Parameters and Earnings Process

The technology parameter $A$ is normalized so that corporate output $Y$ is equal to one in the steady state of the deterministic version of our economy. I choose a discount factor $\beta = 0.93$ to match the pre-1980 average capital-output ratio of 2.16. The depreciation rate is set to $\delta = 0.103$ as in Anagnostopoulos et al. (2012).

The idiosyncratic labor productivity process is taken from Davila et al. (2012). They construct this stochastic process to generate inequality measures for earnings and wealth that are close to U.S. data. As shown in Table 1.1, this is achieved with a three-state Markov chain with transition matrix

$$\prod = \begin{bmatrix} 0.498 & 0.443 & 0.059 \end{bmatrix}$$

which exhibits very strong persistence, and with productivity values

$$\epsilon \in \begin{bmatrix} 1 & 5.29 & 46.55 \end{bmatrix}$$

that assign productive individuals 46 times the productivity of unproductive individuals. The resulting stationary distribution is denoted by $\prod^*$.

I take average marginal tax rates on dividend income $\tau^d$ from TAXSIM and McGrattan and Prescott (2005). For the pre-1980 period, the average $\tau^d$ equals $39,31\%$. For the post-1980 period, the average $\tau^d$ equals 20.7%. I take the sum of mutual fund costs and annuitized sales loads relative to the sum of fund assets $\kappa$ from the Investment Company Institute (ICI). For the pre-1980 period, average $\kappa$ equals 2.26%. For the post-1980 period, the average $\tau^d$ equals , 0.7%. Finally, I calibrate $\xi$ to match the average of equity Tobin's Q in pre-1980 and post-1980 years.

## 1.7 Quantitative Results

The aggregate effect of the observed changes in $\tau^d$, $\kappa$ and $\xi$ on the capital-output ratio, net-equity-wealth-output ratio and the corporate labor share is shown in table 1.2. To understand the results, first note that model gives equilibria characterized by $r$ and $K/Y$. Since we observe in the data the Tobin's Q variation, we can calculate $\xi$ to obtain the post-1980 -average of- $p/y$.

| $\sigma = 0.7$ | Pre-1980 equilibrium | Post-1980 equilibrium |
|---|---|---|
| $(\tau^d, \kappa, \xi)$ | $(39,31\%$ ,2.26%, 0.9834) | (20.7% , 0.7%, 0.9745) |
| $r$ | 2.98% | 6.86% |
| $\frac{p}{Y}$ | 1.1854 | 1.6032 (+49.48%) |
| $\frac{K}{Y}$ | 2.16 | 1.6 (−25.92%) |
| $\frac{wL}{Y}$ | 0.712 | 0.6729(−5.53%) |
| *Tobin's Q* | 54.9% | 100.2% |

Table 1.2: Quantitative Results

The model predicts that the corporate sector has indeed become more short-term oriented, although, surprisingly, values below one are found for both periods.

Changes in the capital-output ratio and wealth-output ratio are similar in magnitude to those observed in the data. More importantly, the model predicts a decline of 5.5 percentage points in the corporate labor income share. Since the corporate labor share had an actual decline of 8 percentage points between 1980 and 2013, and the Tobin's Q channel explains a decline of 5.5 percentage points, the change in Tobin's Q explains roughly two-thirds of the observed decline in the corporate labor share.

## Conclusion

In this paper I revisit the distributional implications of rising wealth-income ratios. I first show that, once we control for the valuation effect given by the rise of equity Tobin's $Q$, rising wealth-output ratios are compatible with the decline of the labor share for standard diminishing returns (i.e. an elasticity of substitution between capital and labor lower than one). Secondly, I use a version of the standard incomplete markets model to explain the rise of the net-equity-wealth-output ratio, the decline of the corporate-capital-output ratio, the decline of the labor share and the rise of equity returns. Thirdly, I identify the causes that have driven equity Tobin's Q up. I show that the steady fall of the average marginal tax on capital income, the reduction of stock market intermediation costs and the switch towards a higher short-term oriented corporate model explain the decrease of investment flows and the rise of the market value of existing capital. The consequence has been an endogenous upsurge of equity Tobin's Q and, importantly, the rise of equity returns. The decline of the labor share is the natural response to investment sluggishness when capital and labor are complements. The joint effect of capital income taxes, stock-market costs and corporate short-termism explains up to two thirds of the decline of the U.S. corporate labor share.

The paper also shows that, by distinguishing between equity and corporate capital, the evolution of the labor share can be appropriately explained using Piketty's data without the need of assuming an extraordinary value on the elasticity of substitution between capital and labor.

# APPENDIX A

## Computing the Stationary Competitive Equilibrium

For a given $r$, the problem of the firm is solved using the first order conditions. The problem of households is solved using value function iteration. Policy rules are then used to obtain the stationary distribution and aggregate variables, which in turn are used to check the market clearing conditions and update prices.

**Step** 1. Compute the stationary level of employment $L$

**Step** 2. Guess the aggregate capital stock $K^0$

**Step** 3. (Firm's problem)

Step 3.1 Solve the firm's problem given an aggregate level of capital $K^0$ and obtain $r^0$ using equation 1.12.

Step 3.2 Use equation 1.11 to obtain $w^0$ and equation 1.17 to obtain the steady state level of dividends $d^0$.

Step 3.3 Use equation 1.16 to obtain the steady state stock market value $p^0$ (equity supply)

**Step** 4. (Households' problem)

Step 4.1 Use the change of variable $a_{it+1} = p_t s_{it+1}$ and compute the households' decision functions given $r^0$ and $w^0$.

Step 4.2 Compute the stationary distribution of assets $\Psi^0$ and the aggregate asset demand $E\left(a\right)^0$ .

Step 4.3 Check if $E\left(a\right)^0 \simeq p^0$. Note that this condition is equivalent to clear the stock market since the aggregate asset demand $E\left(a\right)^0 = \int p^0 s(\epsilon,\, s) d\Psi(\epsilon,\, s)$ equals the stock market value when the stock market clears $\int s(\epsilon,\, s) d\Psi(\epsilon,\, s) = 1$.

- If $E\left(a\right)^0 > p^0$, the stock market return $r^0$ is too high and the aggregate level of capital $K^0$ is too low. Update $K$ with $K^1 > K^0$
- If $E\left(a\right)^0 < p^0$, the stock market return $r^0$ is too low and the aggregate level of capital $K^0$ is too high. Update $K$ with $K^1 < K^0$

- Update the aggregate level of capital until the equilibrium $E(a)^0 \simeq p^0$ is achieved.

# APPENDIX B

## Additional figures

(to be commented). To calculate corporate-capital-output ratio for the whole corporate sector, I proceed as follows. I use the series "Non-Financial assets" from Piketty and Zucman (2014a), which sums produced tangible capital, non-produced tangible capital, and intangible capital for the whole corporate sector (financial and non-financial sectors). Then I use the Chain indexes provided by BEA to get a real value of the corporate gross value added and the level of corporate fixed assets.

FIGURE 1.8: Corporate-Capital-Output Ratio in real terms

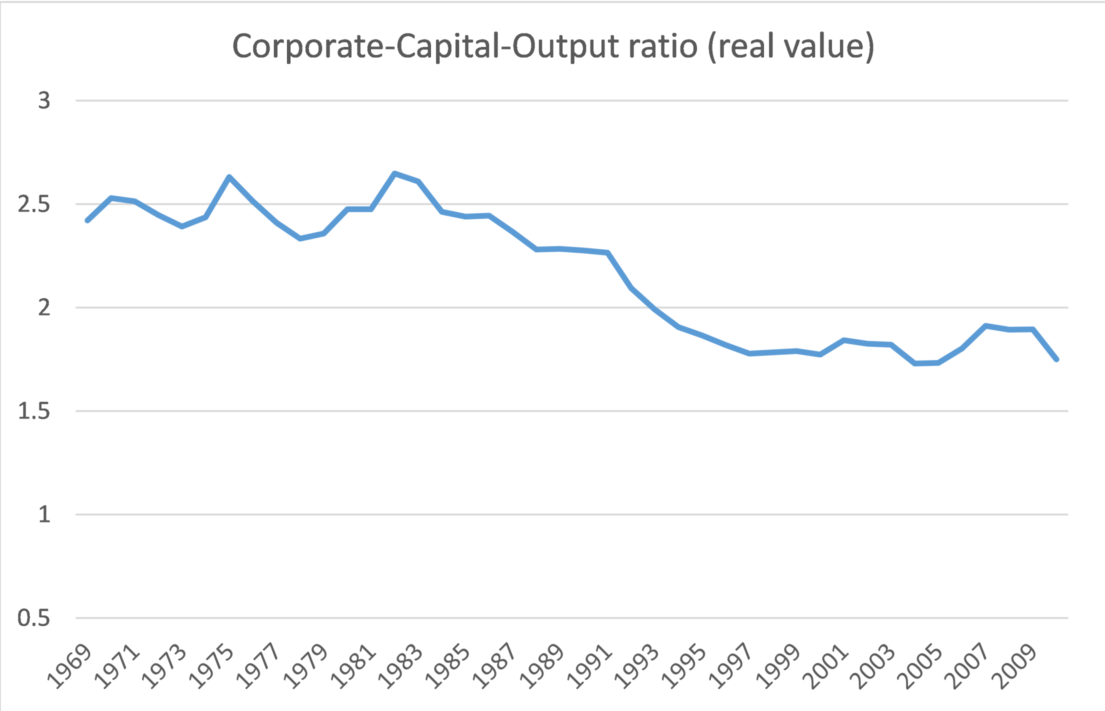
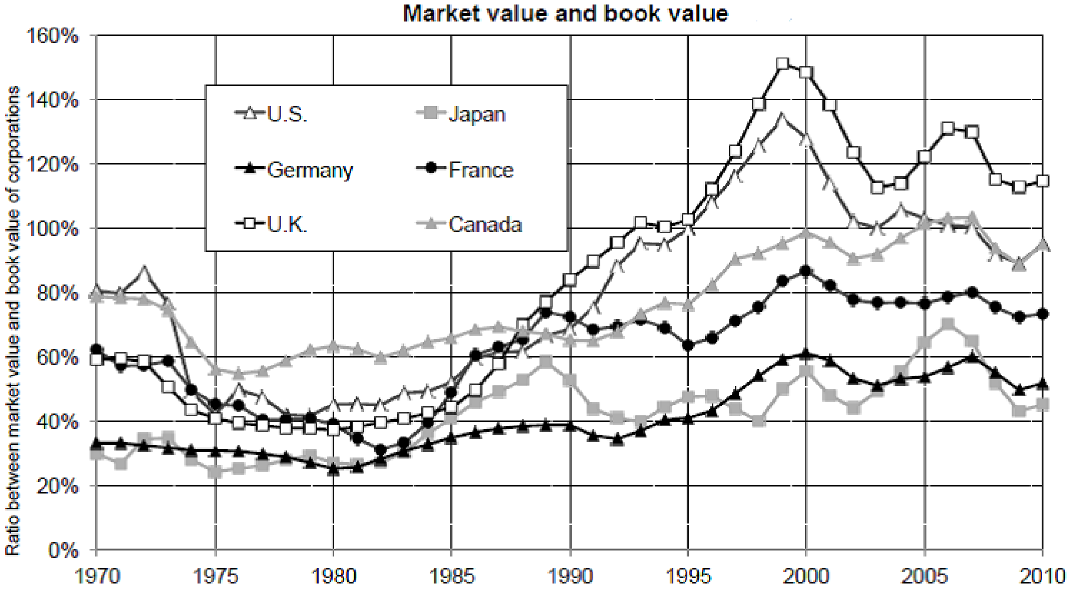


FIGURE 1.9: Equity Tobin's Q, different economies




Tobin's Q (i.e. the ratio between market value and book value of corporations) has risen in rich countries since the 1970s-1980s. Sources and series: see piketty.pse.ens.fr/capital21c.

# Chapter 2

# Finance and the global decline of the labour share

*Abstract*

The labor income share has been decreasing across countries since the early 1980s, sparking a growing literature about the causes of this trend (Elsby et al., 2013; Karabarbounis and Neiman, 2014; Piketty and Zucman, 2014a). At the same time, again since the early 1980s, there has been a global steady increase in equity Tobin's $Q$ which shows the increasing trend of asset prices in modern economies. This paper uses a simple model to connect these two phenomena and evaluates its empirical validation. In our model a raise in equity Tobin's $Q$ increases equity returns and, importantly, depresses the capital-output ratio. The impact on the capital-output ratio reduces the labor share for standard values of the elasticity of substitution. Based on a common factor model, we find that the increase in Tobin's $Q$ explains almost 60% of the total decline in the labor income share. This implies that financial markets have direct and significant consequences in inequality through their impact on the functional distribution of income. We highlight the implications of this result and, in the context of the model, we suggest different policies that can revert this declining trend.

**JEL Codes**: E25, E44, E22.

**Keywords**: Labour Share, Tobin $Q$, Finance, Capital-Output Ratio.

## 2.1 Introduction

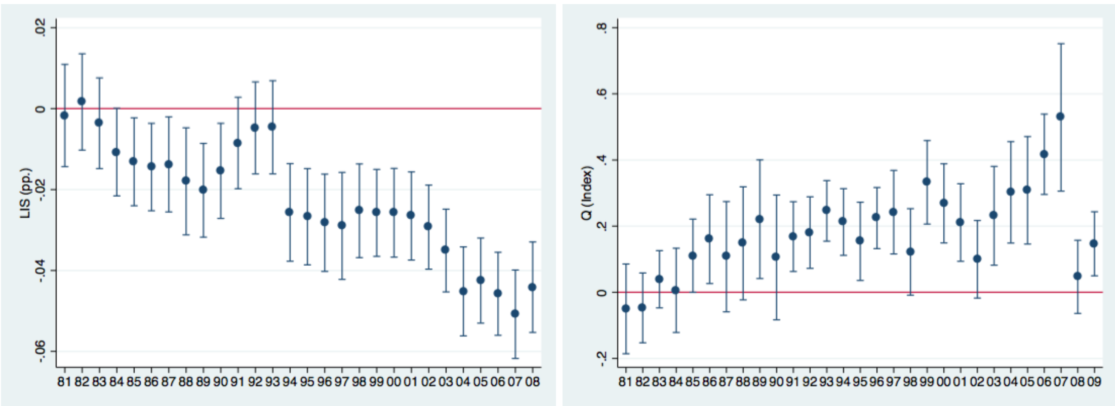
The decline of the labor income share is becoming an increasing popular research topic. The constancy of factor shares, once featured among Kaldor's stylised facts of economic growth, has been challenged by recent literature. For example, Karabarbounis and Neiman (2014) document that the global labor share has declined significantly since the early 1980s, with the decline occurring within the large majority of countries and industries. Elsby et al. (2013) use alternative measures of the labor share and provide convincing evidence of this declining trend for the U.S. economy. More noticeably, Piketty and Zucman (2014a) show, for a set of advanced economies, a decreasing (increasing) trend of the labor (capital) income share since the late 1970s.

Figure 2.1.a shows the figure of concern. It displays the evolution of the global labor share according to our data by plotting the year fixed effects from a GDP weighted regression along with its 90% confidence intervals. Country fixed effects are included to eliminate the influence of countries entering and exiting the data set. Taking 1980 as the reference year, we observe that the global labor share has exhibited a clear downward trend only disrupted by the sudden -but short- rise in the early nineties. If we normalised 1980 to equal its weighted average value (57%), labor share reaches a level of roughly 52% at the end of the sample, implying an actual decline of 8.9 per cent during the period considered.

Attempts to explain the non-constant behaviour of the labor share have often departed from reconsidering at least two previously standard assumptions namely - that aggregate technology is Cobb-Douglas and that markets are perfectly competitive. Explanations based on departures from the Cobb-Douglas production function usually assume that technology is characterised by a constant elasticity of substitution (CES) production function. As long as firms produce with a CES technology and the labor market is perfectly competitive, the labor share can be expressed as a function of the capital-output ratio, $LIS = g(K/Y)$. Given this relation, this literature emphasizes the role of capital deepening as the main determinant of the labor share. This is the case in Bentolila and Saint-Paul (2003), who refer to this relationship as the share-capital schedule (or curve). This relationship is not altered by changes in factor prices or quantities, or in labour-augmenting technical progress, which are all encompassed in the schedule. Note that within this curve, when everything else is constant, labor share dynamics can only be explained if the economy is not on a balanced growth path, meaning that capital and output are not growing at the same rate, like in Piketty and Zucman (2014a) and Karabarbounis and Neiman (2014).

Labor and product market imperfections are also frequently brought up as explanatory factors of the labor share decline. Even when technology is Cobb-Douglas, movements of factor shares can be triggered by changes in the bargaining power of workers and/or in the monopoly power of firms, that is to say, factors that break the equality between marginal costs and marginal products/revenues (Raurich et al., 2012 and Gonzalez, 2016a).

FIGURE 2.1: Labor income share and Tobin's $Q$, 1980-2009




(a) Labour Income Share

(b) Tobin's $Q$

*Notes:* Own calculations obtained as year fixed effects from a GDP weighted regression including country fixed effects to control for the entry and exit of countries throughout the sample.

In light of the previous potential explanatory departures, which are the actual drivers of the downward trend of the labor share? The literature has pointed out three potential candidates: (i) globalization, (ii) the institutional framework, and (iii) structural/technological causes. This paper contributes to the debate by exploring the role played by a new factor: the negative impact of finance on corporate investment, commonly referred as the financialization process of the non-financial corporate sector, which we connect with the global evolution of equity Tobin's $Q$.

