Tobin's Q and Inequality*

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Abstract

Since the early 1980s, equity Tobin's Q has experienced a secular increase in the US, as equity wealth and corporate physical capital have followed divergent trajectories. During the same period, labor productivity and wages have significantly decoupled, leading to a decline in the U.S. corporate labor share. We build an incomplete markets model (in the Bewley-Hugget-Aiyagari tradition) with financial assets and monopoly power to explain the connection between these phenomena. Our model is consistent with several stylized facts of the U.S. economy since 1980. The evolution of capital taxation and the rise of monopoly markups explain the decrease in investment flows and the rise in the market value of existing capital. Wage-productivity decoupling is the natural response not only to the rise of markups, but also to investment sluggishness when capital and labor are complements. We therefore reconcile a simultaneous decrease in the labor share and an increase in the market value of capital with an elasticity of substitution below one. Our model also explains the historical upsurge of equity returns. By explicitly modelling the interaction between monopoly profits and different capital taxes, our framework sheds light on the current debate on capital taxation in the U.S. and elsewhere. We conclude that the secular increase in the relative value of financial wealth is not only a nominal phenomenon, but has had real effects in general equilibrium, rendering a more unequal pre-distributive allocation of income. These secular trends in taxes and market structure have reduced welfare, since the increase of financial wealth, which is mostly experienced by the richest households, occurs at the expense of corporate investment and labor earnings, which are the main source of income for a large portion of the population.

JEL Codes: E25, E44, E22.

Keywords: Tobin's Q, Equity returns, Asset Prices, Capital-Income ratios, Investment, Dividends and Capital Gains Taxes, Corporate Tax, Monopoly markups, Labor Share, Inequality, Welfare.

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1 Introduction

Wealth-to-income ratios have significantly risen in major advanced economies since the early 1980s. As convincingly shown by Piketty and Zucman (2014), a large portion of this rise can be attributed to a long-run swing in relative asset prices. At a global scale, house prices can account for a big part of the increase in the value of wealth, but there are particular countries in which other assets have significantly contributed to it. The U.S. case is illustrative. The equity market value of U.S. non-financial corporations has more than tripled with respect to its total gross value added during the period 1980-2015.

At the same time, the period 1980-2015 has been characterized by a slowdown in corporate investment. In the non-financial corporate sector, the average growth rate of real investment during the period 1947-1979 was 4.97 per cent and declined to 3.63 during the period 1980-2015. Investment also declined relative to output and capital. Net fixed capital formation was, on average, 4.06 per cent of gross value added and 2.55 per cent of net capital stock during the period 1947-1979. These numbers fell respectively to 3.03 and 1.83 during the period 1980-2015.

The decoupling of equity wealth and real capital poses a challenge for standard neoclassical theory. In standard models where firms accumulate capital and households accumulate corporate securities, the aggregate market value of these two variables is expected to move in the same direction. Productive capital is the part of firms' net worth that yields the flow of future dividends capitalized in the market value of corporate securities. In fact, in the absence of frictions, standard theory says that in equilibrium these two aggregates are equal and their ratio, Tobin's Q, should be equal to one.

However, historical values of Tobin's Q have neither been constant nor equal to one. The standard measure of Q is equity wealth over non-financial plus financial assets minus non-equity liabilities. Figure 1 shows the evolution of standard as well as alternative measures of Q for the non-financial corporate sector. Consistent with the surge in equity and the decline in physical capital formation discussed above, Tobin's Q has experienced a secular increase since the 1980s and seems to have stabilized after the burst of the dot.com bubble despite the big fluctuations associated with the recession and the recovery. In 2015, standard Q was 1.01.

In this paper, we show that the secular rise of Tobin's Q cannot be ignored in the discussion about growth and inequality after 1980 because it reflects the role of certain pro-capital policies that have real effects on aggregate outcomes. We present an incomplete markets model in the Bewley-Huggett-Aiyagari tradition that takes the distinction between equity wealth and corporate capital seriously. As in Anagnostopoulos et al. (2012), we 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 financial capital, which is owned by households, and physical capital, which is owned by firms, we can study how changes in Tobin's Q impact those aggregates. We use the model to explain the recent evolution of these two aggregates for the U.S. corporate sector and their consequences on inequality and welfare. In particular, we show that the observed increase in the equity-wealth-to-income ratio is compatible with the slowdown of investment and therefore the decline of the physical-capital-to-income ratio.

We argue that the post-1980 evolution of the U.S. equity Tobin's Q has been mostly driven by two factors. On the one hand, a deep change in capital income taxation during the past decades, which we document thoroughly in section 3.2. On the other hand, a rise in monopoly rents, which we connect to recent literature. In our model, because monopoly rents emerge as part of standard corporate payouts, they are capitalized in the value of equity, and therefore, claims on these monopoly rents are already incorporated into households' tradable stock market wealth. This is an important and realistic feature of our model. To complete the picture, we also incorporate an additional mechanism: a small fee on portfolio management that can account for inefficiencies in financial markets and that is conceptually equivalent to a tax on financial wealth. Finally, we explore the role of short-termism and show that increasing short-termism is observationally equivalent to a rise of monopoly markups.[1]

We show that, through the increase in asset prices, the rise in Tobin's Q has strong general equilibrium effects that have not been usually considered in the literature. The model predicts that investment and the physical-capital-to-income ratio decrease when Tobin's Q rises. In other words, the wealth originated from lower capital taxes and the capitalization of monopoly rents crowds out capital formation. This has an impact on labor productivity and wages, as is easily inferred from any theory where wages and real capital are connected, and is therefore consistent with the well-known stagnation of real median wages in the post-1980 period.[2] In this context, and beyond the direct impact of the markup on wage-setting decisions by firms, wage-productivity decoupling and the decline of the labor share are natural responses to investment sluggishness if capital and

[1] Our approach is different to that of Hayashi (1982), who formalizes the idea that the market value of capital and its replacement cost can be different when capital is costly to install. Hayashi (1982) established the conditions under which marginal and average Q are the same. One of these conditions, anticipated by Tobin and Brainard (1977), is precisely that the firm has to be a price-taker.

[2] For different figures on wage stagnation, see the EPI report "Wage Stagnation in Nine Charts", available at http://www.epi.org/publication/charting-wage-stagnation/

labor are, on average, complements. This would imply an elasticity of substitution within the range of estimates found by the specialized literature, which has mostly suggested values between 0.4 and 0.7 (Oberfield and Raval, 2014; Chirinko and Mallick, 2017).

Moreover, the model also predicts an increase in equity returns as a result of an increase in Tobin's Q, which is consistent with the post-1980 U.S. economy, as reported by McGrattan and Prescott (2003). In a latter paper, McGrattan and Prescott (2005) study the secular increase in Tobin's Q using a representative agent model, a framework that does not allow to analyze long-run changes in equity returns. In contrast, we use an incomplete-markets framework, which turns out to be crucial for changes in Tobin's Q to affect equity returns. In our model, when the market valuation of existing capital rises, shareholders can enjoy a higher amount of wealth with lower capital intensity. As in Anagnostopoulos et al. (2012), this is an equilibrium outcome where higher wealth implies higher demanded returns, and less capital implies higher offered returns.

The adverse consequences of the joint rise of equity wealth and the slowdown of capital formation are evident. The heterogeneous-agent assumption also allows us to put these secular aggregate changes in a distributional perspective. While owners of equity benefit greatly from the rise of its value and from increasing equity returns, households whose income depends mostly on labor suffer from the decline of capital formation. Given the resulting distribution of income, the model also predicts a very unequal welfare impact that is particularly severe for households without substantial asset holdings.

Our paper is connected to recent debates on capital income taxation in the U.S. and elsewhere. We first show that, apart from the rise of monopoly markups, the joint evolution of dividend and capital gains taxes might explain a substantial part of Tobin's Q upsurge and its effects on capital formation. Regarding capital formation, we show that the positive effects of the observed decrease in effective corporate taxes shrinks compared to the negative effects of the observed decrease in dividend taxation.[3] Furthermore, we show that a decline in these taxes exacerbates the general equilibrium effects of the monopoly rent. Finally, our model shows that, in the presence of monopoly power, the ability of the corporate tax to foster investment diminishes. This happens precisely because a reduction in the rate also raises the effective monopoly rent and amplifies the general equilibrium effects through the rise in asset prices and Tobin's Q. Consequently, according to the results of the model, and given the current fiscal structure, we believe that the debate on capital income taxation should pay more attention to taxes on the distribution of profits rather than on profits themselves.

[3] Moreover, given our modelling strategy, the predicted positive impact of the corporate tax rate is likely to be an upper bound because we are not considering interest deductibility on corporate debt.

The rest paper is organized as follows. In section 2 we discuss related literature connected to our contribution. In section 3 we discuss the empirical evidence of both the secular trends in macroeconomic aggregates and the changes in policy rates and other frictions that we argue have affected Tobin's Q. In section 4, we introduce our hypothesis in a simple, graphical and intuitive way. In section 5 we sketch the model. Section 6 discusses the different transmission mechanisms in isolation, while section 7 combines them in a calibration exercise. In section 8 we conduct a welfare analysis In section 9 we discuss another potentially important mechanism that we leave for future research and section 10 concludes.

2 Related Literature and Discussion

Our starting point is Piketty and Zucman (2014). They find that rich countries have experienced a gradual rise of wealth-to-income ratios in recent decades, driven by a long-run asset price recovery and by the slowdown of productivity and population growth. One of their main arguments connects the rise of wealth-to-income ratios with the rise in capital shares and, given the joint concurrence, they conclude that a parsimonious explanation for it would be abnormally low diminishing returns to capital. In terms of the standard neoclassical aggregate production function, this implies an elasticity of substitution between capital and labor, σ, substantially larger than one.