The presence of globalization as a driving force candidate is not surprising. The unprecedented global integration process that economies have experienced during the last decades has substantially altered many economic relationships. With regard to the distribution of income, from a theoretical perspective, globalization has an ambiguous effect. On one side, the relative larger capital mobility makes easier for a company to change the location of its production. The change of location can decrease the labor share by the simple elimination of jobs. In addition, given the increasing international competition, firms can also use this as a threat to decrease the bargaining power of workers (Rodrik, 1997) and, thus, the labor income share. On the other side, globalization has a counterbalance effect by increasing product competition. This increase in competition decreases firms' mark-ups, and this can have a positive impact on the labor income share. Therefore, impact of globalization is something that has to be empirically evaluated. Guscina (2006) and Jaumotte and Tytell (2007) find a negative relationship between globalization and the labor income share in developed countries. In their analysis, they include different globalization proxies such as: international trade, trade with developing countries, offshoring, and the export/import relative prices, finding a robust negative relationship.[1] More recently, Elsby et al. (2013) study the role played by the offshoring process in the U.S. labor share decline. They find that the increased exposure to imported goods accounted for 85% of the total decline in the past quarter century. Therefore, empirical studies suggest a negative impact of globalization on the labor share of income.

The role of the institutional framework has also received a strong attention in the study of factor share dynamics. The literature has focused on the impact of both labor and product market regulations. Kristal (2010), for example, finds that dynamics of the labor share are largely explained by indicators for workers' bargaining power. Blanchard and Giavazzi (2003) emphasize that labour market regulations have a positive effect in the short-run, but negative in the long-run, because in the long-run employers can substitute capital for relatively more expensive labor. With respect to product market regulations, Raurich et al. (2012) find a negative relationship between imperfect competition and the labor share, showing that estimates of the elasticity of substitution are biased when price mark-ups are ignored. Finally, Azmat et al. (2012), investigating a different channel, find that a fifth of the total labor share decline observed is a consequence of the privatization of public companies through job shedding.

Despite the documented importance of globalization and market regulations, most of the current literature has focused on structural/technological explanations. This branch of the literature relies on the aforementioned one-to-one relation between the labor share and the capital-output ratio $LIS = g(K/Y)$, where the direction of the effect depends on the elasticity of substitution between capital and labour.

[1] It is worthy to note that both papers find that technology has played a more important role than globalization.

The contribution of this literature relies on looking at structural drivers of the labor share by making endogenous the dynamics of the capital-output ratio. Piketty and Zucman (2014a), for example, argue that a persistent gap between the rate of return to capital and the growth rate of output results in a growing accumulation of capital because capitalists save most of their income. This would explain the observed movements of the factor shares in advanced economies. Also based on the share-capital schedule, Karabarbounis and Neiman (2014) argue that the persistent global decrease in the relative price of investment goods has induced firms to use more capital at the expense of labor, increasing the accumulation of physical capital and depressing the labor income share. They model capital-biased technological change using a version of the model presented in Greenwood et al. (1997).

Note that although Piketty and Zucman (2014a) and Karabarbounis and Neiman (2014) emphasize different channels, both use the share-capital schedule and have the common view that the increase in the capital-output ratio has been the main cause of the recent trend of factor shares. In response to higher capital accumulation, and due to low diminishing returns, the return to capital has not adjusted sufficiently downwards and this has led to an increase in the capital share. In mathematical terms, this is equivalent to say that the elasticity of substitution is larger than one. Only when capital and labor are, in the technological sense, substitutes enough, can capital be accumulated without decreasing much its rate of return.

This degree of substitutability, however, has seldom been found in the empirical literature. Economists have often estimated values of the elasticity of substitution ($\sigma$) far below one (Antràs, 2004; Chirinko, 2008).[2] Notably, Chirinko and Mallick (2014a) using a sectoral dataset and combining a low-pass filter with panel data techniques, find an aggregate elasticity of substitution of 0.4. Furthermore, when they allow the elasticity to differ across sectors, they find that all the sectoral values are below 1. In the context of the current debate, they convincingly argue that the secular decline in the labor share of income cannot be explained by decreases in the relative price of investment, or by any other mechanism that increases the capital-output ratio.[3]

[2] Chirinko (2008) provides a summary of the empirical literature and lists estimates from different papers, concluding that "the weight of the evidence suggests that gross $\sigma$ lies in the range between 0.40 and 0.60"

[3] Most of the criticisms of Piketty's Capital have emphasised this point, like Rognlie (2015) and Acemoglu and Robinson (2015)

In this paper we contribute to this recent literature by proposing a new mechanism and by evaluating its empirical validation with recent panel data techniques. Our mechanism emphasizes the role of finance and the relation between financial markets and corporate behaviour. In particular, we argue that the widespread increase in equity Tobin's $Q$ has occurred at the expense of corporate investment and the labor income share. We provide a simple model which shows that when equity Tobin's $Q$ raises, the equilibrium capital-output ratio falls. Importantly, this fall has a standard impact on the labor income share because it requires a value of the elasticity of substitution in line with the estimates traditionally found in the empirical literature.

Although the modelling strategy is different, our theoretical argument is similar to Gonzalez (2016b). When equity Tobin's $Q$ raises, financial wealth raises accordingly and, to hold this additional wealth, investors demand a higher return on equity. In any standard model, like ours, equity returns are linked to the marginal productivity of capital. This implies that if firms are forced to increase the return on equity, they have to reduce investment on capital. This circumstance depresses the capital-output ratio and has a direct impact on the labor share.[4]

Note that the mechanism of our model makes use of the share-capital schedule: we impact the labor share through changes in the capital-output ratio. In that sense, our paper is close to structural/technological explanations like the mechanism proposed by Karabarbounis and Neiman (2014). However, in our model the movement along the share-capital goes in the opposite direction. In response to an increase in equity Tobin's $Q$, investment and the capital-output ratio fall, not raise, and equity returns raise, not fall. This way, our the mechanism suggests that it is not too much investment what causes the decline of the labor income share, like in Karabarbounis and Neiman (2014), but too little, making our model compatible with standard values of the elasticity of substitution (i.e., $\sigma < 1$).

The relation of our paper with Piketty and Zucman (2014a) is more subtle. On one hand, they emphasize the role of increasing capital-output ratios in explaining the recent evolution of capital and labor shares. This makes their contribution closer to Karabarbounis and Neiman (2014). On the other hand, they calculate corporate

[4]In an unpublished but illustrative manuscript, Michele Boldrin and Adrian Peralta-Alva realized that corporate capital stock and market value of corporate equity were negatively correlated in U.S. data between 1951 and 2001. They find a correlation coefficient of -0.73 and they considered this finding a puzzle which cannot be solved by any standard theory. Our model shows that, when the demand of assets is increasing in equity returns, there is not any puzzle. The slides of the unpublished draft are available at http://www.micheleboldrin.com/research/buscycles.html

capital using the stock market value of equity holdings. That is, they assume that Tobin's Q is equal to one and proceed by equating the market value of physical capital to the stock market value of the corporate sector. However, they emphasize the important role of asset prices in driving the evolution of capital-output ratios and, for a set of advanced economies, they show a clear upward trend of equity Tobin's Q during the last 35 years. Furthermore, and consistent with our theory, they find declining or stagnant trends when they calculate corporate capital-output ratios using the PIM method and, not surprisingly, they estimate that, in absence of capital gains, national wealth-income ratios would have remained stagnant or declined.[5]

Our theory gives rise to several questions: Does the raise of Tobin's $Q$ capture the impact of finance on factor shares? What is behind the global evolution of Tobin's $Q$? And more importantly, is it a relevant mechanism?

We certainly do not argue that Tobin's $Q$ is a perfect indicator of financial activity and we neither try to show that Tobin's $Q$ is a variable that captures the whole impact of finance on the capital-output ratio and the factor shares. We simply check the empirical validation of a model that shows that when Tobin's $Q$ raises, the equilibrium capital-output ratio and the equilibrium labor share fall.

Our mechanism is relevant but, to the best of our knowledge, empirically unexplored. It is first relevant because it resembles the widely discussed arguments used by the literature on financialization (Epstein, 2005; Davis, 2009), which has recently been connected with the evolution of factor shares (Stockhammer, 2013) and inequality in general (Lin and Tomaskovic-Devey, 2013). This literature studies the increasing role of financial markets and financial motives within the non-financial corporate sector. In particular, it emphasises mechanisms that raise equity wealth and corporate payouts but depress corporate investment, just like in our model.

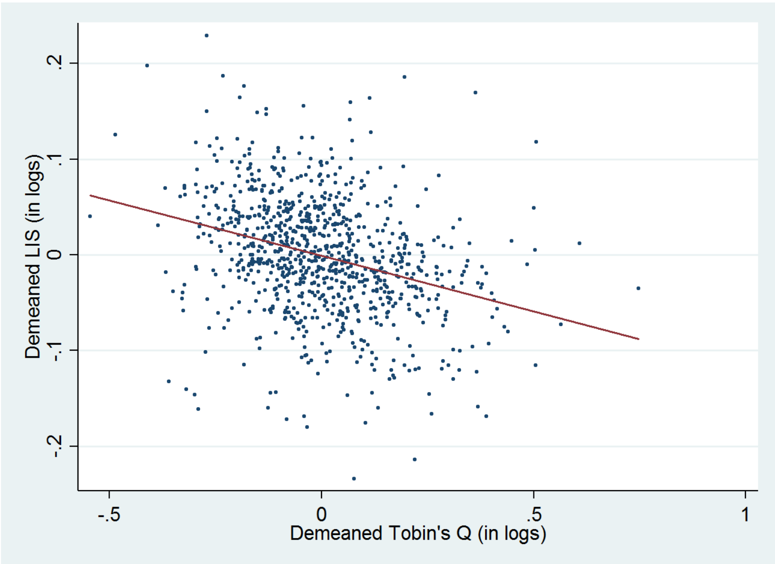
There are different mechanisms whose impact can be encompassed through an increase of equity Tobin's $Q$. Among them, financialization literature has emphasized the role played by the short-termism and increasing search of "shareholder-value". According to this literature, corporations, after the early 80s, tend to pursue short-term payout policies that increase the equity price but that happen to reduce long-term investment (Stiglitz, 2015). However, there are other mechanisms which can also increase the price of equity and reduce the investment on

[5]See data for different countries in Piketty and Zucman (2014a), Appendix Figures A71, A92, and A129, available on line at http://piketty.pse.ens.fr/en/capitalisback.

physical capital. These are, for example, the decrease of dividend income tax rates, the decline of stock market transaction costs and the rise of monopoly rents (Gonzalez, 2016a and Gonzalez, 2016b). Any of these mechanisms can be embodied in a version of the model we present below. The important aspect is that they all impact the equilibrium capital-output ratio and the labor share through an increase in equity Tobin's $Q$. For this reason we prefer to abstract from any specific factor and focus on the impact of Tobin's $Q$ alone.

Figure 2.1.b shows the evolution of global Tobin's $Q$ according to our data by plotting the year fixed effecs from a GDP weighted regression where 1980 is taken as the reference year (1980 = 0). If we consider the weighted average value in 1980, Figure 2.1.b shows a steady Tobin's $Q$ increase from a value below 1.2 to values around 1.7 in 2007.

FIGURE 2.2: Labor income share against Tobin's $Q$




*Notes:* Own calculation based on a sample of 41 countries and 911 observations. Variables are demeaned to control for fixed-effects. Correlation coefficient= $-0.28$.

Figure 2.2 is more illustrative. It shows a negative correlation between the labor income share and the Tobin's $Q$ when we control for country fixed effects. It is therefore the figure that better anticipates the answer to our research question.

For our empirical analysis, we rely on recently developed panel time-series techniques that account for macroeconomics data characteristics. In particular, we present different Mean Group-style estimators which rely on a common factor model approach. Importantly, with this empirical approach we can deal with unobservable heterogeneity while we also control for the panel-time-series characteristics of macro data (i.e., cross-section dependence and nonstationarity) in a tractable way. [6] This is particularly important given the nature of our data. The existence of multiple potential unobservable factors and potential cross-section dependence makes this method particularly appropriate for us. Furthermore, country-specific impact of our variables of interest can be obtained. We opt to further control for the relative price of investment goods to compare our mechanism with that of Karabarbounis and Neiman (2014).[7]

Our results show a robust and significant negative impact of Tobin's $Q$ on the labor income share. Our preferred estimate indicates that Tobin's $Q$ can explain up to 57% of its decline since 1980. However, we do not find any significant impact of the relative price of investment goods. Like Chirinko and Mallick (2014a), our results suggest that the decline of the labor income share cannot be explained by the secular decline of the relative price of investment goods.

Since Tobin's $Q$ impacts the labor share through an endogenous decline of the capital-output ratio, our results reconcile the secular decline in the labour income share with standard values of the elasticity of substitution. This is starkly in contrast with the explanations given by Piketty and Zucman (2014a) and Karabarbounis and Neiman (2014). We consequently conclude that deep causes for the secular decline of the labor share have to be found not in the mere accumulation of physical capital or in capital biased-technological changes, but in the way financial markets and corporations relate. In particular, the deep causes for factorial inequality should be found in policies or institutional changes that have increased financial wealth at the expense of real investment.

The remaining of the paper is structured as follows. Section 2.2 develops the theoretical framework relating the Tobin's $Q$ with the labor income share. Section 2.3 introduces and explains the data used in our empirical analysis. Section 2.4 and 2.5 present, respectively, the econometric methodology and the results. Section **??** summarises and concludes.

[6] For a detailed review of these recent estimators, see Eberhardt and Teal (2011b); **?**

[7] Changes in the relative price of investment goods impacts the capital-output ratio but they do not change the Tobin's $Q$ because Tobin's $Q$ adjusts accordingly. This can be seen in Gonzalez (2016b)

## 2.2 Theoretical framework

This section presents a model that connects the labor share with financial wealth, physical capital stock and the Tobin's $Q$. We consider a representative agent economy where households accumulate financial wealth and receive direct utility from the ownership of wealth. The firm accumulates physical capital and distribute dividends to households.

### 2.2.1 Households

There is a representative household whose maximisation problem is the following (in recursive form):

$$\begin{aligned} V(s) &= \max_{c,s'} \frac{c^{1-\mu}}{1-\mu} + \frac{\gamma(p_{-1}s)^{1-\theta}}{1-\theta} + \beta V(s') \qquad (2.1) \\ s.t. \qquad & c + ps' = w + (Qd + p)s, \end{aligned}$$

where, $c$ represents consumption, $w$ is the average wage, $d$ is the amount of dividends distributed in the current period, $p$ is the price of stocks and $s$ represents the amount of stocks owned today. The term $p_{-1}s$ is simply a measure of wealth, where $p_{-1}$ is given for the household and $s$ is a state variable which was decided yesterday. $Q$ represents the fraction of dividend income received by the households. At every given period there is one equity share outstanding. Hence, market clearing in the market for shares requires $s = 1$ for any period.

The first term of the utility function is the standard Constant Relative Risk Aversion (CRRA) formulation of consumption utility. The second term, proposed by Carroll (1998) and used by Reiter (2004) and Piketty (2011), says that investors derive utility from the ownership of wealth ($p_{-1}s$) and not merely from consumption. A similar specification of wealth in the utility function has been recently used in Kumhof et al. (2015). The inclusion of wealth in the utility function is an essential aspect of the model because, as it is shown later, it allows to obtain an increasing demand for assets, which turns out to be crucial for the comparative statics of the model.

In a frictionless economy, households receive the total amount of dividends distributed by the firm and $Q$ equals one. In our case, we assume that there is a constant fraction of the dividend income $1 - Q$ which does not go to households.

An obvious example of this type of friction is a capital income tax which detracts from households a constant fraction of dividends. However, other frictions, like financial transaction costs, can be thought similarly. In this context, the return on equity is given by $1 + r = \frac{Qd+p}{p_{-1}}$.

We show later that $Q$ is exactly the equity Tobin's $Q$. This is the simplest way to have a Tobin's $Q$ different from one and, for this reason, we opt for it. In this simple case, Tobin's Q is constant along the whole domain of equity returns.[8]

We can simplify the problem of the household by using a change of variable. Let $a'$ denote the value of assets acquired by the representative household at the current period. The problem becomes:

$$V(a) = \max_{a'} \frac{[(1+r)(a) - w - a']^{1-\mu}}{1-\mu} + \frac{\gamma a^{1-\theta}}{1-\theta} + \beta V(a'), \tag{2.2}$$

where $a' = ps'$ and $1 + r = \frac{Qd+p}{p_{-1}}$.

The intertemporal first order condition with respect to $a'$ gives the Euler equation:

$$c^{-\mu} = \beta[(1+r')c'^{(-\mu)} + \gamma a'^{(-\theta)}], \tag{2.3}$$

and its corresponding steady state formulation:

$$1 = \beta[(1+r) + \frac{\gamma a^{-\theta}}{c^{-\mu}}] \tag{2.4}$$

Note that at the steady state, consumption equals the flow of total interests plus total wage, $c = ra + w$. Given this Euler equation, we can express the steady state demand of financial wealth like:[9]

$$a = \left[\frac{r^{-\mu} - \beta r^{-\mu} - \beta r^{1-\mu}}{\beta\gamma}\right]^{\frac{1}{-\theta+\mu}} \tag{2.5}$$

[8]There are other modelling strategies to achieve a Tobin's $Q$ different from one, which rationalise other frictions. Gonzalez (2016b) shows that stock market costs and different stochastic discount factors between managers and shareholders can also give rise to an equity Tobin's $Q$ different from one. Gonzalez (2016a) shows that similar effects can be obtained assuming imperfect competition. The impact on equilibrium capital-output ratio, however, is similar in the sense that when Tobin's $Q$ raises the capital-output ratio always declines.

[9]For simplicity we do not include $w$ in the steady state equation. This simplification would be equivalent to a model where, in addition to the problem of the shareholder, there is a representative worker with perfect inelastic supply where wages are simply determined by the marginal productivity of labor.

**Proposition 2.1.** *The steady state demand of financial wealth is an increasing function of the return* $r$ *for* $0 < r < (\frac{1}{\beta} - 1)$ *if* $\mu \geq 0$ *and* $\theta > \mu$.

*Proof.* The derivative of $a$ with respect to $r$ is:

$$\frac{\partial a}{\partial r} = \underbrace{\left[\frac{r^{-\mu} - \beta r^{-\mu} - \beta r^{1-\mu}}{\beta\gamma}\right]^{\frac{1}{-\theta+\mu}-1}}_{\text{Term A}} \underbrace{\left[\frac{-\mu r^{-\mu-1} + \beta\mu r^{-\mu-1} - \beta(1-\mu) r^{-\mu}}{\beta\gamma}\right]}_{\text{Term B}} \underbrace{\frac{1}{-\theta+\mu}}_{\text{Term C}}$$

For $\beta\gamma > 0$, term A is positive if $0 < r < (\frac{1}{\beta} - 1)$. Term B is negative for any value of $r$ between 0 and $\frac{1}{\beta} - 1$ if $\mu \geq 0$. Accordingly, to have $\frac{\partial a}{\partial r} > 0$ along this range of returns, term C has to be negative and, therefore, $\theta > \mu$ must be satisfied. □

Summing up, when $r$ is below $\frac{1}{\beta} - 1$, the steady state demand of financial assets is monotonically increasing with respect to capital return if $\mu \geq 0$ and $\theta > \mu$. Interestingly, an increasing steady state demand of financial assets shows that using wealth in the utility function within the representative agent framework can be interpreted, for a range of realistic parameter values, as a reduced form for precautionary savings. Indeed, in the standard incomplete markets model, which is often used to model precautionary behaviour, the aggregate demand of assets is increasing and $r < \frac{1}{\beta} - 1$ is satisfied in equilibrium.[10] Although accumulating wealth for precautionary behaviour is a plausible interpretation for the shape of $a(r)$, other interpretations are also possible. For example, people might also derive direct utility from wealth accumulation due to the social status conferred by wealth (Piketty, 2011). Or people might accumulate wealth for dynastic altruism, that is, to leave a bequest to their descendants. Whatever the interpretation, by using wealth in the utility function, we get an increasing demand for financial assets, which, as shown below, is crucial for the results of the paper. This is in contrast with the standard model where only consumption is included in the utility function and that, according to Carroll (1998), is unable to explain households' saving behaviour. In that case, wealth disappears from the Euler equation and the steady state demand of assets becomes perfect elastic at $\frac{1}{\beta} - 1$. Finally, note that according to our specification, marginal utility is decreasing both in consumption and in wealth, but the restriction $\theta > \mu$ means that it diminishes less rapidly in consumption.

[10] Although concavity is not required for the desired result, it turns out that it is also satisfied, as Figure 2.3 shows.

From now onwards, the steady state demand of financial assets will be expressed as $a(r)$, where:

$$a(r) = \Big[\frac{r^{-\mu}(1-\beta) - \beta r^{1-\mu}}{\beta\gamma}\Big]^{\frac{1}{-\theta+\mu}}, \tag{2.6}$$

and:

$$\frac{\partial a(r)}{\partial r} > 0; \quad \forall r < \frac{1}{\beta} - 1 \quad \text{if} \quad \theta > \mu \quad \text{and} \quad \mu \geq 0.$$

## 2.2.2 The Firm

The representative firm accumulates physical capital $K$, pays the wage bill $w$ and uses a CES technology to produce output $Y$:

$$Y = \Big[\phi K^{(\frac{\sigma-1}{\sigma})} + (1-\phi)L^{(\frac{\sigma-1}{\sigma})}\Big]^{\frac{\sigma}{\sigma-1}}, \tag{2.7}$$

where $\phi$ is a distributional parameter and $\sigma$ is the elasticity of substitution between labour and capital. The labor share of income $LIS$ can be expressed in terms of the current period capital-output ratio ($\frac{K}{Y}$):

$$LIS = 1 - \phi\Big(\frac{K}{Y}\Big)^{\frac{\sigma-1}{\sigma}}, \tag{2.8}$$

where the sign of $\frac{\partial LIS}{\partial \frac{K}{Y}}$ depends on whether $\sigma$ is higher or lower than one. In recursive formulation, the problem of the firm is:

$$\begin{aligned} V(K) &= \max \quad d + m'V(K') \\ s.t. \quad & d = F(K,L) - (K' - (1-\delta)K) - w, \end{aligned} \tag{2.9}$$

where $\delta$ accounts for the depreciation rate of capital. The firm's discount factor is:

$$m' = \frac{\beta u_{c'}}{u_c - \beta v_{a'}} = \frac{1}{1+r'}, \tag{2.10}$$

which makes the problem of the firm consistent with the problem of the households.

Given that, the firm solves:

$$V(K) = \max F(K,L) - (K' - (1-\delta)K)) - w + \frac{1}{1+r'}V(K'), \tag{2.11}$$

.

The FOC with respect to $K'$ is

$$F_{K'}(K', L') = \delta + r', \tag{2.12}$$

from where we obtain a standard demand for capital $K'(r)$, which is decreasing in the level of capital returns. Using the transversality condition, the constant-returns-to-scale assumption (which is satisfied under a CES technology) and abandoning the recursive formulation, we can express total capital stock as a function of future dividends.

$$K_{t+1} = \sum_{j=0}^{\infty} \frac{d_{t+1+j}}{\Pi_{h=1}^{j-1}(1 + r_{t+h})}, \tag{2.13}$$

.

From the definition of equity returns, $\frac{Qd'+p'}{p} = 1 + r'$, the stock price ($p$) can be expressed, using forward substitution, as a function of the future stream of received dividends:

$$p_t = \sum_{j=0}^{\infty} \frac{Qd_{t+1+j}}{\Pi_{h=1}^{j-1}(1 + r_{t+h})} \tag{2.14}$$

Tobin's $Q$ is the ratio of the stock market value to the replacement cost of capital. Using the expressions above, Tobin's $Q$ results in:

$$Q_t = \frac{p_t}{K_{t+1}}, \quad \forall t \tag{2.15}$$

Note that under this specification, Tobin's $Q$ is constant along the whole domain of equity returns. Since the demand of capital has been obtained from the problem of the firm, the value of financial assets is:

$$p(r) = QK'(r)$$

### 2.2.3 Equilibrium

Equilibrium in the capital market would occur at the intersection between $p(r)$ and $a(r)$. Since $a(r)$ is monotonically increasing and $p(r)$ is monotonically decreasing, there is a unique equilibrium characterised by the return to equity ($r^*$) given by:

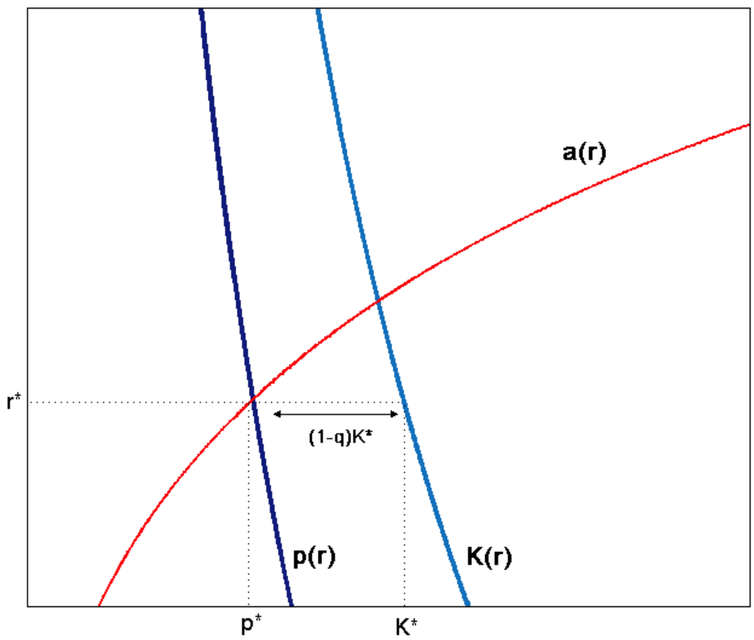
$$p(r^*) = a(r^*) \tag{2.16}$$

Note that since the capital demand is monotonically decreasing with respect to the return, there is a single level of capital corresponding to $r^*$. We denote this level $K^*(r^*)$. Importantly, the equilibrium $p(r^*) = a(r^*)$ depends on $Q$. If $Q$ is larger, then the equilibrium equity return would be higher because investors would demand a higher return to hold the additional financial wealth. Therefore, the equilibrium level of $r$ depends positively on $Q$.

When $Q$ changes, there is a change in equilibrium $r^*$, but also a change in the amount of physical capital demanded by the firm. Figure 2.3 is illustrative at this point. When $Q$ grows, the gap between $p(r)$ and $K(r)$ becomes smaller and $r^*$ raises because the equilibrium is moving upwards along $a(r)$. In response to it, the firm will tend to decrease the amount of physical capital to raise the return on equity, which from equation (2.12) is directly linked to the marginal productivity of capital. Therefore, we can express the equilibrium level of capital $K^*$ in terms of $r^*$, and subsequently, in terms of $Q$:

$$K^*(r^*(Q)) = K^*(Q) \tag{2.17}$$

FIGURE 2.3: Market for capital




*Notes:* The curves $a(r)$, $p(r)$ and $K(r)$ are built using standard parameter values: $\mu = 2$, $\theta = 3$, $\sigma = 0.9$. Tobin's $Q$ is assumed to be constant, like in the model, and equal to 0.6.

**Proposition 2.2.** *The relation between Tobin's $Q$ and equilibrium capital $K^*$ is negative.*

*Proof.* Since $p(r) = QK(r)$, the equilibrium condition $p(r) = a(r)$ can be expressed as $G(K,Q) = 0$ where $G(K,Q) = \frac{a(r(K))}{K} - Q$. Applying the implicit function theorem, we have that $\frac{dK(Q)}{dQ} = -\frac{\frac{\partial G}{\partial Q}(K^*,Q)}{\frac{\partial G}{\partial K}(K^*,Q)} = \frac{-(-1)}{\frac{\partial a}{\partial r}\frac{\partial r}{\partial K}K^{*-1} - a(r(K^*))K^{*-2}}$. Since $\frac{\partial a}{\partial r}$ is positive and $\frac{\partial r}{\partial K}$ is negative, $\frac{dK(Q)}{dQ}$ has to be negative. □

The equilibrium of the model makes explicit the relation between the capital level of equilibrium and the Tobin's $Q$. Since the labor share depends on the capital-output ratio (see equation (2.8)), we can make explicit the relation between the equilibrium labor share and Tobin's $Q$:

$$LIS^* = 1 - \phi\Big[\frac{K^*(Q)}{Y^*(K^*(Q))}\Big]^{\frac{\sigma-1}{\sigma}}, \quad \text{and} \quad \frac{\partial LIS}{\partial Q} = \frac{\partial LIS}{\partial \frac{K}{Y}}\frac{\partial \frac{K}{Y}}{\partial K}\frac{dK(Q)}{dQ}, \tag{2.18}$$

where:

$$\begin{aligned} \frac{\partial LIS}{\partial \frac{K}{Y}} &> 0 \quad \text{if} \quad \sigma < 1; \\ \frac{\partial \frac{K}{Y}}{\partial K} &> 0 \quad \text{due to CRS;} \\ \text{and} \quad \frac{dK(Q)}{dQ} &< 0 \quad \text{given by proposition 2.2.} \end{aligned}$$

Importantly, the mechanism proposed here works through the capital-output ratio, that is, Tobin's $Q$ impacts the labor share through its effect on investment and capital. In that sense, as remarked before, our model is in the spirit of Karabarbounis and Neiman (2014). In particular, Karabarbounis and Neiman (2014) build a model to explain the decline of the labor income share with recent movements in the relative price of investment goods. Their mechanism can be easily embedded into our model by adding the relative prices of capital goods ($rp_t$) in the budget constraint of the firm, like in Greenwood et al. (1997).

$$F(K,L) = d + rp[K' - (1-\delta)K] + w, \tag{2.19}$$

where the demand of capital is dependent on $rp$, and more specifically, it raises when the relative price of capital goods falls, that is, $\frac{\partial K'(r)}{\partial rp} < 0$. We empirically evaluate the potential impact of this mechanism compared to ours.

## 2.3 Data

In order to empirically study the relationship between the Tobin's $Q$ and the labor income share, this paper combines three different databases.

### 2.3.1 Tobin's $Q$

Tobin's $Q$ is the market value of capital over its replacement cost. We use data from Worldscope Database to calculate the Tobin's $Q$ as the market value of the sum of equity and non-equity liabilities over the sum of their book value, which is generally acknowledged as the most accurate available procedure, given the difficulty to obtain data of the replacement cost of capital. Chung and Pruitt (1994) find that a simple market-to-book ratio explains at least 96.6 per cent of the variability of Tobin's $Q$ -calculated as the market value of capital over its replacement cost.

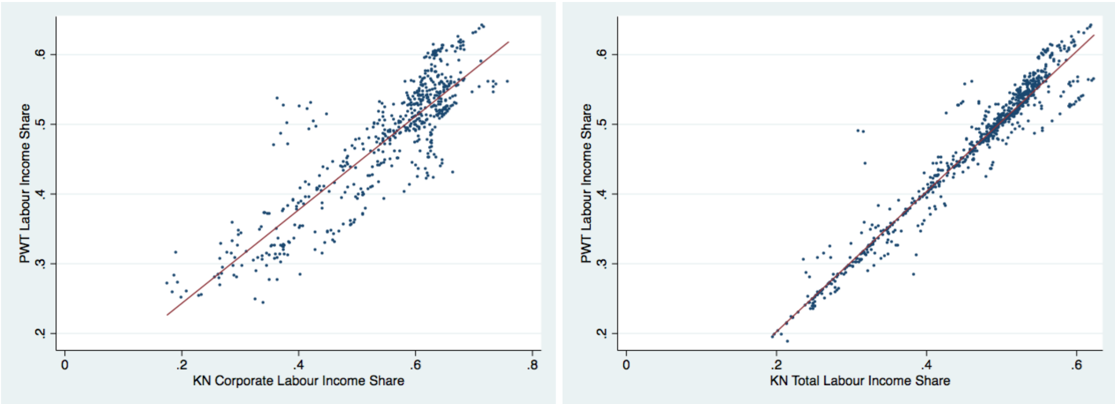
We aggregate firm level data from publicly traded companies following Doidge et al. (2013) methodology. That is, in a first stage firms are clustered in 17 different sectors using the Fama-French 17 industries classification, where a median $Q$ is computed for each industry. Countries' $Q$ are calculated as the market value weighted average of the median industries' $Q$. The use of industry medians let us overcome the problem of potential outliers in the sample.

### 2.3.2 Labor income share

Regarding the $LIS$, Karabarbounis and Neiman (2014) have developed a database of the corporate labor income share for a considerable number of countries obtaining the data from several sources. However, the use of their database would force us to exclude a non-negligible number of countries in our analysis. As an alternative, we lean to use the $LIS$ variable from the Extended Penn World Table 4.0 (EPWT 4.0).

The EPWT 4.0 draws information from different United Nations sources and measures the labor income share as the share of total employee compensation in the Gross Domestic Product with no adjustment for mixed rents, and without distinguishing the corporate sector. Although we are aware of the potential drawbacks from using this $LIS$ definition, the correlation with the corporate labor share and the total labor share used by Karabarbounis and Neiman (2014) is 0.87 and 0.96 respectively (Figure 2.4). We consider this a safe level in order to use our variable.

FIGURE 2.4: EPWT LIS vs KN LIS




(a) EPWT vs Corporate Labour Share

(b) EPWT vs Total Labour Share

### 2.3.3 Relative prices

The relative price of investment goods with respect to consumption goods is obtained by extending Karabarbounis and Neiman (2014) database.

In order to obtain the relative price in domestic terms, we divide the country-specific relative price obtained from the Penn World Table 7.1 ($\frac{Pi_i}{Pc_i}$), which is calculated using ppp exchange rates, over the relative price of investment in the United States ($\frac{Pi_{US}}{Pc_{US}}$). We then multiply this ratio by the ratio of the investment price deflator to the personal consumption expenditure deflator for the United States ($\frac{ID_{US}}{PCD_{US}}$) obtained from BEA.

$$RP = \frac{\frac{Pi_i}{Pc_i}}{\frac{Pi_{US}}{Pc_{US}}} * \frac{ID_{US}}{PCD_{US}}$$

## 2.4 Empirical methodology

Beyond the theoretical relationships, we face the challenge of carrying out a robust estimation of the relationship between Tobin's $Q$ and the labor share. This section explains in detail (i) how we go from the theoretical model to an empirical equation, and (ii) the empirical tools which allow us to infer a causal relationship.

### 2.4.1 Empirical implementation

For empirical purposes, we do not impose a specific production function and, therefore, we do not restrict the functional form of the labor share to be the one derived from a CES technology. We simply assume a general multiplicative form where changes in the capital-output ratio have an impact on the labor share:

$$LIS = g\Big(\frac{K}{Y}\Big) = a\Big(\frac{K}{Y}\Big)^{\alpha} \tag{2.20}$$

This way, our empirical specification is similar to Bentolila and Saint-Paul (2003). Note that we remain agnostic about $\alpha$ and then we do not know ex-ante whether the impact of $\frac{K}{Y}$ on the labor share is positive or negative.