These empirical findings opened a vivid debate in academic circles about the implications of rising wealth-to-income ratios and the high value of the elasticity of substitution inferred by Piketty and Zucman (2014).[4] While this discussion was insightful, the evidence that wealth-to-income ratios were driven mostly by an asset price recovery, including the recovery of stocks prices, received less attention. But the recovery was significant in rich countries. The value of corporate securities increased much more than the available measures of corporate capital stock, and the country-specific series of Tobin's Q reported by Piketty and Zucman (2014) display a growing trend since 1980 until the early 2000s, with the rise being particularly intense in the U.S. and the U.K.[5]

Piketty and Zucman (2014) used the market value of corporations to construct national wealth aggregates and, despite the positive trends of Q, they also use the market value of corporations as their measure of corporate capital input, an assumption motivated by

[4] Rognlie (2014), for example, reviews the evidence on the behavior of capital income to changes in aggregate capital, and concludes that diminishing returns are powerful enough to produce a decrease in the capital share as capital is accumulated.

[5] Among the reviews of Piketty (2014), one who emphasized this particular point was Rowthorn (2014).

measurement problems in available estimates of the corporate capital stock.[6] This is conceptually equivalent to assuming that Tobin's Q was equal to one during the post-1980 period.[7] Although we share the measurement concerns, we instead believe that assuming that Tobin's Q is constant and equal to one shadows the important role of pro-capital policies on its evolution, and through it, on aggregate outcomes. These policies have inflated stock market prices at the cost of corporate investment. Our paper emphasizes the role of capital income taxation and monopoly rents.

Sialm (2009) investigates whether personal taxes on equity securities are related to aggregate stock valuations and finds that stock valuations tend to be relatively low when tax burdens are relatively high. McGrattan and Prescott (2005) find that the large decline in the effective marginal tax rate on U.S. corporate distributions can account for the high value of equities in the late 1990s relative to the 1960s. In their representative agent framework, households temporarily benefit from an increase in asset prices, but long-run real aggregates are not affected. Anagnostopoulos et al. (2012) show that when household heterogeneity is considered, a reduction in dividend tax rates has the effect of reducing aggregate investment and the capital stock. Our model is similar to theirs but we introduce capitalized monopoly rents and corporate taxation. An important implication of this set-up is that dividends respond strongly and positively to a decrease in dividend taxes, even though investment is financed exclusively using internal funds.[8] In our context, this is exacerbated by the presence of monopoly markups.[9] In our calibration exercise, we assume that tax reforms are unexpected and perceived as permanent, like most of the literature. Korinek and Stiglitz (2009) show that a temporary dividend tax rate reduction can also be associated with an increase in share prices and dividend payments and a lowering of investment.

Our paper is connected to the literature on Tobin's Q. Lindenberg and Ross (1981) and Salinger (1984) use Tobin's Q to measure monopoly power and examine the relation between market structure and profitability. We obtain a similar expression for Tobin's Q

[6] One of their main concerns is the measurement of R&D. After the 2013 revision, the BEA has improved the measurement by treating expenditures in R&D as investment in durable capital and not as intermediate nondurable goods.

[7] They also report book values of national wealth where corporate wealth is based on PIM estimates of corporations' non-financial assets.

[8] Sinn (1991) shows that most corporate capital is generated by retained earnings rather than equity issuance. Gourio and Miao (2010) show that firms that distribute dividends and use retained earnings to finance investment represent more than 90 per cent of investment and account for more than 90 per cent of the capital stock. Chetty and Saez (2010) obtain a similar result using an agency model of the firm.

[9] On the one hand, our model would conform to the so called new view on dividend taxation, as in Anagnostopoulos et al. (2012), since the marginal source of financing is retained earnings. But on the other hand, dividend taxes have real effects on investment and dividends, which in our case are exacerbated by the presence of monopoly markups. For a detailed discussion of the traditional and the new view, see Poterba and Summers (1983).

by assuming Dixit-Stiglitz preferences and we use it in general equilibrium to asses the aggregate and distributional effects of an increase in monopoly power. Cao et al. (2013) propose a theory where Tobin's Q reflects the value of a "quasi-rent" that weakens the relation between investment and Q. In our model, that rent is a monopoly rent.

A growing body of research puts emphasis on the recent rise in monopoly power. Stiglitz (2015) argues that the disparity of wealth and productive capital might partially be due to the capitalized value of monopoly rents and other rents. Grullon and Michaely (2015) show that, over the past two decades, firms in industries with the largest increases in product market concentration have also realized higher profit margins and abnormally high stock returns. Azar (2012) analyses the existence of implicit collusion through portfolio diversification and shows that the relation between markups and networks of common ownership is empirically significant. Loecker and Eeckhout (2017) document the evolution of markups based on firm-level data for the US economy since 1950. Their main finding is that while average markups were fairly constant between 1960 and 1980, there was a sharp increase starting in 1980, with the increase occurring mainly in the top of the markup distribution. Barkai (2016) argues that a decline in competition is necessary to generate simultaneous declines in the labor and capital shares when the return on capital is measured by the cost of borrowing, and shows that increases in industry concentration are associated with declines in the labor share. Bessen (2015) shows that regulatory rents are related to corporate valuations and profits.

Our paper is closely related to Gutierrez and Philippon (2017). They show that since the early 2000s investment has been weak relative to measures of profitability and valuation, particularly Tobin's Q. They argue that this is associated to intangibles, competition and short-termism. Their empirical results are consistent with our model but, in our view, most of the indicators of profitability, including Tobin's Q and markup estimates, started to decouple from the aggregate trends of gross and net investment in the early 80s. Our approach is also different. Our aggregate Tobin's Q contains the aggregate asset price effect of capital income taxes and monopoly rents. Therefore, by construction, we expect a weak relation between observed Tobin's Q and investment.[10]

[10] Regressions of investment on Q for the period under consideration seem to support our interpretation. Figure 13 in the appendix plots Net Investment-to-Capital vs Tobin's Q. The correlation of current investment to lagged Q is positive but insignificant during most of the period, and turns significantly negative from the 2000s onward. In our opinion, data is inconclusive enough as to infer reliably a specific estimate from a given decade. We have also run tests using Net-Investment-to-Output and other measures of equity as the explanatory variable. Their correlation is even weaker, insignificant, and if anything, negative, for most of the time period. Weak significance can be due to other factors affecting investment independently of Tobin's Q, notably changes in the relative price of investment goods, as proposed by Karabarbounis and Neiman (2014) and Chen et al. (2017). Gonzalez and Trivin (2016) use panel time series regressions and find that the labor share is negatively related to Tobin's Q but they find no significant relation between the labor share and the relative price of investment goods and between

We build on the model proposed by Aiyagari (1994), which has become a workhorse in the literature on heterogenous agents in macroeconomics. An important feature of these models is that the elasticity of capital supply is finite, as opposed to the infinite supply curve that characterizes complete markets models. This feature is particularly convenient when studying the response of aggregate returns to changes in capital, and viceversa. Although most of this literature is characterized by over-accumulation due to the precautionary savings motive, Davila et al. (2012) show that for a realistic calibration of the income and wealth distributions, the market outcome is characterized by under-accumulation. A similar result is inferred from our welfare analysis.[11] However, our analysis provides an additional mechanism by which this sub-optimally low level of the capital stock is achieved in the steady state.

Finally, our paper resonates with the recent literature on secular stagnation. This literature has focused on explaining the secular decline in the natural rate of interest, a decline that has coincided in timing with the secular changes that we study. In this literature, a persistent excess of savings over investment pushes the real rate down. Eggertsson et al. (2017) emphasize the contribution of demographic and technological factors in the decline of the interest rates since 1970. Rovo (2017), like us, emphasizes the role of market power and shows that an increase in the markup puts a downward pressure on the equilibrium interest rate. However, we take a different scope, as our modelling of the capital market puts emphasis on the rise of asset prices and the financial price of equity relative to capital, rather than a mismatch between savings and investment. Although we do not model aggregate uncertainty, the price that adjusts in our model is the return to equity, which is conceptually different to the real interest rate[12], and has remained abnormally high. This equity return reflects after-tax profits, including the capitalization of monopoly rents. As a consequence, the firm internalizes its stockholders desired return when taking its investment decisions, which have a one-for-one relationship with asset prices via Tobin's Q. The rise in returns and in Tobin's Q negatively impact the firm's demand for investment. In this sense, our theory provides an alternative explanation for the decrease in the capital-to-output ratio that the literature on secular stagnation has emphasized. Moreover, our analysis highlights additional mechanisms by which institutional factors,

Tobin's Q and the relative price of investment goods.

[11] Hubmer et al. (2016) also use a version of this model and compute that the most important driver of wealth inequality during the last three decades has been the significant drop in tax progressivity that started in the late 70s.

[12] Some papers have recently formalized a distinction between the profit share and the capital share, the latter given by the flow from capital priced at its marginal product after adjusting for the markup (Barkai, 2016). In our model, this flow is part of the return to equity and does not represent a claim *per se*. Therefore, the so-called capital share cannot be thought of as an independent object in the context of our model.

such as capital taxation or the regulation of competition, ultimately affect the aggregate performance of the economy.[13]

3 Stylized facts in the U.S.

This section is divided in two parts. The first part discusses the empirical evidence on the evolution of Tobin's Q, physical capital and wealth-to-income ratios and equity returns. The joint evolution of these aggregates draws the general picture that our hypothesis aims at explaining. In the second part of this section we explain how secular changes in Tobin's Q might have been caused by fundamental changes in the taxation of capital and the rise of monopoly rents.