Nevertheless, contrary to Bentolila and Saint-Paul (2003), we further endogenise the capital-output ratio. Our model shows that the equilibrium capital-output ratio depends, among other things, on the Tobin's $Q$, and that the sign of this relation is negative. However, and again for empirical purposes, we do not impose a particular relation derived from the specifics of the model. Rather, we also assume a general multiplicative form where the capital-output ratio is expressed as a function of Tobin's $Q$. Following Karabarbounis and Neiman (2014), we also include the relative price of investment goods ($RP$) as an argument of $\frac{K}{Y}$.

$$\frac{K}{Y} = f(Q, RP) = Q^{\psi_1} RP^{\psi_2} \tag{2.21}$$

We use these two forms to obtain an estimable equation of the labor share in terms of $Q$ and $RP$:

$$LIS = g\Big(\frac{K}{Y}\Big) = g(f(Q, RP)) = a(Q^{\psi_1} RP^{\psi_2})^{\alpha} \tag{2.22}$$

Taking natural logarithms:

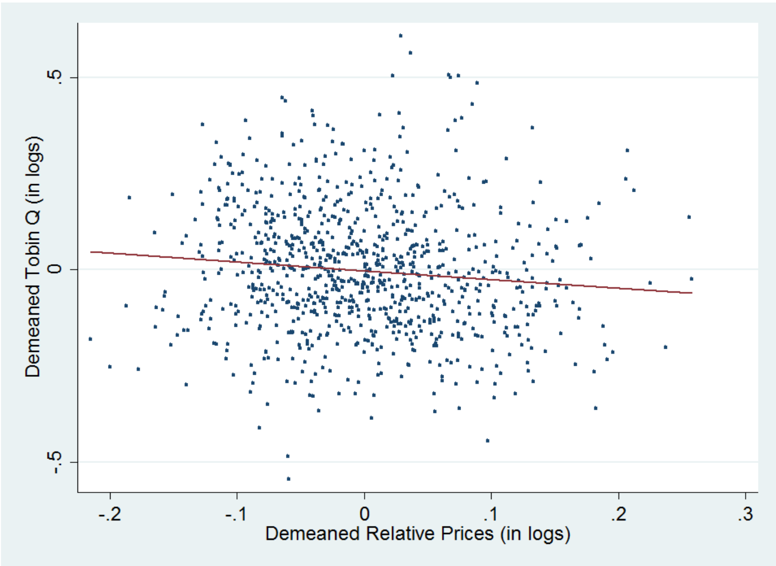
$$\log(LIS) = \log(a) + \alpha\psi_1 \log(Q) + \alpha\psi_2 \log(RP) + \mu_{it}, \tag{2.23}$$

or simplifying:

$$lis_{it} = \beta_0 + \beta_1 q_{it} + \beta_2 rp_{it} + \mu_{it} \tag{2.24}$$

Where $lis$, $q$, and $rp$ are the natural logarithm values of our variables of interest, and $\mu$ is a standard error term. Note that according to proposition 2.2 and expression (2.18) we expect $\beta_1$ to be negative. The sign of $\beta_2$ is expected to be negative if, as we assume in the model, $\sigma$ is lower than one and capital and labour and complements. In that case, an increase in the relative price of capital goods depresses investment and this impacts negatively on the labor share. However, if we follow Karabarbounis and Neiman (2014), we should expect $\beta_2$ to be positive because declines in the price of capital induce firms to shift away from labour and toward capital, driving the labour share down.

FIGURE 2.5: Tobin's $Q$ against relative prices




*Notes:* Own calculation based on a sample of 41 countries and 911 observations. Variables are demeaned to control for fixed-effects. Correlation coefficient= $-0.09$.

We are not concerned about multicollinearity. The figure above shows that the correlation between Tobin's Q and the relative prices of investment is very low, illustrating that the two mechanisms are very different.

### 2.4.2 Econometric methodology

Characterized by a small number of cross-sectional units (N) compared to the time dimension (T), macroeconomics panel data have been traditionally estimated following microeconomics panel data techniques under the assumptions of parameter homogeneity (across countries), common impact of unobservable factors, cross-section independence, and data stationarity.[11] However, if these assumptions are

[11]See Roodman (2009) for a detailed explanation on the potential risks of the popular Difference and System GMM estimators.

violated, results would be subject to misspecification problems. In order to overcome these potential sources of misspecification, we rely on recently developed panel data techniques (panel time-series), which have been especially developed for macroeconomics data characteristics (Pesaran, 2015).[12]

Our empirical framework is based on a common factor model (for details, see Eberhardt and Teal, 2011a, 2013a,b). Formally, assuming for simplicity an one-input model, a common factor model is as follows:

$$y_{it} = \beta_i x_{it} + u_{it}, \qquad u_{it} = \varphi_i f_t + \psi_i + \varepsilon_{it}, \tag{2.25}$$

$$x_{it} = \delta_i f_t + \gamma_i g_t + \pi_i + e_{it}, \tag{2.26}$$

$$f_t = \tau + \phi f_{t-1} + \omega_t, \qquad g_t = \mu + \kappa g_{t-1} + \nu_t, \tag{2.27}$$

where $y_{it}$ and $x_{it}$ represent, respectively, the dependent and independent variables, $\beta_i$ represents the country-specific impact of the regressor on the dependent variable, and $u_{it}$, apart from the error term ($\varepsilon_{it}$), contains unobservable factors. In particular, unobservable time-invariant heterogeneity is captured through a country fixed effect ($\psi_i$), while time-variant heterogeneity is accounted through a common factor ($f_t$) with country-specific factor loadings ($\varphi_i$). At the same time, the model allows the regressor to be affected by $f_t$ or other common factors $g_t$, which represent i) unobservable global shocks (e.g., oil prices or financial crisis) that affect all the countries -although with different intensities- and ii) local spillovers (Chudik et al., 2011; Eberhardt et al., 2013). The presence of the same unobservable factor ($f_t$) as a determinant of both the independent and the dependent variable raise endogeneity problems which complicate the estimation of $\beta_i$ (Kapetanios et al., 2011).[13]

We can see the previous common factor model as a general empirical framework which encompasses several simpler structures. In particular, we can classify the models between "Homogeneous models", where the impact of the regressors on the dependent variable is common across countries (i.e., $\beta_i = \beta$), and "Heterogeneous models", which leave the coefficients unconstrained (i.e., $\beta_i$ is estimated for each

[12] Although empirical applications of these methods are still not widespread in the literature, it is worthy to acknowledge the valuable contribution made to the field by Markus Eberhardt and coauthors in the last years. The empirical methodology of this Chapter relies on several of their papers.

[13] Equation (2.27) models these factors as a simple AR(1), where no constrains are imposed to get stationary processes. Note that nonstationarity could provoke a spurious relationship between our variables of interest. If our variables are nonstationary, we have to analyse the cointegration relationship among them to infer any causal relationship.

country). In the latter case, the estimator is defined as the simple average of the country-specific estimators (i.e., $\beta^* = N^{-1} \sum_{i=1}^{N} \beta_i$).

Within each group, the assumptions about the structure of the unobservable factors leads to different estimation methods. For the case of homogeneous estimators, we consider the common Pooled Ordinary Least Square (POLS), the Two-way Fixed Effects (2FE), and the Pooled Common Correlated Effects (CCEP) estimators. While the first two are standard in the literature and account for unobservable heterogeneity through time and country dummies, the CCEP estimator has a more flexible structure, which allows for a different impact of the unobserved factors across countries and time.[14] Empirically, it eliminates the cross-sectional dependence by augmenting equation (2.24) with the cross-section averages of the variables.[15]

With regard to heterogeneous models, we consider different Mean Group estimators. In particular, we present the results for the Pesaran and Smith (1995) Mean Group estimator (MG), the Pesaran (2006) Common Correlated Effects Mean Group estimator (CMG), and the Chudik and Pesaran (2015) Dynamic CMG estimator (CMG2).

Pesaran and Smith (1995) Mean Group estimator (MG) allows for a country-specific impact of both the regressor and the unobservable heterogeneity. The impact of the last one is assumed to be constant, and is empirically accounted by adding country-specific linear trends ($t$). Therefore, the estimable equation takes the form:

$$lis_{it} = \beta_{0i}^{MG} + \beta_{1i}^{MG} q_{it} + \beta_{2i}^{MG} rp_{it} + \beta_{3i}^{MG} t + \Omega_{it} \tag{2.28}$$

where $\beta_j^{MG} = N^{-1} \sum_{i=1}^{N} \beta_{ij}^{MG}$. As explained before, the MG estimator is computed as the simple average of the different country-specific coefficients, which are calculated by regressing the previous equation for each country. However, although it overcomes the potential misspecification from assuming parameter homogeneity, the introduction of country-specific linear trends could be too simple to rule out all the possible cross-section dependence from the unobserved heterogeneity.

In this sense, Pesaran (2006) proposes the Common Correlated Effects Mean Group estimator (CMG), which is a combination of the MG and the CCEP estimators. In particular, it approximates the unobserved factors by adding the

[14] POLS and 2FE estimators assume that the time-varying heterogeneity has the same impact across countries for a given year.

[15] Eberhardt et al. (2013) provide the intuition behind this mechanism.

cross-section averages of the dependent and explanatory variables, and then running standard panel regressions augmented with these cross-section averages. In this case, the estimable equation is:

$$lis_{it} = \beta_{0i}^{CMG} + \beta_{1i}^{CMG} q_{it} + \beta_{2i}^{CMG} rp_{it} \tag{2.29}$$
$$+ \beta_{3i}^{CMG} \overline{lis_t} + \beta_{4i}^{CMG} \overline{q_t} + \beta_{5i}^{CMG} \overline{rp_t} + \Omega_{it} \tag{2.30}$$

where $\beta_j^{CMG} = N^{-1} \sum_{i=1}^{N} \beta_{ji}^{CMG}$. It is easy to see that the first line is the Pesaran and Smith (1995) MG estimator (without linear trend), and the second line is the way the Pesaran (2006) CMG estimator approximates the unobservable processes.

So far, we have discussed how to deal with different sources of misspecification like the assumption of parameter homogeneity or the existence of cross-section dependence. This paper also analyses potential misspecification arising from a possible dynamic structure of the relation under study by estimating both static and dynamic specifications. Although Pesaran (2006) CMG estimator yields consistent estimates under a variety of situations (see Kapetanios et al., 2011; Chudik et al., 2011), it does not cover the case of dynamic panels or weakly exogenous regressors. Chudik and Pesaran (2015) propose an extension of the CMG approach (CMG2) to account for the potential problems arising from dynamic panels. In particular, they prove that the inclusion of extra lags of the cross-section averages in the CMG approach gives a consistent estimator of both $\beta_i$ and $\beta^{CMG}$. Empirically, we proceed by using an Error Correction Model of the following form:

$$\begin{aligned}\Delta lis_{it} = {} & \beta_0^{CMG2} + \beta_1^{CMG2} lis_{i,t-1} + \beta_2^{CMG2} q_{i,t-1} + \beta_3^{CMG2} rp_{i,t-1} + \beta_4^{CMG2} \Delta q_{it} + \beta_5^{CMG2} \Delta rp_{it} \\ & + \beta_6^{CMG2} \overline{\Delta lis_t} + \beta_7^{CMG2} \overline{lis_{t-1}} + \beta_8^{CMG2} \overline{q_{t-1}} + \beta_9^{CMG2} \overline{rp_{t-1}} + \beta_{10}^{CMG2} \overline{\Delta q_t} + \beta_{11}^{CMG2} \overline{\Delta rp_t} \\ & + \sum_{l=1}^{p} \beta_{12}^{CMG2} \overline{\Delta lis_{t-p}} + \sum_{l=1}^{p} \beta_{13}^{CMG2} \overline{\Delta q_{t-p}} + \sum_{l=1}^{p} \beta_{14}^{CMG2} \overline{\Delta rp_{t-p}} + \Omega_{it},\end{aligned}$$

where the first line represents the Pesaran and Smith (1995) MG estimator, the inclusion of the second gives the Pesaran (2006) CMG estimator, and the three lines together are the Chudik and Pesaran (2015) Dynamic CMG estimator (CMG2).[16]

Likewise, given the way they control for unobservables, CMG style estimators are suitable for accounting for structural breaks and business cycle distortions, making the use of yearly data perfectly valid in order to infer long run relationships.

[16] Chudik and Pesaran (2015) recommend to set the number of lags equal to $T^{1/3}$. We consider up to 2 extra lags of the cross-section averages.

## 2.5 Results

In order to give a systematic view of our results, this section is divided in four subsections. Subsection 2.5.1 presents an exhaustive analysis of the time-series properties of our variables of interest. Subsection 2.5.2 shows the results for a baseline model, where just Tobin's $Q$ is considered as a regressor. Subsection 2.5.3 further includes the relative price of investment in the analysis, and Subsection 2.5.4 provides evidence supporting the interpretation of our results as a causal relationship.

### 2.5.1 Time-series properties

The order of integration and potential cross-section dependence in the data play a central role in panel time series. In order to deal with potential problems, Tables 2.1 and 2.2 analyse, respectively, the order of integration and the cross-section dependence of the variables used in our analysis.

Regarding the order of integration, Table (2.1) presents the results for two specifications of the Pesaran (2007) cross-sectional augmented panel unit root (CIPS) test. In particular, panel 2.1.a) shows the results when a constant is included in the Augmented Dickey-Fuller (ADF) regressions, while 2.1.b) also includes a deterministic trend.

TABLE 2.1: Unit root tests

| a) Pesaran (2007) CIPS test: Constant | | | | | | |
|---|---|---|---|---|---|---|
| Lags | $lis$ | $(p-value)$ | $q$ | $(p-value)$ | $rp$ | $(p-value)$ |
| 0 | 0.431 | 0.667 | -2.744 | 0.003 | -0.118 | 0.453 |
| 1 | -0.207 | 0.418 | -2.405 | 0.008 | -0.141 | 0.444 |
| 2 | -1.199 | 0.115 | 0.103 | 0.541 | 0.655 | 0.744 |
| 3 | 1.802 | 0.964 | 2.942 | 0.998 | 2.254 | 0.988 |
| 4 | 5.477 | 1.000 | 6.091 | 1.000 | 7.211 | 1.000 |
| **b) Pesaran (2007) CIPS test: Constant and deterministic trend** | | | | | | |
| Lags | $lis$ | $(p-value)$ | $q$ | $(p-value)$ | $rp$ | $(p-value)$ |
| 0 | 1.044 | 0.852 | -2.068 | 0.019 | 2.483 | 0.993 |
| 1 | 0.390 | 0.652 | -1.628 | 0.052 | 2.052 | 0.980 |
| 2 | -0.033 | 0.487 | 1.304 | 0.904 | 0.998 | 0.841 |
| 3 | 5.280 | 1.000 | 6.785 | 1.000 | 6.006 | 1.000 |
| 4 | 8.090 | 1.000 | 8.949 | 1.000 | 9.127 | 1.000 |

*Notes*: Pesaran (2007) CIPS test values are obtained from the standardised Z-tbar statistic. $H_0$ = nonstationarity. Lags indicates the number of lags included in the ADF regression.

Pesaran (2007) CIPS test belongs to a $2^{nd}$ generation of panel unit root tests, which are characterized by allowing potential cross-section dependence of the variables. CIPS test proposes a standardized average of individual ADF coefficients, where the ADF processes have been augmented by the cross-sectional averages to control for the unobservable component.

Table (2.1) presents the Pesaran (2007) CIPS test values along with their corresponding $p-value$ for our three variable of interest. "Lags" indicates the lag augmentation in the Dickey-Fuller regression. Given that the null of nonstationarity is only rejected in 4 out of 30 cases, we can safely assert that the variables under analysis are nonstationary.

Table 2.2: Cross-section dependence tests

| a) Levels: | | | | b) Diff: | | | |
|---|---|---|---|---|---|---|---|
| Variable | $lis$ | $q$ | $rp$ | Variable | $\Delta lis$ | $\Delta q$ | $\Delta rp$ |
| CD-test | 16.73 | 29.76 | 42.37 | CD-test | 12.99 | 34.45 | 6.66 |
| $p$-value | 0.00 | 0.00 | 0.00 | $p$-value | 0.00 | 0.00 | 0.00 |
| corr | 0.132 | 0.250 | 0.345 | corr | 0.11 | 0.296 | 0.049 |
| abs(corr) | 0.472 | 0.394 | 0.558 | abs(corr) | 0.235 | 0.349 | 0.223 |
| **c) Het. AR(2)** | | | | **d) Het. AR(2) CCE** | | | |
| Variable | $lis$ | $q$ | $rp$ | Variable | $lis$ | $q$ | $rp$ |
| CD-test | 9.93 | 33.58 | 3.40 | CD-test | -0.24 | -0.66 | -2.38 |
| $p$-value | 0.00 | 0.00 | 0.00 | $p$-value | 0.81 | 0.51 | 0.02 |
| corr | 0.088 | 0.301 | 0.027 | corr | -0.006 | -0.011 | -0.023 |
| abs(corr) | 0.243 | 0.344 | 0.213 | abs(corr) | 0.220 | 0.237 | 0.213 |

*Notes*: CD-test shows the Pesaran (2004) cross-section dependence statistic, which follows a $N(0,1)$ distribution. $H_0$ = cross-section independence. corr, and abs(corr) report, respectively, the average and average absolute correlation coefficients across the $N(N-1)$ set of correlations.