3.1 Secular trends in macro-economic aggregates

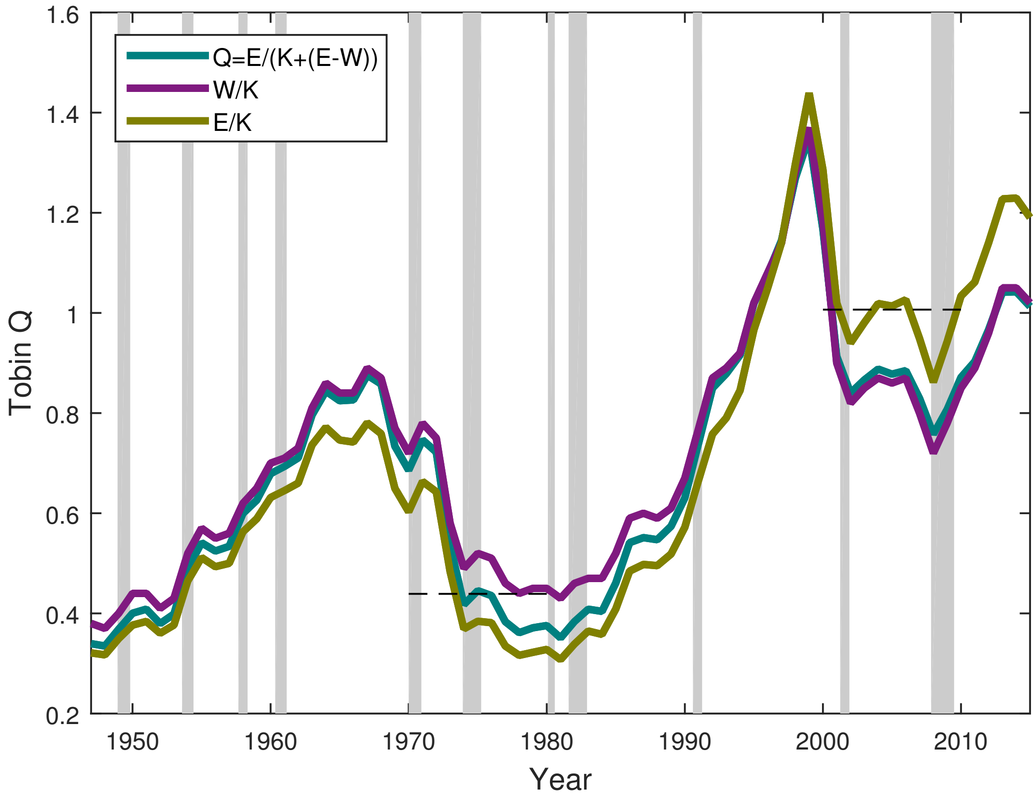
Equity Tobin's Q is the ratio of equity value to the sum of non-financial assets, financial assets and negative corporate liabilities. Figure 1 plots Tobin's Q for the non-financial corporate sector. We observe that during the 70s, the U.S. corporate sector had a relatively low Tobin's Q, and that it started to grow from 0.4 to values close to one by the end of 90s. This rise of asset prices implied substantial capitals gains for corporate shareholders which seemed to occur at the same time that corporate investment rates were declining.[14]

In figure 16 (in the appendix), we decompose total corporate value into equity, non-equity liabilities and financial assets for the corporate sector both with and without financial corporations. For the non-financial corporate sector, financial assets and non-equity liabilities display a similar trend, which suggests that changes in Tobin's Q are mainly driven by the relative size of corporate equity to non-financial assets. On the other hand, for the aggregate corporate sector, financial assets almost double the rise of non-equity liabilities, and equity-to-output surges to values over 4. Therefore, the dynamics in the financial sector seem to differ widely from those of the rest of the corporate sector, driving the aggregate behavior of the sector as a whole. In particular, the accumulation of financial assets by financial corporations explodes from the early 1990s. Since we do not attempt to model the behavior of financial corporations, our focus is on non-financial sector aggregates.

[13] Our results are consistent with Sharpe and Suarez (2014) who find that i) most firms claim their investment plans to be quite insensitive to decreases in interest rates, and ii) that the hurdle rate has not decreased, despite the downward trend in market interest rates.

[14] 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.

Figure 1: Tobin's Q, 1947-2016



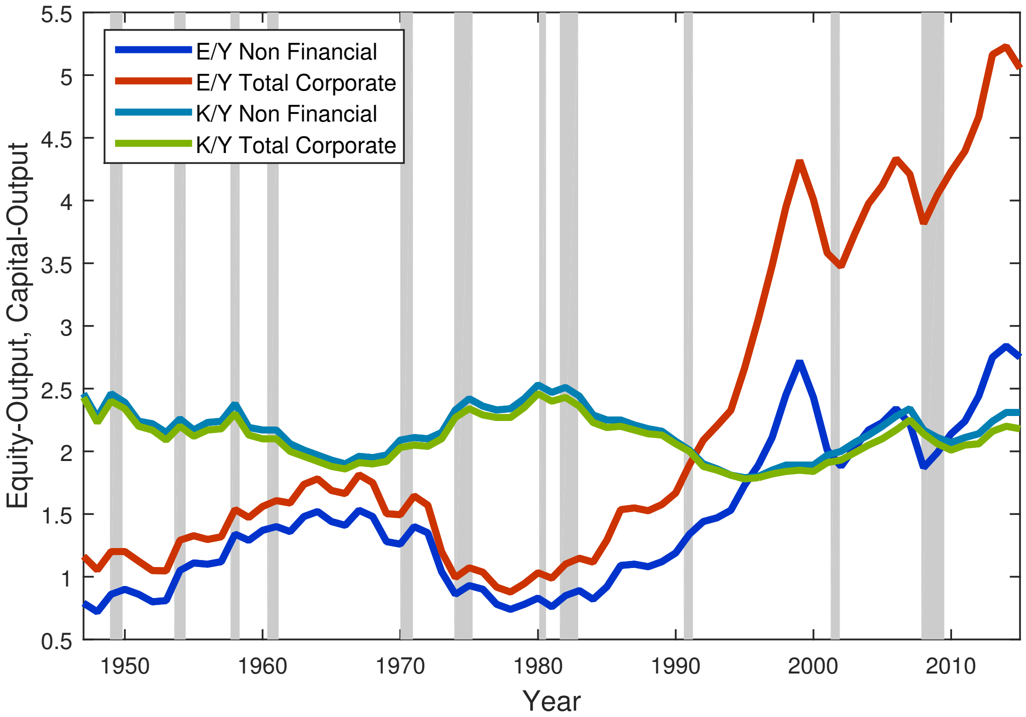
We report three different values of Q. The standard measure of Q is Equity Wealth (E) over Non-financial assets (K) plus Financial Assets minus Non-Equity Liabilities. We also report an alternative measure that puts these last two items in the numerator instead of the denominator, subtracting Financial Assets and summing Non-Equity Liabilities to Equity, yielding total value W. Since our model does not feature Non-Equity Liabilities nor Financial Assets owned by corporations, we also report the Equity-to-physical-Capital ratio. Black horizontal dashed lines are decade averages for E/K.

Equity-to-output in the U.S. corporate sector has risen remarkably since the early 1980s. This increase coincides in time with a slowdown of corporate investment[15] and a decline of the corporate capital-to-output ratio. These are the main aggregates in the numerator and the denominator of Tobin's Q, respectively. Figure 2 shows the evolution of the two ratios separately: equity-wealth-to-output (equity to gross corporate product) and capital-output (non-financial assets to gross corporate product) both for the aggregate corporate sector and excluding financial corporations. Equity-to-output experiences fluctuations around values ranging from 1 to 1.5 from the late 1940s until 1980, when it initiates a secular increase that stabilizes after the 2000s. On the other hand, the capital-output ratio has experienced a slow but steady decline. Note that it seems to increase slightly from the beginning of the 2000s. However, an analysis of the capital-output ratio

[15] See figure 14 in the appendix.

in real terms[16] shows that the downward trend is not reverted, suggesting that these upward movements are potentially due to a price effect of corporate real state.[17] Data on net capital formation also confirm the downward trend in capital intensity.

Figure 2: Equity-Wealth-Output and Corporate-Capital-Output ratios, 1947-2016

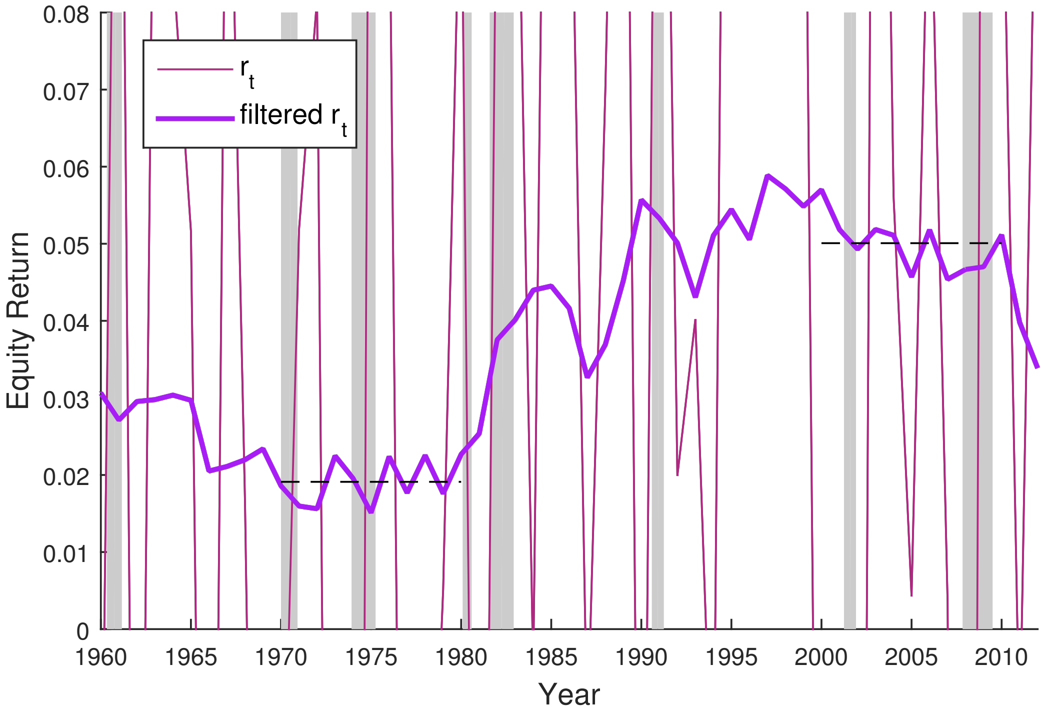


The measure of corporate capital sums all the non-financial assets (real estate, equipment, intellectual property products and inventories). Equity wealth sums the market value of equities for the whole corporate sector.