Table 2.2 shows the Pesaran (2004) CD test for cross-section dependence in panel time-series data. This test uses correlation coefficients between the time-series for each panel member and has proved to be robust to nonstationarity, parameter heterogeneity and structural breaks even in small samples.[17] Table 2.2 is divided in four different panels representing different transformations of the variables. Panels a) and b) show the CD test for the levels and growth rates of our variables. The null hypothesis of cross-section independence is rejected in all the cases. Panels c) and d) present the results when the test is applied to the residuals of an autoregressive regression of order 2 (AR(2)) of each variable. The difference between the two is that, while regressions in panel c) are estimated by the Pesaran and Smith (1995) Mean Group estimator, Panel d) shows the results when the AR process is augmented with cross-section averages in the spirit of Pesaran's (2006) CMG estimator. The difference between both shows the power of the cross-section averages to control for unobservable cross-section dependence.

The presence of nonstationary variables and cross-section dependence in our data make the use of traditional panel data techniques invalid. To be sure that our

[17] The test is computed as:

$$CD = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \sqrt{T_{ij}}\rho_{ij},$$

where $\rho_{ij}$ represents the correlation coefficient between country $i$ and $j$, while $T_{ij}$ is the number of observations used to computed that correlation.

regression results are not subject to biases due to cross-section dependence or to spurious relationships due to the order of integration, we will pay specially attention to regression residuals' characteristics. In particular, in our preferred specification residuals are stationary (which is an informal test for cointegration among the variables) and they do not have problems of cross-section dependence ( which indicates that unobservable heterogeneities are successfully captured in the model).

### 2.5.2 Baseline results

Tables 2.3 and 2.4, present the results for our baseline model, where just the impact of Tobin's $Q$ on the labor income share is studied. Columns [1] - [4] display the homogeneous-type estimators, where $\beta$ is constrained to be the same across countries. We present results for the standard OLS estimator with time-dummies (POLS), the 2FE estimator and the CCEP estimator, with and without including a country-specific linear trend. Columns [5] - [7] present the heterogeneous-type estimators. In particular, we show the estimates for the MG, and the CMG estimator with and without country-specific trends. As we have explained before, country-specific regressions are estimated and the final estimator is the average of the country-specific coefficients.[18]

Table 2.3 presents the estimates corresponding to a static model, where we consider 41 countries and 915 observations.[19] Regarding the homogeneous-type estimators, we find a negative and significant impact of the Tobin's $Q$ on the labor income share in all but the POLS estimator (where the impact is positive and significant). However, CIPS and CD tests indicate that the residuals present nonstationarity and cross-section dependence. That is to say, [1] to [4] regressions are suffering from some type of misspecification, which from our discussion before could be: (i) the imposition of parameter homogeneity, (ii) an unsuitable structure of the unobservable heterogeneity, or (iii) that the nature of the relationship is not static. The importance of the first two potential sources of misspecification can be tested analysing the Mean Group-style estimators (columns [5] - [7]). A negative and significant impact of the Tobin's $Q$ on the labor income share is still present, ranging from $-0.053$ to $-0.06$. However, although the residuals present an improvement

[18] Pesaran and Smith (1995) show that the Mean Group-style estimators will produce consistent estimates of the average of the parameters.

[19] Table A.1 in the appendix shows the specific countries and period under analysis.

in terms of absolute correlation, we still observe cross-section dependence. Stationarity in the residuals is now present in 2 out of the 3 regressions. These results indicate that, although the introduction of parameter heterogeneity improves the specification, it is not enough to solve all the potential misspecification problems.

Table 2.4 analyses the third potential source of misspecification through the estimation of a Partial Adjustment Model (PAM), where the first lag of the dependent variable is included as a regressor. Due to data restrictions, we consider 40 countries with the number of observations ranging from 850 to 885. The first important result is that a clear negative and significant long-run relationship is observed between the Tobin's $Q$ and the labor share irrespective of the estimator under analysis. The second remarkable fact is that most of the residuals show cross-sectional independence and stationarity, indicating the absence of the previous source of misspecification. Given its flexibility to control for the unobserved factors, our preferred model is the one showed in the last column (CMGt2)) which represents the Chudik and Pesaran (2015) Dynamic CMG estimator, where 2 extra lags of the cross-section averages are included in the regression to control for the potential dynamic bias. We observe that a 1% increase in Tobin's $Q$ decreases the labour income share in the long-run by 0.08%.

### 2.5.3 The Effect of the Relative Price of Investment Goods

As explained before, Karabarbounis and Neiman (2014) have argued that the global decline in the labor share can be explained, at least partially, by the decrease in the relative price of investment goods. They estimate that the lower price of investment goods explains roughly half of the observed decline in the labor share. In this section we test their hypothesis by including the relative price of investment goods in our regressions and compare their mechanism with our Tobin's $Q$ channel. Tables 2.5 and 2.6 show the results.

Table 2.5 displays th results from the static model. The inclusion of the relative price of investment does not alter the negative relationship found between the Tobin's $Q$ and the labor share. With respect to their effect, they present a negative impact under the homogeneous-type estimators. However, once we allow for parameter heterogeneity, they no longer show any kind of influence on the labor income share. Nevertheless, similar to the static model analysed in Table 2.3, residuals present cross-section dependence and nonstationarity.

TABLE 2.3: Static baseline model

| | [1] POLS | [2] 2FE | [3] CCEP | [4] CCEPt | [5] MG | [6] CMG | [7] CMGt |
|---|---|---|---|---|---|---|---|
| $q$ | 0.14 | -0.083 | -0.05 | -0.052 | -0.057 | -0.053 | -0.06 |
| | (0.052)*** | (0.025)*** | (0.017)*** | (0.016)*** | (0.015)*** | (0.020)*** | (0.016)*** |
| $t$ | | | | | -0.003 | | -0.003 |
| | | | | | (0.001)** | | (0.001)** |
| Constant | -0.647 | -0.665 | | | -0.656 | -0.483 | -0.714 |
| | (0.036)*** | (0.017)*** | | | (0.032)*** | (0.068)*** | (0.105)*** |
| Number Id | 41 | 41 | 41 | 41 | 41 | 41 | 41 |
| Observations | 915 | 915 | 915 | 915 | 915 | 915 | 915 |
| R-squared | 0.11 | 0.93 | 0.99 | 0.99 | | | |
| RMSE | 0.2244 | 0.0629 | 0.0500 | 0.0474 | 0.0443 | 0.0435 | 0.0336 |
| Trends | | | | | 0.73 | | 0.59 |
| CD test | 28.3495 | -2.6979 | 8.688 | -2.9706 | 3.8019 | 9.5781 | 5.4416 |
| Abs Corr | 0.4730 | 0.4211 | 0.3710 | 0.3660 | 0.3052 | 0.3243 | 0.2658 |
| Int | I(1) | I(1) | I(0)/I(1) | I(1) | I(1) | I(1)/I(0) | I(0) |

*Notes*: Robust standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.
POLS = Pooled OLS (with year dummies), 2FE = 2-way Fixed Effects, CCEP = Pooled Pesaran (2006) Common Correlated Effects (CCE), CCEPt = CCEP with linear trend, MG = Pesaran and Smith (1995) Mean Group (with country-specific linear trends), CMG = Pesaran (2006) CCE Mean Group, CMGt = CMG with country-specific linear trends.
CD-test reports the Pesaran (2004) test statistics, under the null of cross-section independence of the residuals. Int indicates the order of integration of the residuals (I(0) - stationary, I(1) - nonstationary) obtained from Pesaran (2007) CIPS test. RMSE presents the root mean squared error. Trend show the share of countries where the linear trend is significant at 5%.

Table 2.4: Dynamic baseline model

| | [1] POLS | [2] 2FE | [3] CCEP | [4] CCEPt | [5] MG | [6] CMG | [7] CMGt | [8] CMGt1 | [9] CMGt2 |
|---|---|---|---|---|---|---|---|---|---|
| $q$ | -0.009 | -0.03 | -0.021 | -0.023 | -0.034 | -0.017 | -0.024 | -0.026 | -0.04 |
| | (0.015) | (0.019) | (0.012)* | (0.012)* | (0.010)*** | (0.011) | (0.012)** | (0.013)** | (0.010)*** |
| $lis_{t-1}$ | 0.977 | 0.771 | 0.749 | 0.718 | 0.64 | 0.767 | 0.608 | 0.537 | 0.502 |
| | (0.008)*** | (0.078)*** | (0.037)*** | (0.041)*** | (0.034)*** | (0.026)*** | (0.032)*** | (0.037)*** | (0.048)*** |
| $t$ | | | | | -0.001 | | -0.001 | -0.001 | -0.001 |
| | | | | | (0.000) | | (0.001)* | (0.001) | (0.001)* |
| Constant | -0.005 | -0.141 | | | -0.232 | -0.135 | -0.358 | -0.418 | -0.318 |
| | (0.009) | (0.051)*** | | | (0.025)*** | (0.026)*** | (0.076)*** | (0.084)*** | (0.078)*** |
| Number of id | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Observations | 885 | 885 | 885 | 885 | 885 | 885 | 885 | 868 | 850 |
| R-squared | 0.97 | 0.98 | 0.99 | 0.99 | | | | | |
| RMSE | 0.0403 | 0.0384 | 0.0307 | 0.0309 | 0.0338 | 0.0246 | 0.0225 | 0.0202 | 0.0178 |
| Trend | | | | | 0.25 | | 0.24 | 0.33 | 0.23 |
| lr-$q$ | -0.4112 | -0.1288 | -0.0854 | -0.0815 | -0.0944 | -0.0725 | -0.061 | -0.0564 | -0.08 |
| se-$q$ | 0.7248 | 0.0613 | 0.0466 | 0.0428 | 0.0296 | 0.0462 | 0.0306 | 0.0281 | 0.0208 |
| CD test | -0.2311 | -1.2989 | -0.9679 | -2.5497 | 8.5344 | -1.3683 | -1.1636 | -0.4342 | -0.5145 |
| Abs Corr | 0.2133 | 0.2253 | 0.2309 | 0.2339 | 0.2240 | 0.2171 | 0.2188 | 0.2331 | 0.2426 |
| Int | Int(0) | Int(0) | Int(0) | Int(0) | Int(0) | Int(0) | Int(0) | Int(0) | Int(0) |

*Notes*: Robust standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.
POLS = Pooled OLS (with year dummies), 2FE = 2-way Fixed Effects, CCEP = Pooled Pesaran (2006) Common Correlated Effects (CCE), CCEPt = CCEP with linear trend, MG = Pesaran and Smith (1995) Mean Group (with country trends), CMG = Pesaran (2006) CCE Mean Group, CMGt = CMG with country-specific linear trends, CMGt1 and CMGt2 = CMGt with, respectively, one and two extra cross-sectional averages lags, as indicated by Chudik and Pesaran (2015).
CD-test reports the Pesaran (2004) test statistics, under the null of cross-section independence of the residuals. Int indicates the order of integration of the residuals (I(0) - stationary, I(1) - nonstationary) obtained from Pesaran (2007) CIPS test. RMSE presents the root mean squared error. Trend show the share of countries where the linear trend is significant at 5%. lr-$q$ and se-$q$ represent respectively $q$'s long-run impact and its standard error.

Table 2.5: Static model with relative prices

| | [1] POLS | [2] 2FE | [3] CCEP | [4] CCEPt | [5] MG | [6] CMG | [7] CMGt |
|---|---|---|---|---|---|---|---|
| $q$ | 0.157 | -0.08 | -0.052 | -0.052 | -0.067 | -0.061 | -0.052 |
| | (0.051)*** | (0.025)*** | (0.015)*** | (0.015)*** | (0.013)*** | (0.019)*** | (0.015)*** |
| $rp$ | -0.344 | -0.113 | -0.1 | -0.101 | 0.005 | -0.001 | 0.017 |
| | (0.100)*** | (0.043)*** | (0.048)** | (0.047)** | (0.085) | (0.111) | (0.078) |
| $t$ | | | | | -0.002 | | -0.002 |
| | | | | | (0.001)* | | (0.002) |
| Constant | -0.589 | -0.642 | | | -0.678 | -0.681 | -0.664 |
| | (0.039)*** | (0.019)*** | | | (0.034)*** | (0.101)*** | (0.078)*** |
| Number of id | 41 | 41 | 41 | 41 | 41 | 41 | 41 |
| Observations | 915 | 915 | 915 | 915 | 915 | 915 | 915 |
| R-squared | 0.12 | 0.93 | 0.99 | 0.99 | | | |
| RMSE | 0.2229 | 0.0625 | 0.0411 | 0.0399 | 0.0405 | 0.0311 | 0.0273 |
| Trend | | | | | 0.56 | | 0.32 |
| CD test | 25.6361 | -2.4791 | 5.4335 | -2.3717 | 3.7041 | 2.4645 | 4.6826 |
| Abs Corr | 0.4506 | 0.4142 | 0.3057 | 0.3102 | 0.2821 | 0.2522 | 0.2517 |
| Int | I(1) | I(1) | I(0)/I(1) | I(0)/I(1) | I(0)/I(1) | I(0) | I(0) |

*Notes*: Robust standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.
POLS = Pooled OLS (with year dummies), 2FE = 2-way Fixed Effects, CCEP = Pooled Pesaran (2006) Common Correlated Effects (CCE), CCEPt = CCEP with linear trend, MG = Pesaran and Smith (1995) Mean Group (with country-specific linear trends), CMG = Pesaran (2006) CCE Mean Group, CMGt = CMG with country-specific linear trends.
CD-test reports the Pesaran (2004) test statistics, under the null of cross-section independence of the residuals. Int indicates the order of integration of the residuals (I(0) - stationary, I(1) - nonstationary) obtained from Pesaran (2007) CIPS test. RMSE presents the root mean squared error. Trend show the share of countries where the linear trend is significant at 5%.

TABLE 2.6: ECM with relative prices

| | [1] 2FE | [2] CCEP | [3] MG | [4] CMG | [5] CMGt | [6] CMGt1 | [7] CMGt2 |
|---|---|---|---|---|---|---|---|
| $lis_{t-1}$ | -0.176 | -0.395 | -0.449 | -0.5 | -0.694 | -0.72 | -0.812 |
| | (0.026)*** | (0.049)*** | (0.034)*** | (0.053)*** | (0.061)*** | (0.085)*** | (0.125)*** |
| $q_{t-1}$ | 0.011 | -0.012 | -0.035 | -0.039 | -0.067 | -0.076 | -0.058 |
| | (0.013) | (0.015) | (0.014)** | (0.018)** | (0.026)** | (0.028)*** | (0.033)* |
| $rp_{t-1}$ | -0.032 | -0.016 | 0.064 | 0.15 | 0.092 | 0.129 | -0.005 |
| | (0.024) | (0.040) | (0.070) | (0.091)* | (0.115) | (0.166) | (0.186) |
| $\Delta q$ | -0.031 | -0.033 | -0.038 | -0.038 | -0.051 | -0.053 | -0.058 |
| | (0.014)** | (0.015)** | (0.009)*** | (0.012)*** | (0.017)*** | (0.019)*** | (0.018)*** |
| $\Delta rp$ | -0.141 | -0.214 | -0.021 | 0.049 | 0.093 | 0.05 | -0.11 |
| | (0.050)*** | (0.056)*** | (0.065) | (0.108) | (0.099) | (0.107) | (0.095) |
| $t$ | | | 0.001 | | 0.001 | 0.001 | 0.001 |
| | | | (0.001) | | (0.002) | (0.003) | (0.004) |
| Constant | -0.106 | | -0.301 | -0.273 | -0.277 | -0.431 | -0.356 |
| | (0.018)*** | | (0.033)*** | (0.050)*** | (0.084)*** | (0.089)*** | (0.124)*** |
| Number of id | 30 | 30 | 30 | 30 | 30 | 29 | 26 |
| Observations | 732 | 732 | 732 | 732 | 732 | 700 | 631 |
| R-squared | 0.26 | 0.59 | | | | | |
| RMSE | 0.0264 | 0.0224 | 0.0191 | 0.0142 | 0.0127 | 0.0101 | 0.0067 |
| Trends | | | 0.23 | | 0.20 | 0.21 | 0.23 |
| lr-$q$ | 0.0621 | -0.0307 | -0.0779 | -0.0785 | -0.0965 | -0.1061 | -0.0718 |
| se-$q$ | 0.0739 | 0.0357 | 0.0327 | 0.0374 | 0.0388 | 0.0405 | 0.0422 |
| lr-$rp$ | -0.1826 | -0.0405 | 0.1417 | 0.2999 | 0.1325 | 0.1796 | -0.0063 |
| se-$rp$ | 0.1306 | 0.1016 | 0.1573 | 0.185 | 0.1661 | 0.2312 | 0.2285 |
| CD test | -2.4749 | -1.5637 | 4.9547 | -0.0134 | -0.2654 | 1.0079 | 1.3218 |
| Abs Corr | 0.1884 | 0.217 | 0.2038 | 0.2189 | 0.2216 | 0.2393 | 0.2466 |
| Int | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) | I(0) |

*Notes*: Robust standard errors in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%. POLS = Pooled OLS (with year dummies), 2FE = 2-way Fixed Effects, CCEP = Pooled Pesaran (2006) Common Correlated Effects (CCE), CCEPt = CCEP with linear trend, MG = Pesaran and Smith (1995) Mean Group (with country trends), CMG = Pesaran (2006) CCE Mean Group, CMGt = CMG with country-specific linear trends, CMGt1 and CMGt2 = CMGt with, respectively, one and two extra cross-sectional averages lags, as indicated by Chudik and Pesaran (2015).
CD-test reports the Pesaran (2004) test statistics, under the null of cross-section independence of the residuals. Int indicates the order of integration of the residuals (I(0) - stationary, I(1) - nonstationary) obtained from Pesaran (2007) CIPS test. RMSE presents the root mean squared error. Trend show the share of countries where the linear trend is significant at 5%. lr-$q$ and se-$q$ represent respectively $q$'s long-run impact and its standard error. lr-$rp$ and se-$rp$ represent respectively $rp$'s long-run impact and its standard error.