Figure 3 shows U.S. equity returns, adjusted for inflation, taxes and portfolio costs.[18] The filtered series show that equity returns have increased with respect to their historical average. During the decade ranging from 1970 to 1980 they fluctuated around a value lower than 2%, but starting in the 1980 they begin a steady increase and have fluctuated around 5% in the post-1990 period.

[16] Figure 15 in the appendix shows $log(K/Y)$ in chained dollars.
[17] This is confirmed by the evolution the real estate price index (Shiller, 2009=100).
[18] Figure 17 in the appendix plots all the series from gross to net returns after successive adjustments.

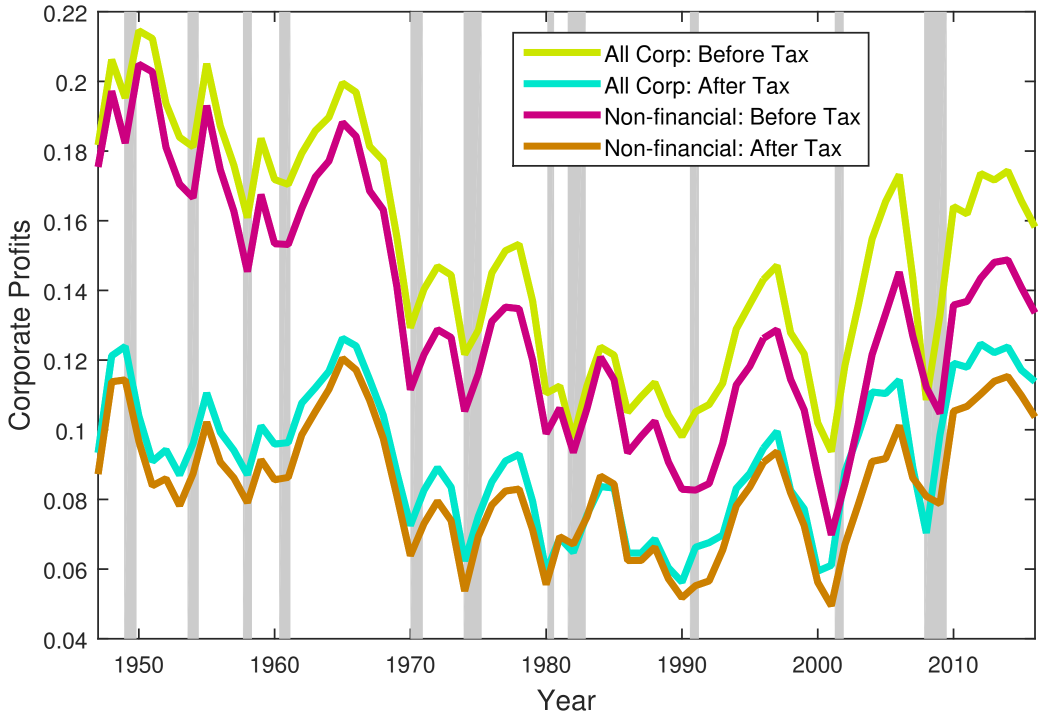
Figure 3: Equity Returns adjusted for Inflation, Taxes and Costs (%), 1960-2012



Ibbotson (2013) provide data on nominal before-tax returns for the period 1926-2012. The following calculation is done to adjust for taxes, diversification costs and inflation: $1 + r_t = \left(1 + r^{Ib} - \tau^d y^{Ib} - \tau_g \left(1 + r^{Ib} - y^{Ib} - \frac{CPI_{t+1}}{CPI_t}\right)\right) / \left(\frac{CPI_{t+1}}{CPI_t}(1+\kappa)\right)$ where r^{Ib} is nominal before-tax total return, y^{Ib} is the income part of the total return (also provided by Ibbotson (2013)), κ is an estimate of the costs of holding a diversified portfolio (provided by the Investment Company Institute), CPI is the Consumer Price Index, τ_d is the tax rate on dividend income and τ_g is the tax on capital gains. Since these are very volatile data, we follow McGrattan and Prescott (2003) in filtering the series with a 31-period centered moving average, that becomes asymmetric in the tails as we reach the end of sample. Returns are shown for the period 1960-2012.

Consistent with the historical increase in equity returns, corporate profits have also increased during the last decades. Figure 4 shows the evolution of corporate profits before and after corporate taxes. The series show a positive trend since the early 90s despite the falls associated with the recession in the early 2000s and the Great Recession. Average corporate profits did not increase during the 80s. However, the corporate payout ratio was as high as during the 90s (Lazonick and Sullivan, 2000), and this is consistent with the observed decline of corporate investment during the 80s (see figure 14).

Figure 4: Corporate Profits, 1947-2012



Corporate profits are expressed as a fraction of corporate gross value added, before and after corporate taxes. Data is from BEA table 1.14 and refer to total corporate business and non-financial corporate business.

Summing up, Tobin's Q, equity-to-output, capital-to-output, equity returns and profits seem to have experienced secular changes from 1980 onward that drove them away from their historical averages. Moreover, they stabilized around the 2000, but haven't reverted back to mean.[19] While the remarkable increase in asset prices and returns was taking place, corporate investment was slowing down and the labor share was falling. This paper proposes a joint explanation for these stylized facts. We build a model where profound changes in the structure of capital taxation and the increase in market power are the main factors driving the increase in Tobin's Q and the slowdown in capital accumulation. The next section discusses evidence on taxes, the costs of financial intermediation and market power.

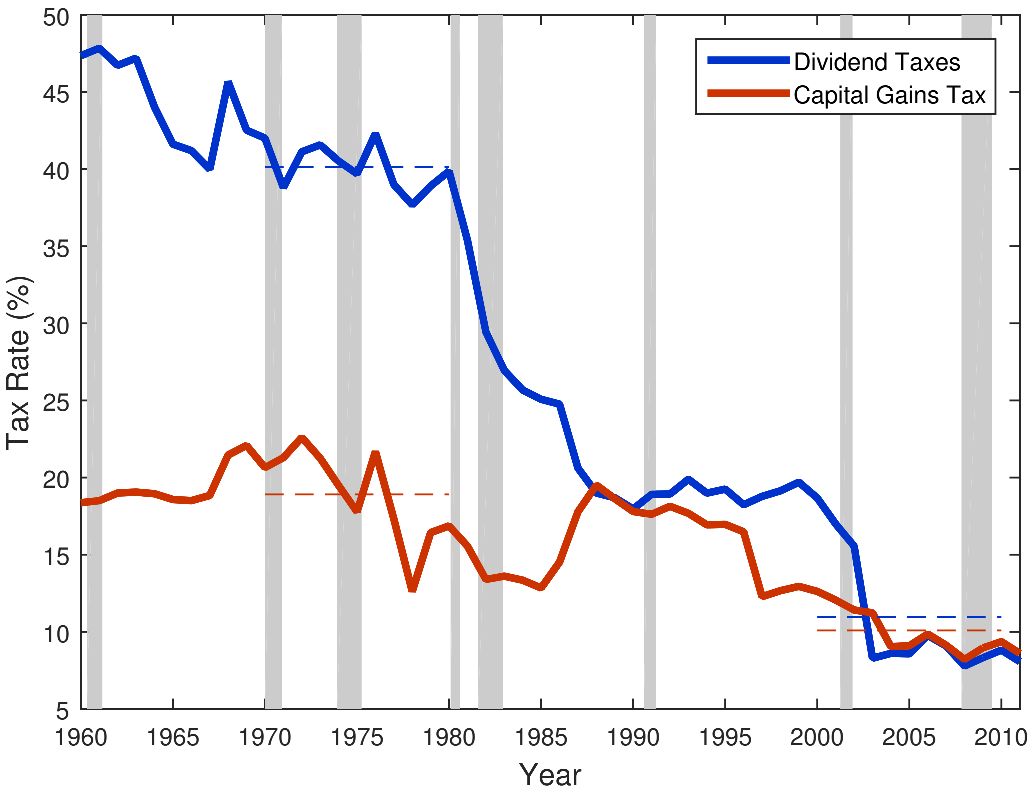
3.2 Capital income taxes, Portfolio Costs and Monopoly Rents

In our model, we show how the structure of capital taxation, financial intermediation and monopoly rents affect Tobin's Q. The fiscal structure facing capital income has signifi-

[19] In line with this evidence, the earnings yields to price ratio has also stabilized from the 2000s onward, after following a secular fall during 1980-2000 (Caballero et al., 2017). This would indicate that capital gains where high during the transition, and have disappeared after asset prices have stabilized.

cantly changed in the past decades. Figure 5 plots our estimates of the average marginal taxes on dividend income and capital gains taxes from the 1960s to 2011. We observe declining trends in both rates. The fall is particularly striking for the dividend income tax. In 1980, average marginal dividend tax rate was close to 40 per cent while we observe rates below 10 per cent in the most recent period. The change in the capital gains tax is not so pronounced but it is non-negligible.