In order to assess problems arising from the dynamic structure of our equation, this time we estimate an Error Correction Model (Table 2.6), where due to data restrictions we are not able to include more than 30 countries. Although we present the results for different estimators, given its larger flexibility, we focus on the ones obtained from the CMG-style estimators (columns [4]-[7]). The first remarkable fact is the presence of stationarity and cross-section independence in the residuals, indicating the absence of the previous misspecification problems. Regarding the impact of our variables of interest, we observe a negative impact of the Tobin's $Q$ in both the short and long run. If we focus on the long run relationship (lr-$q$), our estimates show that an increase of 1% in Tobin's $Q$ would decrease the labor income share between 0.072% and 0.11%. However, in contrast to Karabarbounis and Neiman (2014), we do not find any empirical support for the role played by the relative prices which, from figure A1, is not a surprising result. This findings support our theoretical model, and, like Chirinko and Mallick (2014a), discard the decline of investment prices as a driver of the labor income share

In order to evaluate the relevance of the Tobin's $Q$ in the secular decline of the labor income share, we undertake a simple simulation exercise. Given the fact that the GDP weighted average Tobin's $Q$ in our sample has increased from a value of 1.15 in 1980 to a value of 1.68 in 2007 (46%), and that the labor income share has evolved from a value of 57% to 52% (−8.9%), our results imply that the increase in Tobin's $Q$ can explain between 41% and 57% of the labor income share decline.

### 2.5.4 Weak exogeneity test

Our analysis has dealt with the presence of endogeneity from common factors driving both inputs and output. However, it is not uncommon in macroeconomics to suffer from endogeneity due to reverse causality.[20]

Traditionally, the literature has used instrumental variable methods to solve this problem. However, given the nature of our data, it is difficult to find a valid set of instruments (i.e., variables which are correlated with the regressor but not with the error term).[21] Therefore, provided that our series are nonstationary and cointegrated, we follow Canning and Pedroni (2008); and Eberhardt and Presbitero (2015) to estimate an informal causality test based on the Granger Representation Theorem (GRT). The GRT (Engle and Granger, 1987) states that cointegrated

[20] In our case, reverse causality implies that besides the relative prices and Tobin's $Q$ affecting the labor income share, the labor income share has in turn, a significant impact on their values.

[21] Under the presence of unobservable common factors and parameter heterogeneity, the use of internal instruments (lags of the variables) is not valid anymore.

series can be represented in the form of an ECM, which in our case is:

$$\Delta lis_{it} = \alpha_{1i} + \lambda_{11}\hat{u}_{i,t-j} + \sum_{j=1}^{K}\phi_{11ij}lis_{i,t-j} + \sum_{j=1}^{K}\phi_{12ij}q_{i,t-j}\sum_{j=1}^{K}\phi_{13ij}rp_{i,t-j} + \epsilon_{1it}, \tag{2.31}$$

$$\Delta q_{it} = \alpha_{2i} + \lambda_{21}\hat{u}_{i,t-j} + \sum_{j=1}^{K}\phi_{21ij}lis_{i,t-j} + \sum_{j=1}^{K}\phi_{22ij}q_{i,t-j}\sum_{j=1}^{K}\phi_{23ij}rp_{i,t-j} + \epsilon_{2it}, \tag{2.32}$$

$$\Delta rp_{it} = \alpha_{3i} + \lambda_{31}\hat{u}_{i,t-j} + \sum_{j=1}^{K}\phi_{31ij}lis_{i,t-j} + \sum_{j=1}^{K}\phi_{32ij}q_{i,t-j}\sum_{j=1}^{K}\phi_{33ij}rp_{i,t-j} + \epsilon_{3it}, \tag{2.33}$$

where $\hat{u}_{it} = lis_{it} - \hat{\beta}_{1i}q_{it} + \hat{\beta}_{2i}rp_{it}$ is the disequilibrium term. In order to identify a long-run equilibrium relationship, the GRT requires at least one of the $\lambda$'s to be nonzero. If $\lambda_{11} \neq 0$, $q$ and $rp$ have a causal impact on the $lis$, if $\lambda_{11}$, $\lambda_{21}$, and $\lambda_{31}$ are nonzero, then all variables are determined simultaneously, and no causal relationship can be identified.

Table 2.7 presents the results for our weak exogeneity test. Column "Model" refers to the method used to estimate the disequilibrium term ($\hat{u}$). The two big blocks "CA" and "no CA" indicate whether equations (2.31)-(2.33) include, or not, cross-sectional averages of the variables. Within each block, the dependent variable of the system is indicated at the top of the column. The information provided shows the results for the average $\lambda$ and its respective $p$-value. Regarding our previous discussion, for a causal effect of the Tobin's $Q$ and the relative prices on the labor share, $\lambda_{11}$ should be different from 0, while $\lambda_{21} = \lambda_{31} = 0$. We find that just 5 out of 42 cases (highlighted with asterisks) are against a causal relationship in our study. Therefore, we safely conclude that our analysis represents the causal impact of Tobin's $Q$ and the relative price of investment on the labor income share.

Table 2.7: Weak exogeneity test

| | | no CA | | | CA | | |
|---|---|---|---|---|---|---|---|
| Model | | *lis* | *q* | *rp* | *lis* | *q* | *rp* |
| MG | Avg. $\lambda$ | -0.52 | -0.45 | 0.02 | -0.50 | -0.41 | -0.04 |
| | $\rho$ | 0.00 | 0.03* | 0.48 | 0.00 | 0.21 | 0.60 |
| CMG | Avg. $\lambda$ | -0.57 | -0.40 | -0.01 | -0.51 | -0.54 | 0.00 |
| | $\rho$ | 0.00 | 0.15 | 0.83 | 0.00 | 0.18 | 0.94 |
| CMGt | Avg. $\lambda$ | -0.75 | -0.65 | 0.00 | -0.69 | -0.74 | -0.04 |
| | $\rho$ | 0.00 | 0.01* | 0.98 | 0.00 | 0.12 | 0.72 |
| CMG1 | Avg. $\lambda$ | -0.59 | -0.23 | 0.04 | -0.51 | -0.58 | 0.03 |
| | $\rho$ | 0.00 | 0.52 | 0.24 | 0.00 | 0.13 | 0.61 |
| CMGt1 | Avg. $\lambda$ | -0.77 | -0.12 | 0.06 | -0.75 | -0.60 | 0.05 |
| | $\rho$ | 0.00 | 0.75 | 0.19 | 0.00 | 0.19 | 0.38 |
| CMG2 | Avg. $\lambda$ | -0.73 | -0.42 | -0.07 | -0.64 | -1.04 | -0.05 |
| | $\rho$ | 0.00 | 0.32 | 0.09* | 0.00 | 0.04* | 0.56 |
| CMGt2 | Avg. $\lambda$ | -0.93 | -0.46 | 0.06 | -0.82 | -1.20 | 0.05 |
| | $\rho$ | 0.00 | 0.29 | 0.25 | 0.00 | 0.01* | 0.44 |

*Notes*: Avg. $\lambda$ shows the robust mean coefficient for the disequilibrium term on the ECM. Asterisks highlight cases which do not support a causality relationship for our analysis.

## 2.6 Conclusion

The secular decline of the global labor share has received vivid attention in the last years. We contribute to this recent literature by proposing a new mechanism that links the evolution of the labor share with the evolution of equity Tobin's Q.

In our model, an increase in equity Tobin's Q boosts financial wealth pushing investors to demand a higher return on equity. Firms are forced to slowdown investment and, consequently, the capital-output ratio. This raises equity returns but drives the labor share down when capital and labor are complements. That way, our paper reconciles the labor share - capital-output framework with the standard values of the elasticity of substitution ($\sigma < 1$).

We test the validity of our model estimating different Mean Group-style estimators based on a common factor model. Results suggest that the global increase of Tobin's $Q$ since 1980 accounts for between 41% and 57% of the decline in the labor income share. When the relative price of investment is included in our estimations, we find that they do not have any significant effect on the labor income share.

Our results show that the relationship between financial markets and corporations, embodied in the equity Tobin's $Q$ ratio, is crucial to understand the dynamics of the capital-output ratio and factor shares. In light of our findings, we believe that the decline in the labor income share is not the irreversible consequence of technological or structural factors, like in Karabarbounis and Neiman (2014) and Piketty and Zucman (2014a), but the result of a change in the functioning of financial markets and its relation with corporate investment decisions. According to our model, policies aiming at reversing the trend in the labor share should target incentives on corporate investment, even if this is at the expense of equity valuation and equity returns. This could be achieved, for example, by imposing higher taxes on corporate distributions, like dividends or share repurchases.

# APPENDIX: Supplementary tables and figures

TABLE A.1: Selected economies and sample period

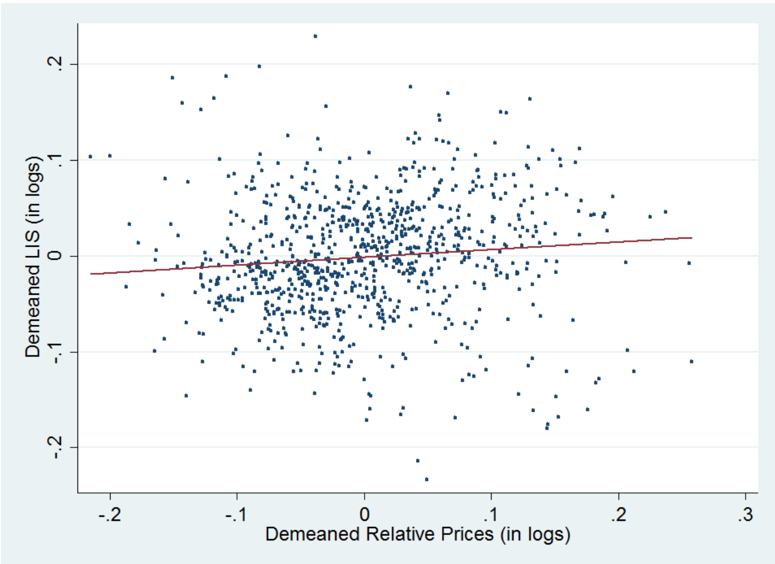
| id | Country | Sample period | id | Country | Sample period |
|---|---|---|---|---|---|
| 1 | Australia | 1980-2008 | 22 | Luxembourg | 1991-2008 |
| 2 | Austria | 1980-2008 | 23 | Mexico | 1988-2008 |
| 3 | Belgium | 1980-2008 | 24 | Morocco | 1998-2007 |
| 4 | Brazil | 1992-2008 | 25 | Netherlands | 1980-2008 |
| 5 | Canada | 1980-2008 | 26 | New Zealand | 1986-2008 |
| 6 | Chile | 1990-2008 | 27 | Norway | 1980-2007 |
| 7 | China | 1995-2007 | 28 | Peru | 1992-2003 |
| 8 | Colombia | 1993-2007 | 29 | Philippines | 1988-2008 |
| 9 | Denmark | 1980-2009 | 30 | Poland | 1995-2008 |
| 10 | Finland | 1987-2009 | 31 | Portugal | 1988-2009 |
| 11 | France | 1980-2009 | 32 | South Africa | 1980-2008 |
| 12 | Germany | 1983-2008 | 33 | Spain | 1986-2008 |
| 13 | Greece | 1988-2009 | 34 | Sri Lanka | 1994-2008 |
| 14 | Hong Kong | 1980-2003 | 35 | Sweden | 1982-2009 |
| 15 | Hungary | 1995-2008 | 36 | Switzerland | 1980-2007 |
| 16 | India | 1991-2008 | 37 | Thailand | 1988-2003 |
| 17 | Ireland | 1981-2008 | 38 | Turkey | 1990-2003 |
| 18 | Israel | 1993, 1995-2008 | 39 | UK | 1980-2008 |
| 19 | Italy | 1980-2008 | 40 | US | 1980-2008 |
| 20 | Japan | 1980-2007 | 41 | Venezuela | 1992-2006 |
| 21 | Korea | 1980-2003 | | | |

TABLE A.2: Descriptive statistics

| Panel A: Raw variables | | | | | |
|---|---|---|---|---|---|
| Variable | Obs | Mean | Std. Dev. | Min | Max |
| *LIS* | 915 | 0.468 | 0.096 | 0.214 | 0.636 |
| *Q* | 915 | 1.241 | 0.268 | 0.519 | 3.229 |
| *RP* | 915 | 1.041 | 0.097 | 0.767 | 1.413 |

| Panel B: Regression variables (in logs) | | | | | |
|---|---|---|---|---|---|
| Variable | Obs | Mean | Std. Dev. | Min | Max |
| *lis* | 915 | -0.785 | 0.234 | -1.543 | -0.452 |
| *q* | 915 | 0.195 | 0.200 | -0.655 | 1.172 |
| *rp* | 915 | 0.036 | 0.092 | -0.265 | 0.346 |

FIGURE A1: Labor income share against relative prices




*Notes:* Own calculation based on a sample of 41 countries and 911 observations. Variables are demeaned to control for fixed-effects. Correlation coefficient= 0.11

# Chapter 3

# Imperfect Competition, Secular Stagnation and Factor Shares

*Abstract*

Secular stagnation is a term coined to describe the last 30-year period of lower economic growth and declining interests rates. Among the potential causes of secular stagnation, the rise of monopoly rents has gained increasing attention in the current policy debates (Furman and Orszag, 2015; Summers, 2016; CEA, 2016). I build a growth model with a corporate sector and imperfect competition and I show that the rise of monopoly power in the labor and the goods market is indeed consistent with phenomena that have characterized the post-1980 U.S. economy, namely, the rise of asset prices and corporate profits, the slowdown of output and investment, the stagnation of wages and the decline of the labor share. All of this, along with empirical indicators of increases in monopoly power, might be taken as evidence that increasing market power is a central argument to explain the evolution of the U.S. economy during the last three decades.

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## 3.1 Motivation

In an influential speech at the 2013 IMF Annual Research Conference (Summers, 2013), Larry Summers suggested the possibility that advanced economies might be suffering from secular stagnation. Secular stagnation is usually defined as a steady downward tendency of the real interest rate, reflecting an imbalance between an excess of desired saving and a decreasing propensity to invest (Eichengreen, 2015). This imbalance would have resulted in a long-term period characterized by persistent output gaps and lower rates of growth and inflation, only interrupted by short cycles of bubbles and unsustainable growth. Whether advanced economies are suffering from secular stagnation is itself a controversial debate. But the fact that industrial economies have been experiencing a decline in long-term real interests over the last three decades is hardly debatable (Desroches and Francis, 2006).

The literature has proposed several explanations for this phenomenon: a decline in investment due to the lack of investment opportunities and low returns to innovation (Gordon, 2012), an excess of savings due to a persistent liquidity trap (Eggertsson and Mehrotra, 2014), a decline of the relative price of investment goods (Thwaites, 2015) and, not less important, Hansen's original theory of a decline in the rate of population growth (Hansen, 1938).

Recently, the rise of market power has gained increasing attention as another potential explanation for secular stagnation. Summers (2016) has wisely noted that previous theories are hardly compatible with a phenomenon that have occurred alongside the slowdown of growth and the decline of interest rates. I refer to the secular increase in the stock market value of nonfinancial corporations.

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

The upswing of asset prices is not a uniquely U.S. phenomenon. The rise of stock market wealth, as measured by Tobin's Q ratio, is a common trend across industrial economies. Not surprisingly, Piketty (2014) shows that asset prices and housing wealth have been the most important drivers of the observed rising wealth-income ratios in the advanced economies, although in the case of asset prices, the most extremes cases are those of the anglo-saxon economies.

As Summers (2016) notes, there is not an immediate explanation for the divergence between rising corporate profits and declining interest rates. If interests rates reflect the prevailing return to capital, corporate profits should generally follow their path. One possible explanation for the disparity between these two variables is an increased prevalence of economic rents. An increase in market power could explain why we observe higher profits and higher stock market valuations but also lower investment and lower output growth. Furthermore, interest rates would fall because investment demand is lower, which would explain the lack of any correlation between borrowing and corporate investment.

Has monopoly power actually increased? Furman and Orszag (2015) and CEA (2016) documents that i) many industries have become more concentrated, partly because the U.S. economy comes from a major merger wave, (ii) there is a growing disparity in returns to invested capital across corporations, iii) union membership has declined, and iv) business formation has also declined. Summers (2016) adds the possibility that new technologies might be favoring monopoly power by exploding increasing returns to scale, and he also emphasizes the increasing role of institutional shareholders, which might have altered corporate incentives due to the overlapping ownership of companies.

The rise of market power would have the additional merit of explaining some striking trends in inequality. The rise of economic rents rises the capital share above the level that conventional returns would imply. Consequently the labor income share would decrease, adding another potential explanation to the recent evolution of factor shares.

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

The rest of the paper is organized as follows. Section 3.2 presents the model and some characterization of the equilibrium. Section 3.3 discusses the effects of market power in light of model's equations. Section 3.4 shows preliminary computational findings. An 3.5 concludes.

## 3.2 Model

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

Firms are owned by capitalists' households, who make savings' decisions and only receive income from the ownership of stocks. At every period there is one equity stock outstanding per firm. Therefore, the market clearing condition in the stock market requires $s_{jt} = 1$. Labor is solely provided by workers' households. Like in Gali et al. (2007), they do not own any asset and, therefore, they are just non-Ricardian households who consume all their current labor income. Campbell and Mankiw (1989) provide evidence of the importance for the aggregate economy of such rule-of-thumb households in the U.S. and other industrialized economies.

Finally, although there is not a continuum of firms, I proceed by assuming that individual firms do not have the ability to influence aggregate output and prices. In this respect, I follow Acemoglu (2009).

### 3.2.1 Capitalists

An infinite lived representative capitalist household seeks to maximize

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

subject to

$$C^c_t = \left(\sum_{j=1}^{n} \left(c^c_{jt}\right)^{\frac{\xi-1}{\xi}}\right)^{\frac{\xi}{\xi-1}} \tag{3.1}$$

and

$$\sum_{j=1}^{n} p_{jt} c^c_{jt} + \sum_{j=1}^{n} v_{jt} s_{jt+1} = \sum_{j=1}^{n} \left(v_{jt} + d_{jt}\right) s_{jt} \quad \forall t \tag{3.2}$$

$C^c_t$ is a CES composite consumption aggregator with elasticity of substitution $\xi > 1$. $c^c_{jt}$ is the consumption level of good $j$, which can be purchased at price $p_{jt}$. $s_{jt}$ denotes the number of stocks of firm $j$ held by the capitalist household at period $t$. Stocks generate a dividend income $d_{jt}$ and can be traded at any period $t$ at price $v_{jt}$. Therefore, the value of the financial wealth owned by the capitalist household at the end of each period $t$ is $\sum_{j=1}^{n} v_{jt} s_{jt+1}$.

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

$$c^c_{jt} = \left(\frac{p_{jt}}{P_t}\right)^{-\xi} C^c_t \tag{3.3}$$

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

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

$$\frac{u'\left(C^c_t\right)}{\beta u'\left(C^c_{t+1}\right)} = \frac{\frac{v_{jt+1}+d_{jt+1}}{P_{t+1}}}{\frac{v_{jt}}{P_t}} \tag{3.4}$$

Denoting $\frac{u'(C^c_t)}{\beta u'\left(C^c_{t+1}\right)}$ as $1+r'_t$, using forward substitution and imposing the transversality condition, we can express the real value of firm $j$'s stock at period $t$ as the stream of future dividends:

$$\frac{v_{jt}}{P_t} = \sum_{t=0}^{\infty} \frac{d_{jt+1}}{\prod_{h=1}^{t} P_{t+h} (1 + r_{t+h})} \tag{3.5}$$

### 3.2.2 Workers

Workers' households only receive income from labor, and maximize total consumption $C^w$. Since they are forced to consume all their current income, their problem is static. To simplify the consumption-labor choice, I assume linear utility in consumption. As in the case of capitalists, $C^w$ is given by a CES aggregation function of all the varieties. To make the labor supply problem as tractable as possible, I assume that each workers' households has $n$ members and that each of them works in a different sector, which resembles the idea that labor markets are segmented. Disutility from labor is assumed to be the same across sectors. Therefore, the problem of workers can be expressed as follows:

$$Max_{c^w_{jt}, l_{jt}} C^w_t - \gamma \sum_{j=1}^{n} \frac{l_{jt}^{1+\theta}}{1+\theta} \tag{3.6}$$

subject to

$$C^w_t = \left( \sum_{j=1}^{n} \left(c^w_{jt}\right)^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}} \tag{3.7}$$

and

$$\sum_{j=1}^{n} p_{jt} c^w_{jt} = \sum_{j=1}^{n} w_{jt} l_{jt} \tag{3.8}$$

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

$$c^w_{jt} = \left(\frac{p_{jt}}{P_t}\right)^{-\xi} C^w_t \tag{3.9}$$

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

$$\frac{w_{jt}}{P_t} = \gamma l_{jt}^{\theta} \tag{3.10}$$

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

### 3.2.3 Firms

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

$$F\left(K_{jt}, L_{jt}\right) = \left(\phi K_{jt}^{\frac{\sigma-1}{\sigma}} + (1-\phi)\, L_{jt}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{3.11}$$

where $\phi$ is a distributional parameter and $\sigma$ is the elasticity of substitution between labor and capital. Firm $j$ purchases capital goods from each of the other firms. Let $i_{jh}$ denote the flow of capital goods produced by firm $h$ and puchased by firm $j$. Firm's $j$ capital stock evolves according to the law of motion

$$K_{jt+1} - K_{jt} = i_{jt} - \delta K_{jt} \tag{3.12}$$

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

$$i_{jt} = \left(\sum_{h=1}^{n} \left(i_{jht}\right)^{\frac{\xi-1}{\xi}}\right)^{\frac{\xi}{\xi-1}} \tag{3.13}$$

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

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

$$Max_{i_{jht}} \left( \sum_{h=1}^{n} (i_{jht})^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}} \tag{3.14}$$

subject to

$$\sum_{h=1}^{n} p_{ht} i_{jht} = m_{jt} \tag{3.15}$$

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

$$\left( \frac{i_{jht}}{i_{jzt}} \right)^{\frac{-1}{\xi}} = \frac{p_{ht}}{p_{zt}} \tag{3.16}$$

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

$$\left( \frac{i_{jht}}{i_{jt}} \right)^{\frac{-1}{\xi}} = \frac{p_{ht}}{P_t} \tag{3.17}$$

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

$$i_t^{dh} = \sum_{j=1}^{n} i_{jht} = \left( \frac{p_{ht}}{P_t} \right)^{-\xi} \sum_{j=1}^{n} i_{jt} = \left( \frac{p_{ht}}{p_t} \right)^{-\xi} i_t^T \tag{3.18}$$

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

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

$$y_j = i^{dj} + c_j^w + c_j^c = \left( \frac{p_j}{P} \right)^{-\xi} \left( i^T + C^w + C^c \right) \tag{3.19}$$

where $C_t^w + C_t^c + i_t^T = y_t^T$ is merely the aggregate demand of the whole economy. The supply of labor faced by firm $j$ is given by equation 3.10. Given that capital $K_j$ is the only individual state, the optimization problem of the firm, expressed in recursive formulation, is:

$$V\left(K_j\right) = Max_{K_j',L_j}\left\{\frac{d_j}{P} + \frac{V\left(K_j'\right)}{1+r'}\right\} \tag{3.20}$$

subject to the following constraints

$$d_j = p_j F(K_j, L_j) - w_j L_j - \sum_{h=1}^{n} p_h i_{jh} \tag{3.21}$$

$$\frac{p_j}{P} = \left(\frac{y_j}{y^T}\right)^{\frac{-1}{\xi}} \tag{3.22}$$

$$\sum_{h=1}^{n} p_h i_{jh} = i_j P \tag{3.23}$$

$$i_j = K_j' - (1+\delta)K_j \tag{3.24}$$

$$\frac{w_j}{P} = \gamma L_j^{\theta} \tag{3.25}$$

where, to make the problem of the firms consistent with that of the households, $\frac{1}{1+r'}$ equals the discount factor of capitalists. Equation 3.21 is the flow and funds constraint of firm $j$. Equation 3.22 is the total demand of variety $j$. Equation 3.23 results from the combination of the investment demand in equation 3.17 and the price index $P_t = \left(\sum_{j=1}^{n} p_{jt}^{1-\xi}\right)^{\frac{1}{1-\xi}}$. Equation 3.24 is the law if motion of capital. Lastly, equation 3.25 is the labor supply. Since firm $j$ is monopsonist employer, he internalizes the entire supply of labor in sector $j$ and chooses the level of employment $L_j$. The problem of firm $j$ results in the following first-order conditions for labor and capital respectively:

$$\frac{w_j}{P} = \left(\frac{\xi-1}{\xi}\right)\left(\frac{1}{1+\theta}\right)\frac{p_j F_L(K_j, L_j)}{P} \tag{3.26}$$

$$P\left(1+r'\right) = \left(\frac{\xi-1}{\xi}\right) p_j' F_K(K_j', L_j') + P'\left(1-\delta\right) \tag{3.27}$$

The presence of $\xi$ adjusts the FOCs of both labor and capital. The deviation from competitive behavior affects the equilibrium wage and return to capital and gives a constant mark-up equal to $\frac{1}{1-\frac{1}{\xi}}$, which measures the degree of monopoly power in the goods market. When the elasticity $\xi$ increases, the degree of substitution between varieties increases and the degree of monopoly of a particular sector $j$ falls, bringing the real interest and the real wage closer to the marginal productivities.

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

As shown below, both $\xi$ and $\theta$ have important implications in the dynamics of capital accumulation, asset prices and factor shares.

### 3.2.4 Equilibrium

Given the firms' symmetry existing in the model, all firms make the same investment decision, produce the same quantity and set the same price. Accordingly, $i_{jt} = i_t$, $i_t^{dj} = i_t^d$, $c_{jt}^w = c_t^w$, $c_{jt}^c = c_t^c$, $L_{jt} = L_t$, $K_{jt} = K_t$, $w_{jt} = w_t$, $y_{jt} = y_t$, $p_{jt} = p_t$, $d_{jt} = d_t$, $v_{jt} = v_t$ for all $j$ and all $t$. Since each firm charges the same price, the price index $P$ can be computed as

$$P_t = N^{\frac{-1}{\xi-1}} p_t \tag{3.28}$$

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

$$y_t^T = N^{\frac{\xi}{\xi-1}} y_t \tag{3.29}$$

Market clearing in the goods market requires

$$F(K_t, L_t) = i_t^d + c_t^w + c_t^c \quad \forall t \tag{3.30}$$

Market clearing in the assets market requires

$$s_t = 1 \quad \forall t \tag{3.31}$$

The market clearing condition in the labor market is expressed in equation 3.25, where the amount of labor supplied by households, $l_{jt}$, has been replaced by the employment level $L_{jt}$ chosen by the firm.

**Definition 3.1.** An equilibrium in this economy is a sequence of prices $\{p_t, v_t, w_t\}_{t=0}^{\infty}$ and allocations of consumption, asset holdings, investment, dividends, labor and capital $\{c_t^w,\, c_t^c,\, s_{t+1},\, i_t,\, d_t,\, L_t,\, K_{t+1}\}_{t=0}^{\infty}$ such that

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

Note that in absecence of monopsony power in the labor market (i.e. when the firms do not internalize the upward-sloping labor supply and/or when $\theta$ is zero)[1] and in absence of monopoly power in the goods market (i.e. when the elasticity $\xi$ tends to infinity and, therefore, the varieties are perfect substitutes), the imperfect competition frictions dissapear from the first order conditions, markups are equal to 1 and the model collapses to the standard neoclassical growth model. On the contrary, when $\theta$ and $\xi$ are positive and finite, the equilibrium allocation differs from the perfectly competitive allocation. But also in this case, since markups are constant, the economy would be characterized by the existence of a unique steady state and the corresponding capital accumulation dynamics would be qualitatitive

[1] When $\theta = 0$, the real wage $\frac{w}{p}$ is constant and equal to $\gamma$ but the firm proceed by adjusting the employment level.

similar to those obtained with the frictionless canonical model. The interesting analysis, however, is to see how the economy responds to changes in the degree of competition. In particular, whether the equilibrium dynamics are qualititatively similar to those observed in the U.S. economy is a crucial question if one desires to consider monopoly power as plausible hypothesis for secular stagnation. The remaining sections of the paper are devoted to address this question.

### 3.2.5 Some characterization of the equilibrium

**Proposition 3.2.** *If the production function displays constant returns to scale, the long-run equilibrium with no inflation is characterized by the following Tobin's Q:*

$$Q_t = 1 + \frac{\sum_{t=0}^{\infty} \frac{(\theta w_{t+1} L_{t+1}) + \frac{1}{\xi}(pF(K_{t+1}, L_{t+1}))}{\prod_{h=1}^{t}(1+r_{t+h})}}{PK_{t+1}} \tag{3.32}$$

*Proof.* Using the FOC with respect to capital 3.27 in non-recursive form and multiplying both sides by $K_{t+1}$, we get

$$\frac{P_t K_{t+1} = \left(\frac{\xi-1}{\xi}\right) p_{t+1} K_{t+1} F_K(K_{t+1}, L_{t+1}) + K_{t+1} P_{t+1}(1-\delta)}{1 + r_{t+1}} \tag{3.33}$$

Using the CRS assumption and the FOC with respect to labor 3.26, we get the following decomposition of firm's output:

$$\left(\frac{\xi - 1}{\xi}\right) F(K_{t+1}, L_{t+1}) = \left(\frac{\xi - 1}{\xi}\right) K_{t+1} F_K(K_{t+1}, L_{t+1}) + \frac{w_{t+1} L_{t+1}(1+\theta)}{p_{t+1}} \tag{3.34}$$

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Combining 3.33 and 3.34 and using constraints 3.21, 3.23 and 3.24, the following expression for the replacement cost of capital is obtained:

$$P_t K_{t+1} = \frac{d_{t+1} + P_{t+1}K_{t+2} - \left(\frac{1}{\xi}p_{t+1}F(K_{t+1}, L_{t+1})\right) - (\theta w_{t+1}L_{t+1})}{1 + r_{t+1}} \tag{3.35}$$

Using forward substitution and imposing the no-inflation condition:

$$PK_{t+1} = \sum_{t=0}^{\infty} \frac{d_{t+1}}{\prod_{h=1}^{t}(1 + r_{t+h})} - \sum_{t=0}^{\infty} \frac{\left(\frac{1}{\xi}pF(K_{t+1}, L_{t+1})\right) + (\theta w_{t+1}L_{t+1})}{\prod_{h=1}^{t}(1 + r_{t+h})} \tag{3.36}$$

In absence of inflation, equation 3.5 becomes

$$v_t = \sum_{t=0}^{\infty} \frac{d_{t+1}}{\prod_{h=1}^{t}(1 + r_{t+h})} \tag{3.37}$$

Then, by combining 3.36 and 3.37

$$v_t = PK_{t+1} + \left(\sum_{t=0}^{\infty} \frac{\left(\frac{1}{\xi}pF(K_{t+1}, L_{t+1})\right) + (\theta w_{t+1}L_{t+1})}{\prod_{h=1}^{t}(1 + r_{t+h})}\right) \tag{3.38}$$

and Tobin's Q, which is the ratio $\frac{v_t}{PK_{t+1}}$ results in equation 3.32.

□

Tobin's Q is the ratio between the equity value (I abstract here from non-equity liabilities) and the replacement cost of capital. Equation 3.32 indicates that moderate levels of monopoly power in the goods and labor market would result in a Tobin's Q larger than one. In that case, the stock market value would be capturing not only the market value or replacement cost of the existing physical capital, but also the discounted sum of the future monopoly rents. Therefore, monopoly rents show up as capital gains.

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

$$pF(K,L) = L\left(\frac{\xi-1}{\xi}\right)pF_L(K,L) + K\left(\frac{\xi-1}{\xi}\right)pF_K(K,L) + \frac{1}{\xi}pF(K,L) \tag{3.39}$$

where the first term in the RHS of 3.39 can be decomposed using 3.26 into the wage bill and the monopsony rent, that is;

$$L\left(\frac{\xi-1}{\xi}\right)pF_L(K,L) = Lw + \theta Lw \tag{3.40}$$

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

Equation 3.40 implies that monopsony rents in the labor market can be equal or larger than the wage bill itself. This is certainly the case when $\theta$ is larger than one. But $\theta \geq 1$ is not the result that one should reasonably expect. Even in presence of imperfect competition in the labor market, the wage bill should be considerably higher that the monopsony rents, suggesting that realistic magnitudes of $\theta$ should be much lower than 1. This is consistent with macro estimates of the Frisch elasticity, which are often in the range of 2 to 4, implying values of $\theta$ between 0.25 and 0.5. In any case, note that the present structure of workers' preferences, where consumption enters in linear form, might exacerbate the value of $\theta$. This is because, in abscence of wealth effects that make the labor supply more inelastic, the inelasticity required to obtain certain levels of monopsony rents can only be achieved by decreasing the substitution effect (that is, by increasing $\theta$).

**Proposition 3.3.** *For any given $r$, the steady state is characterized by more capital $K$ when the economy is more competitive if $\frac{\xi}{\xi-1} < \frac{1}{\ln N}$.*

*Proof.* Using the FOC with respect to capital 3.27 and imposing the steady state condition, we define function $G$ like

$$G(K,\xi) = \frac{P(r+\delta)}{p} - \left(1-\frac{1}{\xi}\right)F_K(K,L) = N^{\frac{1}{1-\xi}}(r+\delta) - \left(1-\frac{1}{\xi}\right)F_K(K,L) \tag{3.41}$$

Applying the implicit function theorem, we have that

$$\frac{dK}{d\xi} = \frac{-\left(\frac{\partial G}{\partial \xi}\right)}{\left(\frac{\partial G}{\partial K}\right)} = \frac{-\left((r+\delta)\frac{1}{(1-\xi)^2}N^{\frac{1}{1-\xi}}\ln N - \frac{1}{\xi^2}F_K(K,L)\right)}{-\left(1-\frac{1}{\xi}\right)F_{KK}(K,L)} \tag{3.42}$$

Using the FOC with respect to capital and operating, it is straightforward to see that the numerator is positive for any $N > 1$ only if $\frac{\xi}{\xi-1} < \frac{1}{\ln N}$. The denominator of 3.42 is always positive because $\xi > 1$ and $F_{KK}(K, L) < 0$. Therefore, $\frac{dK}{d\xi}$ is positive for any $N > 1$ and $\xi$ such that $\frac{\xi}{\xi-1} < \frac{1}{\ln N}$. □

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

The idea that the U.S. economy has been stuck in a period of low investment and weak economic growth due to the rise of monopoly power is consistent with the previous proposition. This is also consistent with the observed decline of the physical-capital-output ratio shown in Gonzalez (2016b) and the idea, emphasized by Stiglitz (2015), that the rise of monopoly rents can be accompanied by a decrease in productive capital, leading to the stagnation or decrease in the mean marginal productivity or average wage of workers. The prediction of the model with respect to labor seems to be also reasonable. The evolution of the employment-population ratio, as shown by Glaeser (2014), illustrates that employment growth has been quite sluggish coinciding with the period usually considered in secular stagnation debates, namely, the post-1980 years.