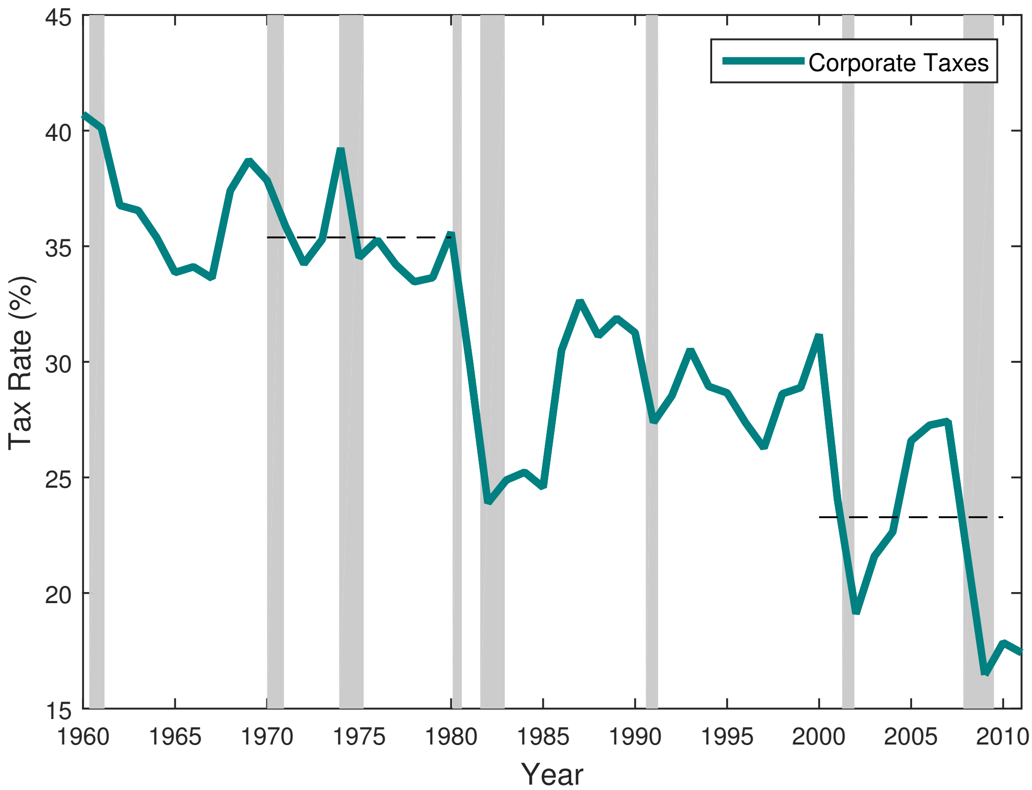
Figure 5: Effective Dividend and Capital Gains Taxes



We use average marginal taxes for taxable investors calculated by the NBER model with micro data from the Statistics of Income Distribution of the Internal Revenue Service. We compute marginal average tax rates by adjusting TAXSIM estimates with the proportion of equities held by taxable investors. The proportion of equity held in taxable accounts is estimated using data on tax-qualified accounts (pension funds, IRAs and non-profits) from the Flow of Funds' database of the Federal Reserve. We also adjust for local and state taxes. We follow Sialm (2009) for the computation of this adjustment.

In figure 6 we plot the effective U.S. corporate tax rate. The series show that the amount of taxes effectively paid by U.S. corporations has decline over time. The rate was 35.5% in 1980 and it fell to 19.1% in 2006. Our model below shows that the corporate tax rate has non-standard effects when monopoly rents are present. In particular, while a decline in the corporate tax rate might encourage investment by itself, it can also contribute to a decline in investment when it interacts with the existence of monopoly power. Our model makes this relation explicit.

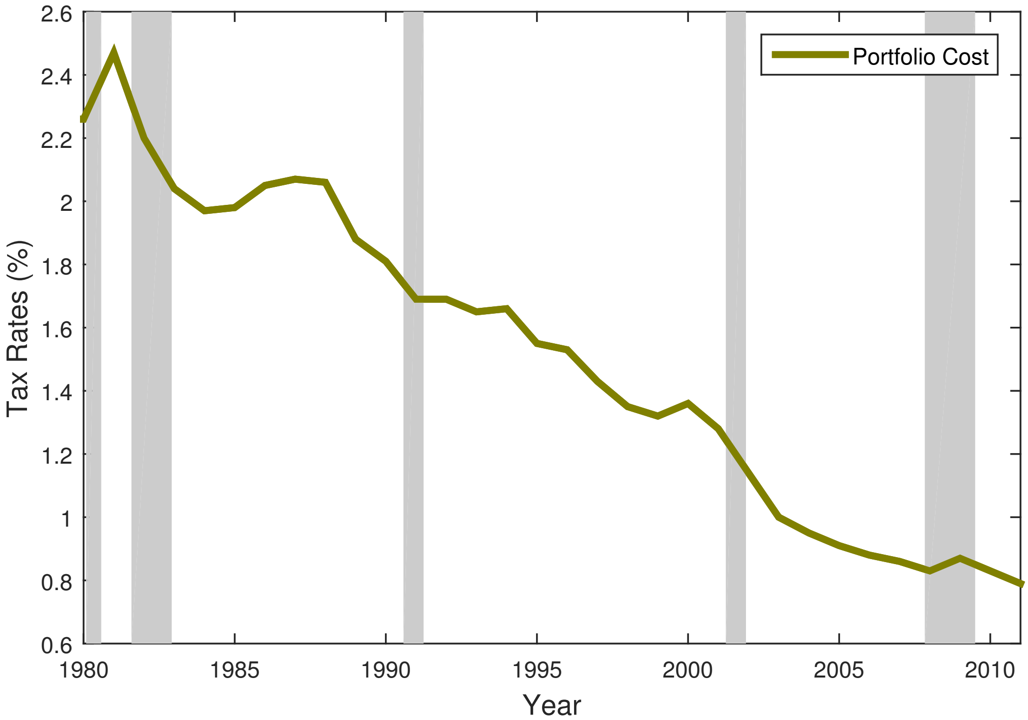
Figure 6: Effective Corporate Tax Rate



The effective tax on corporate income is set equal to the ratio of corporate tax liabilities to corporate before tax profits. Because profits of the Federal Reserve Banks are taxed at 100 percent we calculate the rate eliminating Federal Reserve profits from tax liabilities and before-tax profits.

We also consider the role of portfolio costs. They play an important role as a cost that shareholders must assume in order to hold a portfolio of stocks. In figure 7 we plot the sum of mutual fund costs and annuitized sales loads relative to the sum of fund assets. As in McGrattan and Prescott (2005), we use these data as an estimate of the costs paid by shareholders to hold a diversified portfolio. Note that costs are expressed as a percentage of total assets held and, therefore, they are conceptually equivalent to a tax on financial wealth. Because they affect a stock, they are not an insignificant friction even though they are small compared to capital taxes, which apply to a flow. They play an important role in the model and allow us to evaluate the potential general equilibrium effects of a proper tax on financial wealth.

Figure 7: Equity Mutual Fund Costs (% of Assets), 1980-2014



Data are from the Investment Company Institute (ICI).

Last but not least, our paper argues that monopoly rents are a main factor lying behind the increase in equity wealth relative to productive capital. Loecker and Eeckhout (2017) document the evolution of monopoly markups based on firm-level data for the U.S. economy since 1950. They show that average markups start to rise in 1980 from 18% above marginal cost to a current value of 67% and evaluate their potential macroeconomic consequences. However, they do not consider the rise of asset prices and its general equilibrium effects. We fill this shortcoming. We show analytically how monopoly power increases Tobin's Q and how that has an impact on firms' capital stock and inequality. Moreover, we emphasize a general equilibrium effect of the increase in asset prices that is usually ignored when evaluating the consequences of market power on investment and output.

Table 1 summarizes the figures from this section, both for tax rates and for aggregate ratios, that we will input and target, respectively, in our calibration exercise:

Table 1: Tax Rates and Aggregate Ratios

Variable	av 1970-1980	e-o-p 1980	av 2000-2010	e-o-p 2010
Dividend Tax Rate τ_d	40.13%	39.87%	10.95%	8.81%
Capital Gains Tax τ_g	18.91%	16.86%	10.09%	9.36%
Corporate Tax τ_c	35.38%	35.59%	23.28%	17.85%
Portfolio Cost κ	2.26%	2.26%	0.99%	0.83%
Equity-Output Ratio $\frac{E}{Y}$	0.99	0.83	2.12	2.14
Capital-Output Ratio $\frac{K}{Y}$	2.29	2.53	2.11	2.07
Tobin's $Q = \frac{E}{K}$	0.44	0.33	1.01	1.03
Equity Return r	1.91%	2.27%	5.01%	5.12%
Labor Share $\frac{wL}{Y}$	64.27	65.47	61.39	57.45
Profit Share (after tax)	7.13	5.56	8.06	10.53

Column 1 and 3 display averages for the period, Column 2 and 4 display end-of-period values. Aggregate ratios are computed for the non-financial corporate sector. Tobin's Q is defined as the ratio of equity to capital and abstracts from non-equity liabilities and financial assets. The labor share is computed from the total compensation series.

4 The Allocation and Distributional Effects of Aggregate Tobin's Q: A Hypothesis

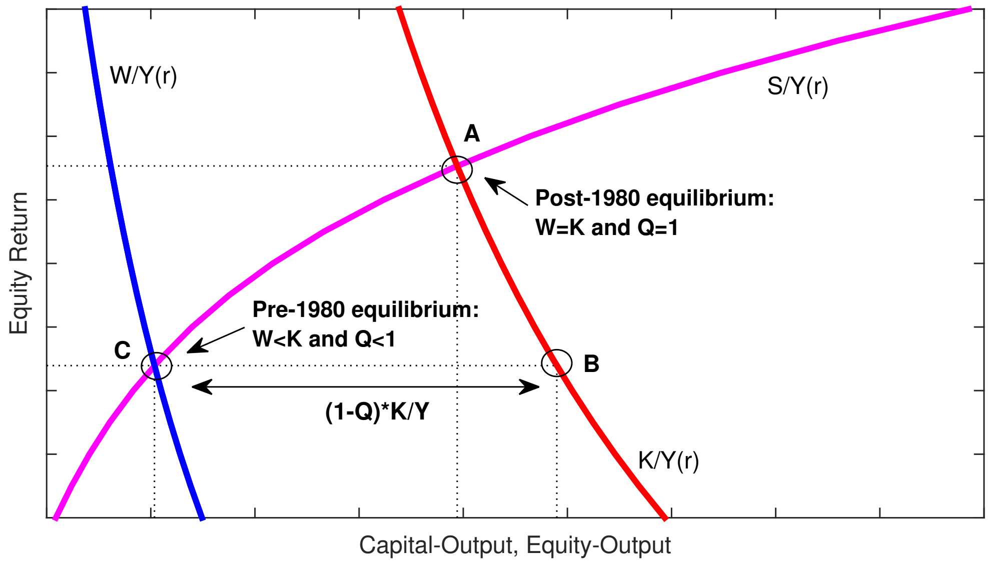
A key result of this paper is that an increase in the wealth-to-income ratio is compatible with a decline in real investment and the rise of factorial inequality. In the following sections, we will evaluate the causes that lie behind the secular change of equity Tobin's Q and build an incomplete markets model to examine how they affect aggregates and allocations. Before that, we think it is worth discussing the intuition behind our results. This is the purpose of this section.

In this section we explain graphically why investment declines in a neoclassical growth model with incomplete markets when equilibrium equity Tobin's Q rises over time. We study the divergent evolution of wealth and capital under the lens of an Aiyagari economy that experiences a transition like the one shown in figure 8. Market incompleteness is an important assumption in our model with a two-fold purpose: first, it helps us explain the change in equity returns and capital-output ratios; second, it allows us to analyze their implications for inequality.

To understand the historical movements in Tobin's Q, the physical-capital-to-output ratio and the equity-wealth-to-output ratio, we use a graphical representation of the capital market (figure 8). The supply of capital is given by the aggregate demand for assets or the stock of savings $S(r)$ represented, relative to output, by the magenta curve. The demand for physical capital $K^d(r)$ is standard and represented by a monotonically decreasing function of the net return to capital r. With a standard neoclassical production function with constant returns to scale, this negative relation also holds for the capital-to-output ratio $\frac{K^d}{Y}(r)$. This relation is represented in figure 8 by the red curve.

In an economy where households accumulate capital and rent it to the firms, like in the standard Aiyagari model, the market equilibrium is achieved where the supply of capital intersects with the demand of physical capital (intersection A in figure 8). 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 not the market value of physical capital, but the market value of shares $W(r)$, and these two schedules might not coincide. When they are different, the market equilibrium occurs at the intersection between $\frac{W}{Y}(r)$ and the supply of savings, $\frac{S}{Y}(r)$. When the market value of shares $W(r)$ and the market value of physical capital $K(r)$ coincide, the two schedules overlap and Tobin's Q, which is the ratio between the two, is equal to 1. In that context, the capital market equilibrium would resemble the equilibrium of a standard Aiyagari economy. This will occur in our model when all taxes and frictions are set to zero.

Figure 8: Capital Market



If equity Tobin's Q is lower than one, as we have observed historically for the U.S. economy, 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 $\frac{W}{Y}(r)$ shifts 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 $(1 - Q) * \frac{K}{Y}(r)$. Since households care about the stock market wealth and not about the replacement cost of corporate capital, the new equilibrium will be at C, where the supply of savings stock $\frac{S}{Y}(r)$ and the stock market wealth $\frac{W}{Y}(r)$ intersect. This equilibrium is characterized by a lower return and a lower level of wealth. However, the capital stock corresponding to this equilibrium is still given by the curve $\frac{K}{Y}(r)$, at B. Note that this stock of capital is larger than the one achieved in the frictionless equilibrium A.

In this paper, following the evidence presented in section 3.1, we argue that the U.S. economy has transitioned from a pre-1980 equilibrium, where $Q < 1$, to a post-1980 equilibrium, where $Q = 1$ by closing the wedge between $\frac{K}{Y}(r)$ and $\frac{W}{Y}(r)$. During the transition, this closing implies higher asset prices and lower investment and results in a higher wealth-to-output ratio and a lower capital-output in the new steady state. Importantly, this type of transition would require an increase in the return to equity, as we have shown to be the case for the U.S. since the early 80s (see figure 3). The final magnitude of the change in wealth and capital-output ratios depends on the change of Q itself, on the underlying mechanism driving the change in Q[20] and, importantly, on the elasticities of $S(r)$ and $K(r)$. These elasticities depend, respectively, on households' risk aversion and the elasticity of substitution between capital and labor.

The elasticity of substitution between capital and labor σ also determines the extent to which the labor share responds to capital-output ratio movements. As it has become standard in the analysis of the labor share, we use an aggregate CES production function to account for changes in factor shares. A CES production function implies a one-to-one relation between the capital-output ratio and the labor share, this relation being positive (negative) when the elasticity σ is lower (higher) than one. Here is where the distinction between financial wealth and physical capital turns out to be crucial. Piketty (2014) and Piketty and Zucman (2014) rely on an elasticity higher than one because they explain the decline of the labor share with an increase in the capital-output ratio, given the observed increase in wealth-to-output and the assumption that Tobin's Q is equal to one.[21] However, as shown above, Tobin's Q has increased during the period in which the labor share has declined and inequality has exploded. During that period, corporate payouts have increased, corporate investment has decreased and real net corporate capital stock has grown at a lower rate than real output (see figure 15). Our model is able to explain these phenomena and, because it predicts a decline in productive capital-to-output ratio despite the increase in the wealth-to-output ratio, it offers an explanation for the decline of the labor share based on an elasticity lower than one.[22] In fact, Piketty and Zucman (2014)

[20]See section 6.

[21]To be precise, the analysis of Piketty and Zucman (2014) is for the aggregate economy and not only for the corporate sector. Tobin's Q equal to one is not a crucial assumption at the aggregate level because aggregate wealth-to-income ratios also increase when corporate wealth is measured through corporate fixed assets. However, if the analysis focuses on the corporate sector, the rise of Tobin's Q is a key fact.

[22]Recent estimates from Chirinko and Mallick (2017) and Oberfield and Raval (2014) place the elas-

find a similar picture when they simulate U.S. wealth-to-income ratios for the aggregate economy. They show that in the absence of capital gains, wealth-to-income ratios would have declined during the past decades.[23]

Finally, figure 8 shows why market incompleteness is a key assumption for these results. When markets are incomplete, the aggregate demand for assets $S(r)$ is increasing in r.[24] This is in contrast to representative-agent economies, where the supply of savings is perfectly elastic.[25] An increasing movement along the $\frac{S}{Y}(r)$ curve is needed to obtain the observed movements in $\frac{K}{Y}$ and r when Tobin's Q rises. However, a change in Tobin's Q in a complete markets economy would affect $\frac{K}{Y}$ to a much lesser extent and leave r unaltered.[26] This is the case in McGrattan and Prescott (2005), where there is neither steady state change in aggregate $\frac{K}{Y}$ nor any inequality implication. Under complete markets, the equilibrium characterized by $Q < 1$ would still occur at the intersection between $\frac{S}{Y}(r)$ and $\frac{W}{Y}(r)$. However, the transition towards $Q = 1$ would not cause a lowering $\frac{K}{Y}$ and an 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 in this type of setting.

5 Model

The model features an infinite horizon economy with endogenous production and uninsurable labor income risk. The economy is populated by a continuum of infinitely lived households indexed by i that trade and save in stocks to insure against idiosyncratic risk. 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 market for its particular commodity. Dixit-Stiglitz preferences over the consumption bundle yield constant monopoly markups for the firm. At every period there is one equity stock s_{jt} outstanding per firm. Therefore, the market clearing condition in the stock market requires $s_{jt} = 1$. Although there is not a continuum of firms, we proceed by assuming that individual firms do not have the ability to influence aggregate output and prices.

ticity σ between 0.4 and 0.7

[23] See their appendix, figure A131.

[24] In fact, S tends to infinity as r approaches $\frac{1}{\beta} - 1$ and the precautionary motive goes to zero. In our model $S(r)$ is also monotonically increasing.

[25] Under complete markets, the demand for assets is given by the Euler equation of the representative household evaluated at the steady state. This yields a horizontal demand for assets stuck at $r = \frac{1}{\beta} - 1$.

[26] For instance, if the change in Tobin's Q is driven by a decrease in dividend taxes, the capital-output schedule would not change. Other mechanisms that affect Tobin's Q, such as monopoly rents, do have a partial equilibrium effect on the demand for capital schedule. We elaborate on this in section 6.