## 3.3 The Rise of Monopoly Power and its Effects.

As mentioned before, the post-1980 period has been characterized by an astonishing rise of stock market wealth, as measured by Tobin's q ratio of the corporate sector. Also, the ratio of the market value of equities to corporate gross value added has been unusually high and it has followed a trend similar to Tobin's Q.[2] The rate of profitability in the U.S. corporate sector, therefore, has been very high and so has been the share of corporate value added going to capital.

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

Given these facts, the rise of corporate monopoly power emerges as a plausible explanation for this apparent puzzle. To see this, first note that an increase in monopoly power can explain the decline of capital accumulation. Proposition 3.3 clearly shows that when the degree of monopoly, measured by markup $\frac{\xi}{\xi-1}$, rises, capital stock can be lower in the steady state.

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

$$Q_t = 1 + \frac{\theta \gamma L^{\theta+1}}{rK} + \frac{\frac{1}{\xi} F(K, L) N^{\frac{1}{\xi-1}}}{rK} \tag{3.43}$$

where I have used $\gamma L^{\theta}$ and $N^{\frac{1}{\xi-1}}$ instead of the real wage $\frac{w}{P}$ and the price relation $\frac{p}{P}$ respectively. When $\theta = 0$ (i.e. when the labor supply is completely elastic) and when $\xi$ tends to infinity (i.e. when the demand of each variety is completely elastic), imperfect competition frictions dissapear, the second and third terms of 3.43 become zero and steady state Tobin's Q equals one. In absence of monopoly rents, the model achieves the same equilibrium than the frictionless version of McGrattan and Prescott (2005) model.

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

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

$$\frac{v}{P} = K + \frac{\left(\frac{\frac{1}{\xi}pF(K,L)}{P}\right) + \left(\frac{\theta wL}{P}\right)}{r} \tag{3.44}$$

When monopoly power increases, the discounted value of future monopoly rents increases but, due to the negative effect on $K$ that proposition 3.3 shows, the final effect on $\frac{v}{P}$ might turn out to be negative. Whether the rise of the rents offset the decline of productive capital is a question that can be determined computationally, using a standard parametrization of the model. I do this in the next section.

The model can also be used to test if the change in the factor shares can be explained with the rise of monopoly rents. Different causes can be behind the decline of the labor share. Recent research has pointed out the evolution of the price of capital goods (Karabarbounis and Neiman, 2014), the shift towards a more IPP intensive economy (Dongya Koh and Zheng, 2015), the offshoring of the labor-intensive component of the U.S. economy (Elsby et al., 2013) and mechanisms -other than monopoly power- that alter the Tobin's Q, like the capital income tax (Gonzalez, 2016b). But up to now, the literature has not discussed the possibility that monopoly rents have contributed to the decline of the labor share.[3]

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

Finally, very recently, the Council of Economic Advisors (CEA, 2016) has examined policies that can strengthen productivity while addressing inequality, and

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

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

There are two principal channels through which rents could increase factorial inequality. To see this, note from equations 3.39 and 3.40 that, in absence of inflation, the labor share equals:

$$\frac{wL}{py} = \frac{1 - rPK - \delta PK - \frac{1}{\xi}pF(K,L) - \theta Lw}{py} \tag{3.45}$$

When monopoly rents increase, the terms $\frac{1}{\xi}pF(K,L)$ and $\theta Lw$ increase at the expense of wages and the rental rate of capital. The first term resembles the additional rents obtained from increasing concentration in the goods market. The second term, $\theta Lw$, is the rent that workers lose when firms increase its monopsony power and it resembles the lost of union's power. In the context of the model, they represent the two channels subject of concern in CEA (2016). However, there is an indirect "technology channel" which also affects the labor share. When monopoly power increases, the stock of capital falls, having an impact on wages through the marginal productivity of labor. If capital and labor are complements, this also has negative impact on the labor share.[4] From Bentolila and Saint-Paul (2003), we know that this happens if the environment is characterized by a CES technology and $\sigma < 1$. The two mechanisms will be present in the computational exercise below.

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

## 3.4 Findings

The goal of this section is to evaluate the quantitative effects of a permanent monopoly power shock. The exercise is not intended to replicate exactly the series of interest. That would required a fully-fledged calibration and the consideration of other different shocks. The exercise only aims to show whether monopoly power can give rise to dynamics similar in sign and shape to those observed for the U.S. economy.

Since I am mostly interested in the effects of markups, I proceed by assuming that there is only one variety. That way, I manage to abstract from the effect that a rise of monopoly power can have on the "love-for-variety" externality, captured in the relative price relation $P_t = N^{\frac{-1}{\xi-1}} p_t$. In addition, I assume that the labor market is competitive and labor supply is inelastic. Therefore, the source of monopoly power only comes from the goods market.[5] The parameter values I use are in the range of those found in other studies:

| $\beta$ | $\mu$ | $\phi$ | $\delta$ | $\sigma$ |
|---|---|---|---|---|
| 0.98 | 2 | 0.4 | 0.08 | 0.7 |

Starting at $t = 0$, the elasticity $\xi$ evolves according to the linear adjustment path

$$\xi_t = \max\{\xi - \Delta t,\, \xi'\}$$

which is perfectly anticipated by households. Parameter $\Delta$ has chosen to be 0.5 to have a relatively smooth adjustment to the new steady state.[6] $\xi$ and $\xi'$ are chosen to be 20 and 10 respectively. These values are consistent with the range of estimated markups for the U.S., which in terms of gross output vary between 1.05 and 1.15 (Jaimovich, 2007). Figure 3.1 shows the dynamics when the economy transits between the two steady states.

Figure 3.1 plots the series of labor share, output, Tobin's Q, capital-ouput ratio, equity-output ratio and return to capital. As can be seen from the figure, output falls but capital falls even more, which drives the capital-output ratio down

[5] The reason for this is that asset prices and Tobin's Q are extremely sensitive to small changes of $\theta$ when realistic values of the Frisch elasticity are considered. This make me thing that the modelling strategy of the labor market exacerbates the impact of monopsony markups. Qualitatively, however, the impact of $\theta$ on assets prices is properly captured by Tobin's Q equation 3.32

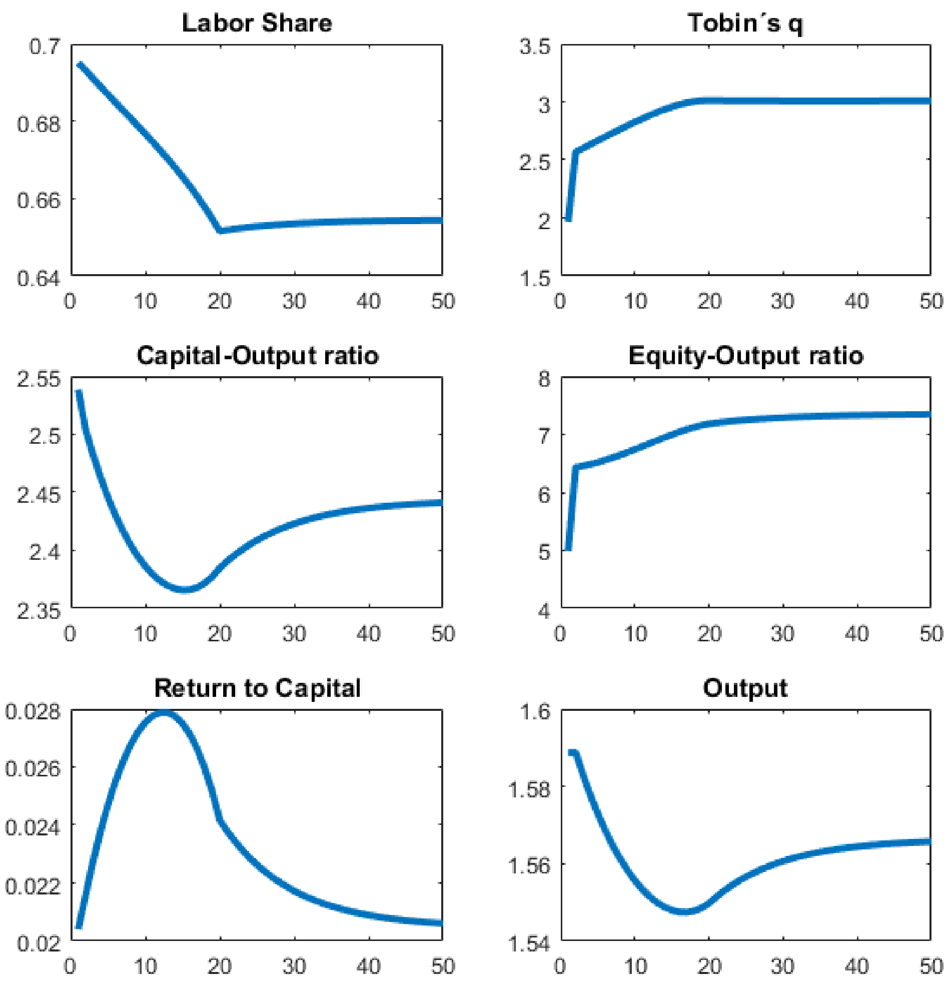
[6] In a proper calibration, $\Delta$ should be chosen to match the length of Tobin's Q adjustment.

to a new lower steady state. This is the computational counterpart of proposition 3.3. This decline is consistent with the evolution, in real terms, of the corporate-physical-capital-output ratio observed in the U.S. economy (see figure 1.8 in Gonzalez, 2016b), although the magnitude of the decline is small compared to the data.

Despite the decline of real investment and capital stock, the real value of the corporate sector grows notably when markups increase. This is perhaps the strongest evidence in favor of market power as a plausible story for secular stagnation. The decoupling between firms' profitability and the lack of new capital investment is here captured by the endogenous response of Tobin's Q. As expected, the equity-output ratio response follows a very similar trajectory, a fact that is also observed in the data. This result, which is absolutely predictable from the context of the model, is quite relevant from the point of view of the policy debate. This is because the joint evolution of Tobin's Q and the equity-output ratio would back the "market power" narrative against the alternative argument according to which the evolution of asset prices can be explained thanks to the rise of intangible capital (see footnote 2).

There is, however, substantial divergence between the Tobin's Q and asset prices values generated by the model and the empirical counterparts (see figure 1.3 in Gonzalez (2016b)). First, note that steady state Tobin's Qs are substantially higher than those observed in the data. This is because the model, by construction, has a lower bound at $Q = 1$ and, more importantly, because asset prices become very sensitive to markup levels. The value of firms' equity reflects not only the value of its productive capital, but also the future monopoly rents, which are perfectly anticipated and, therefore, can be very high in relation to their current capital. Second, U.S. Tobin's Q series has been growing but the evolution differs quite remarkably from the Tobin's Q generated by the model. Whereas Tobin's Q in the data started growing slowly and soared during the late 1980s, the model predicts a rapid growth during the first years and a subsequent slowdown. This is because monopoly power has not followed a linear path and, more importantly, because -again- perfect foresight permit agents to anticipate the value of future monopoly rents, and this has a higher impact on immediate asset values.

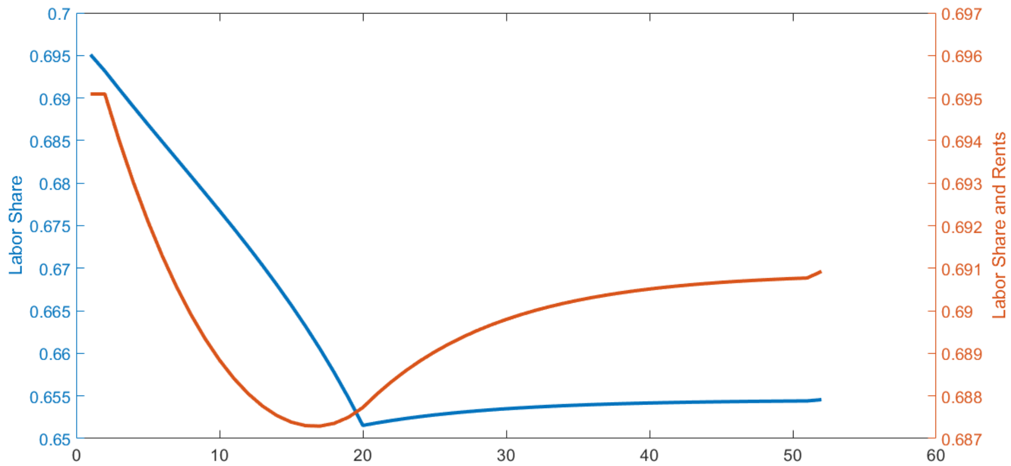
FIGURE 3.1: Transition dynamics: Labor Share and Tobins Q




The model also predicts an increase in corporate capital returns which, from figure 1.5 in Gonzalez (2016b)), we know that have also been increasing in the U.S. since the early 80s. The predicted increase is small compared to what we observe in the data, but the model abstracts from capital income tax and stock market costs, which have also changed a lot during the recent period. Importantly, the return to capital reverts to its original steady state value because, at the steady state, the return is always stuck at $\frac{1}{\beta} - 1$. This would be the main difference with respect to Anagnostopoulos et al. (2012) where, more realistically, the return to capital move from one steady state to another steady state along an increasing demand of assets.

The model is also consistent with the widely discussed evolution of the U.S. labor share. Figure 3.2 plots the series of the labor share (in blue) and the value of the labor share that would have prevailed if workers had kept the subtracted rents (in red). The labor share falls because i) the size of the monopoly rent increase in relation to the marginal productivity of labor and because ii) the marginal productivity of labor itself falls more than the level of output. The first effect is purely distributional. The second effect captures an allocative change but that also has distributional implications.

FIGURE 3.2: Labor share decomposition




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

$$\frac{LF_L(K,L)}{y} = 1 - \phi \left(\frac{K}{y}\right)^{\frac{\sigma-1}{\sigma}} \tag{3.46}$$

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

$$\frac{wL}{py} = \left(1 - \frac{1}{\xi}\right)\left(1 - \phi\left(\frac{K}{y}\right)^{\frac{\sigma-1}{\sigma}}\right) \tag{3.47}$$

The total decline of the labor share is captured by the blue line. A decrease in the elasticity from 20 to 10, which represents an increase in the markup of 5.6 per cent, causes a decline in the labor share of 5.9 per cent. To isolate the effect of the capital-output ratio, I simulate the labor share leaving constant the proportional size of the rent $1/\xi$ but allowing the capital stock to move according to the implied transition. This series is given by the red line in figure 3.2. Not surprisingly, the shape of this series is very similar to the capital-output ratio series. This is because the elasticity of substitution is $\xi = 0.70$, which implies complementarity between capital and labor and a corresponding positive relation between $\frac{K}{y}$ and $\frac{LF_L(K,L)}{y}$ (see equation 3.46). However, the simulated labor share only declines 0.6092 per cent, implying a very small effect of the capital-output ratio (note that axes in figure 3.2 have different scales). The reason for this limited effect is twofold. On one hand, the effect that the change in $\xi$ has on the capital-output ratio is limited itself. Figure 3.1 shows that the capital-output ratio transits from 2.53 to 2.44, implying a decline of 3.88 per cent, which is still small compared to what we have observed in the U.S. On the other hand, our value of $\sigma$, which presumes a relatively high degree of complementarity, might not be low enough. Indeed, the preferred estimate in Chirinko and Mallick (2014b) is 0.4. In that case, the implied effect of the capital-output ratio on the labor share would have been substantially higher.

In any case, the model is able to disentangle between the two channels. Because of that, it is a convenient framework where to include other important frictions (like capital income taxes) and conduct a better calibration, in order to distinguish between the distributional effects of pure allocative changes and the pure distributional implications of monopoly power.

## 3.5 Conclusion

Is monopoly power a reasonable explanation for secular stagnation? The analysis of this paper suggests that it is. I propose a growth model that incorporates imperfect competition in the goods and labor market. Within the context of the model, I derive an expression for Tobin's Q in terms of future monopoly rents and I show that, under certain conditions and for a given return to capital, a higher degree of monopoly power implies lower output and lower capital stock. More importantly, the model predicts phenomena that have actually happened during the last three decades in the U.S. economy. In response to an increase of monopoly markups within the range of values found by the literature, the model generates convincing series of asset prices, Tobin's Q, returns to capital, the capital-output and the equity-output ratios, and the labor income share. The model is good at explaining why firms have become more profitable while decreasing the investment on new capital, although asset prices are be very sensitive to markup changes whereas capital and output are very little. The model also provides a good framework to study the distributional aspects of secular stagnation caused by monopoly power because it is able to disentangle between the pure distributional effects of monopoly power and the distributional implications of the allocative effects of monopoly power. These results, along with the existing evidence of increases in monopoly power, suggests that market power deserves increased attention to understand the last decades of the U.S. and, possibly, other advance economies. This model only pretends to be a very first step in that direction.

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