5.1 Households

Households have identical preferences over sequences of consumption $c_i \equiv \{c_{it}\}_{t=0}^{\infty}$, described by the expected utility function

$$U(c_i) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_{it}) \tag{1}$$

where $\beta \in (0,1)$ is the subjective discount factor and $\mathbb{E}_0$ denotes expectation conditional on information at time $t = 0$. The utility function $u(c_{it})$ is strictly increasing, strictly concave, continuously differentiable and satisfies the Inada conditions. The term c_{it} represents household's i total consumption and equals the standard CES composite aggregate with elasticity of substitution $\xi > 1$:

$$c_{it} = \left(\sum_{j=1}^{n} (c_{jit})^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}} \tag{2}$$

where c_{jit} represents household i's consumption of good j. Households decide how to allocate a given amount of financial resources m_{cit} among the different goods. This decision results in the standard Dixit-Stiglitz relative demand function of good j

$$c_{jit} = \left(\frac{p_{jt}}{P_t} \right)^{-\xi} c_{it}, \tag{3}$$

where $P_t = \left(\sum_{j=1}^{n} p_{jt}^{1-\xi} \right)^{\frac{1}{1-\xi}}$. Households insure against idiosyncratic risk by saving in stocks. We denote s_{ijt} the number of stocks of firm j held by the subject i at the beginning of period t. Stocks are traded between households every period at a competitive price v_{jt} and they entitle shareholders to a dividend d_{jt} and a capital gain $v_{jt} - v_{jt-1}$ per share. There is neither aggregate uncertainty nor idiosyncratic asset risk and, consequently, stocks returns are known for the households. The government levies proportional taxes on dividends, capital gains and labor income at rates τ_d, τ_g and τ_l respectively. Households also have to pay stock markets costs of rate κ per share. The cost term κ is expressed as a percentage of the total value of household's asset holdings. Since we abstract from idiosyncratic asset risk, we can interpret costs κ as the price of holding a diversified equity portfolio, in line with McGrattan and Prescott (2003). Furthermore, because they are expressed as a fraction of total assets held, they are conceptually equivalent to a tax on financial wealth.

In addition to stock returns, household i earns a risky labor income. We assume that labor supply is fixed for every household (and normalized to one) but their productivity, ϵ_{it}, is a random variable, identically and independently distributed across households, that follows a Markov process. The Markov process is characterized by a transition matrix $\prod(\epsilon' \mid \epsilon)$ where ϵ is drawn from a finite set S_ϵ of possible realizations. Households labor earnings per period are thus equal to $w_t\epsilon_{it}$ where w_t is the aggregate average wage rate.

Households sell all their stocks every period at price v_{jt} and use their labor income and their after-tax and after cost capital income to purchase consumption goods $p_{jt}c_{jit}$ and to buy next period stocks s_{jit+1}. Household i's budget constraint is:

$$P_t c_{it} + \sum_{j=1}^{n} v_{jt}s_{jit+1} = w_t\epsilon_{it} + \frac{\sum_{j=1}^{n}\left(v_{jt} + (1-\tau_d)d_{jt} - \tau_g(v_{jt} - \frac{P_t}{P_{t-1}}v_{jt-1})\right)s_{jit}}{(1+\kappa)} \tag{4}$$

where $P_t c_{it} = \sum_{j=1}^{n} p_{jt}c_{jit}$. Consequently, the value of the financial wealth owned by household i at the end of period t is $\sum_{j=1}^{n} v_{jt}s_{jt+1}$. For computational convenience, we assume that the tax base for capital gains is in real terms, and we discount inflation from the asset price change $v_{jt} - \frac{P_t}{P_{t-1}}v_{jt-1}$. While this is not the case in the U.S., figure 17 in the appendix shows the implied returns considering both a real and a nominal capital gains tax base, and their differences are minor.[27]

Households decide how much they spend on total consumption c_{it} and how many stocks s_{it+1} they buy given their current income. They solve the intertemporal problem by maximizing the objective function 1 subject to the budget constraint 4 and the borrowing constraint $s_{jit+1} \geq 0$. The latter constraint prevents households from borrowing in stocks and it guarantees households unanimity with respect to each firms investment decision (Carceles-Poveda and Coen-Pirani, 2009). This problem yields, for each unconstrained household, a standard Euler equation that has to be satisfied with respect to each firm j's equity returns:

$$\frac{u'(c_{it})}{\beta\mathbb{E}_t u'(c_{it+1})} = \frac{\frac{v_{jt+1}+d_{jt+1}(1-\tau_d)-\tau_g\left(v_{jt+1}-v_{jt}\frac{P_{t+1}}{P_t}\right)}{P_{t+1}}}{\frac{v_{jt}}{P_t}}\frac{1}{1+\kappa} \tag{5}$$

Since equation 5 imposes $\frac{u'(cit)}{\beta\mathbb{E}_t u'(cit+1)}$ to be the same across households, we denote this

[27] As in Anagnostopoulos et al. (2012), we have assumed that capital gains taxes are paid on an accrual basis, and capital losses are subsidized at the same rate. In the appendix, we further discuss the implications of these assumptions for the adjustment of the net returns series.

ratio $1 + r_{t+1}$. Using forward substitution and imposing a "no-bubble condition"

$$\lim_{k\to\infty} \frac{1}{\prod_{l=1}^{k}(1+\frac{\kappa+r_{t+l}}{1-\tau_g})} \frac{v_{jt+k}}{P_{t+k}} = 0$$

we can express the real value of firm j's stock at period t in terms of the future flows of real net dividends:

$$\frac{v_{jt}}{P_t} = \frac{1-\tau_d}{1-\tau_g} \sum_{k=1}^{\infty} \frac{1}{\prod_{l=1}^{k}(1+\frac{\kappa+r_{t+l}}{1-\tau_g})} \frac{d_{jt+k}}{P_{t+k}} \tag{6}$$

5.2 Firms

Each of the n varieties is produced by a monopolistically competitive firm. A representative firm j uses inputs K_{jt} and L_{jt} to produce a differentiated good Y_{jt} with a CES production technology of the following type:

$$Y_{jt} = A_t F(K_{jt}, L_{jt}) = A_t \left(\phi K_{jt}^{\frac{\sigma-1}{\sigma}} + (1-\phi) L_{jt}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{7}$$

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

$$K_{jt+1} - K_{jt} = i_{jt} - \delta K_{jt} \tag{8}$$

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

$$i_{jt} = \left(\sum_{h=1}^{n} (i_{jht})^{\frac{\xi-1}{\xi}}\right)^{\frac{\xi}{\xi-1}} \tag{9}$$

Note that this aggregation functions uses the same parameter $\xi > 1$ that the 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). Therefore, for simplicity, the elasticity is assumed to be the same. A modelling alternative would be to assume a final producer that aggregates all the goods into a final good that can be consumed or invested. This is a standard procedure in the literature, but it obscures the underlying assumption of equal elasticities in consumption and investment.

As in the households' decision, the problem of the firm is solved in two stages. In 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:

$$\max_{i_{jht}} \left(\sum_{h=1}^{n} (i_{jht})^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}} \tag{10}$$

subject to

$$\sum_{h=1}^{n} p_{ht} i_{jht} = m_{jt} \tag{11}$$

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

$$\left(\frac{i_{jht}}{i_{jt}} \right)^{\frac{-1}{\xi}} = \frac{p_{ht}}{P_t} \tag{12}$$

Since all the firms face the same problem, the demand of good h by all the firms, which we denote i^{dh}, is given by the following sum:

$$i_t^{dh} = \sum_{j=1}^{n} i_{jht} = \left(\frac{p_{ht}}{P_t} \right)^{-\xi} \sum_{j=1}^{n} i_{jt} = \left(\frac{p_{ht}}{p_t} \right)^{-\xi} i_t^T \tag{13}$$

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 amount of gross investment demanded by firm j.

In the second stage, firms choose the amount of inputs that maximize their real value. Since they are monopolies in the market of each own variety, they internalize the whole demand for that variety. Total demand of each good j is given by the sum of the households' and firms' individual demands for variety j:

$$y_{jt} = i_t^{dj} + c_{jt} = i_t^{dj} + \int c_{jit}\, d\Phi_{t-1}(s,\epsilon) = i_t^{dj} + \left(\frac{p_{jt}}{Pt} \right)^{-\xi} \int c_{it}\, d\Phi_{t-1}(s,\epsilon) = \left(\frac{p_{jt}}{Pt} \right)^{-\xi} \left(i_t^T + C_t \right) \tag{14}$$

where $C_t + i_t^T = y_t^T$ is merely the aggregate demand of the whole economy. At period t, firm j's real value V_t equals

$$V_t = \frac{1-\tau_d}{1-\tau_g} \frac{d_{jt}}{P_t} + \frac{v_{jt}}{P_t}. \tag{15}$$

Given that capital K_j is the only individual state for firm j, we can express firm's j objective function using the following recursive formulation:

$$V\left(K_j\right)=\max_{K_j',L_j}\left\{\frac{1-\tau_d}{1-\tau_g}\frac{d_j}{P}+\frac{V\left(K_j'\right)}{1+\frac{\kappa+r'}{1-\tau_g}}\right\} \tag{16}$$

We assume that the firm maximizes the objective function subject to the following constraints:

$$d_j=p_jF(K_j,L_j)-w_jL_j-\sum_{h=1}^{n}p_hi_{jh}-\tau_c\left(p_jF(K_j,L_j)-w_jL_j-\delta PK_j\right) \tag{17}$$

$$\frac{p_j}{P}=\left(\frac{y_j}{y^T}\right)^{\frac{-1}{\xi}} \tag{18}$$

$$\sum_{h=1}^{n}p_hi_{jh}=i_jP \tag{19}$$

$$i_j=K_j'-(1-\delta)K_j \tag{20}$$

where, to make the problem of the firms consistent with that of the (unconstrained) households, r' equals: $\frac{u'(c_{it})}{\beta\mathbb{E}_tu'(c_{it+1})}-1$. Equation 17 is the flow and funds constraint of firm j. Equation 18 is the (relative) demand of variety j. Equation 19 results from the combination of the investment demand in equation 12 and the price index $P_t=\left(\sum_{j=1}^{n}p_{jt}^{1-\xi}\right)^{\frac{1}{1-\xi}}$. Equation 20 is the law if motion of capital. The problem of firm j results in the following first-order conditions for labor and capital respectively (we apply envelope theorem for the FOC wrt K'):

$$\frac{w_j}{P}=\left(\frac{\xi-1}{\xi}\right)\frac{p_jF_L(K_j,L_j)}{P} \tag{21}$$

$$P'\left(1+\tilde{r}'\right)=\left(\frac{\xi-1}{\xi}\right)p_j'F_K\left(K_j',L_j'\right)(1-\tau_c)+P'(1-\delta)+P'\tau_c\delta \tag{22}$$

where $\tilde{r}_{t+1}\approx\frac{r_{t+1}+\kappa}{1-\tau_g}$.

The presence of ξ 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 markup equal to $\frac{1}{1-\frac{1}{\xi}}$, which measures the degree of monopoly power in the goods market. When the elasticity ξ increases, the degree of substitution between varieties increases and the degree of monopoly of a particular sector j falls, bringing the real return to capital and the real wage closer to the marginal productivities.

5.3 Government

We assume that the government balances its budget every period by adjusting the tax on labor income given prices, wages and stock prices, and aggregate quantities of labor, capital and dividends. We are going to take the rest of the fiscal mix of the government (dividend, capital gains and corporate taxes) as variables exogenous to the model. In section 7, we show how changes in this fiscal structure, among other factors, have affected Tobin's Q and the equilibrium of the economy.

5.4 Equilibrium

Given that all firms face the same optimization problem, we focus on the symmetric equilibrium, where they all set the same price, own the same level of capital stock and produce the same quantity. Without loss of generality, we will also assume that there is only one firm that produces one variety to abstract from the potential effects derived from the "taste of varieties", that are typically present in CES preferences. Moreover, we are in a monetary economy with prices, but we do not characterize a monetary policy rule that helps us close the model, so we cannot pin down the price level. However, the symmetry embedded in the model allows us to solve the model in real terms, and we leave the price level and nominal variables undetermined.

Given a set of policy rates $\{\tau_d, \tau_g, \tau_l, \tau_c\}$, an initial level of the aggregate capital stock K_0 and of stock holdings s_0, a fiscal budget target $\bar{g}$, and a joint distribution $\Psi_0(m, \epsilon)$ over idiosyncratic states, the equilibrium of this economy is a sequence of relative prices $\{r_t, \frac{w_t}{P_t}, \frac{v_t}{P_t}\}$, real aggregate quantities $\{K_t, L_t, \frac{d_t}{P_t}\}$, individual decision rules $\{c(m, \epsilon), a'(m, \epsilon)\}$[28] and government policy τ_l such that:

- The individual policy rules $\{c(m, \epsilon), a'(m, \epsilon)\}$ solve the household optimization problem 1 subject to the budget constraint 4.
- The firm maximizes its equity market value subject to the relative demand for its own product, by taking investment and labor demand decisions according to the First Order Conditions:

$$\frac{w_t}{P_t} = \left(\frac{\xi - 1}{\xi}\right) F_L(K_t, L_t)$$

and

$$1 + \tilde{r}_{t+1} = 1 + \left(\frac{\xi - 1}{\xi}\right)(1 - \tau_c)F_K\left(K_{t+1}, L_{t+1}\right) - (1 - \tau_c)\,\delta \tag{23}$$

[28]Policy rules are solved as a function of cash-on-hand, $m_{it} = (1 + r_t)a_{it} + (1 - \tau_l)w_t\epsilon_{it}$.

- The capital market clears

$$\int a'(m, \epsilon\} d\Psi_t(m, \epsilon) = \int \frac{v_t}{P_t} s_{it+1} d\Psi_t(m, \epsilon) = \frac{v_t}{P_t} \int s_{it+1} d\Psi_t(m, \epsilon) = \frac{v_t}{P_t} \tag{24}$$

- The labor market clears

$$\int \epsilon_{it} d\Psi_t(m, \epsilon) = L_t \tag{25}$$

- The goods market clears

$$C_t + I_t + G_t \approx Y_t \tag{26}$$

- The government balances its budget

$$G_t = \bar{g} Y_t = \tau_d \frac{d_t}{P_t} + \tau_g (\frac{v_t}{P_t} - \frac{v_{t-1}}{P_{t-1}}) + \tau_c (Y_t - \frac{w_t}{P_t} L_t - \delta K_t) + \tau_l \frac{w_t}{P_t} L_t \tag{27}$$

An explanation is in order. In our model, the households pay a rate over their total wealth holdings, that we have assimilated to a fee for managing the portfolio composed by the equity of the firm. However, there is no financial sector in our model to receive this payment, so this amount disappears from the model. It is a very small amount, correponding to $\frac{\kappa}{1+\kappa}\left((1-\tau_d)\frac{d_t}{P_t} + \frac{v_t}{P_t}\right)$, but we do not expect the goods market to exactly clear due to this discrepancy. Hence, we use the approximate symbol in 26 instead of the equal sign.

We solve for the household's policy functions numerically using a Value Function Iteration algorithm with Carroll (2006)'s Endogenous Grid Method. The distribution function $\Psi_t(m, \epsilon)$ and aggregate asset supply are approximated following Heer and Maussner (2009)'s algorithm. Finally, the market equilibrium is found using a bisection method. All these proceedings are explained, respectively, in sections 11.2, 11.3 and 11.4 in the appendix.

5.5 Some characterization of the equilibrium

Proposition 1. *If the production function displays constant returns to scale, the replacement cost of capital is equal to:*

$$K_{jt+1} = \sum_{k=1}^{\infty} \left(\frac{1}{\prod_{l=1}^{k}(1+\tilde{r}_{t+l})} \frac{d_{jt+k}}{P_{t+k}} - \frac{1}{\xi}(1-\tau_c) \frac{p_{jt+k}}{P_{t+k}} \frac{F(K_{jt+k}, L_{jt+k})}{\prod_{l=1}^{k}(1+\tilde{r}_{t+l})} \right) \tag{28}$$

Proposition 2. *If the production function displays constant returns to scale, the long-run equilibrium is characterized by the following Tobin's Q:*

$$Q_t = \frac{1-\tau_d}{1-\tau_g}\left(1+\frac{1}{\xi}\frac{1-\tau_c}{K_{jt+1}}\sum_{k=1}^{\infty}\frac{p_{jt+k}F(K_{jt+k},L_{jt+k})}{P_{t+k}\prod_{l=1}^{k}(1+\tilde{r}_{t+l})}\right) \tag{29}$$

which is the ratio between the Equity Price schedule 6 and the replacement cost of capital, given by proposition 1[29].

The proofs of proposition 1 and 2 are in the appendix. Under perfect competition, that is, as $\xi \to \infty$, the value of durable productive assets would simply be given by the present discounted value of future dividends and the Tobin's Q would simply be the ratio of one minus dividend tax over one minus capital gains tax, as in Anagnostopoulos et al. (2012).[30] In our model, however, the replacement cost of capital has an additional term. We interpret it in the following way. Period dividends are generated by productive capital, which is part of the firm's net worth. However, were the firm to sell its capital, it would not gain its total value inside firm. This is because the firm would lose the monopoly rents that this capital yields, which are captured by the second, negative term. This translates into a Tobin's Q that renders not only a fraction of taxes, but also a fraction of the capitalized monopoly rents with respect to the level of capital stock.[31]

The capital market is characterized by the household sector's supply of assets, on the one hand, and the firm's demand for capital on the other. However, households and firms exchange financial assets. Taxes, financial frictions and market power create a wedge between the financial valuation of a firm and the replacement cost of its physical capital. As a result, we have a demand side of the capital market characterized by the physical capital schedule and the stock price schedule, but only the stock price schedule will intersect with the household sector's asset supply in order to clear the capital market.

Lemma 3. *In the Steady State, the physical capital schedule is:*

$$\boldsymbol{K(r)} = \left(-\frac{\phi}{1-\phi}+\frac{1}{1-\phi}\left(\frac{\xi}{\xi-1}\frac{\frac{\kappa+r}{(1-\tau_g)(1-\tau_c)}+\delta}{\phi}\right)^{\sigma-1}\right)^{-\frac{\sigma}{\sigma-1}} L \tag{30}$$

[29] Note that capital is expressed in real terms and its relative price with respect to the consumption bundle is one.

[30] In a model with retained earnings, the replacement cost would also reflect their discounted value.

[31] We obtain an expression for Tobin's Q that is similar to the Q that Salinger (1984) uses to study the relationship between market structure and profitability.

The physical capital schedule is the inverse of the marginal product of capital of a CES production function. The differences with respect to a frictionless economy are the portfolio costs κ, corporate and capital gains taxes τ_c and τ_g and the markup $\frac{\xi}{\xi-1}$, that shift the user cost of capital. In the next section, we evaluate how each of these mechanisms affect the demand for capital, Tobin's Q and ultimately the equilibrium of the economy.

Lemma 4. *The stock price schedule is:*

$$\frac{\boldsymbol{v(r,K)}}{\boldsymbol{P}} = \frac{(1-\tau_d)d}{(\kappa+r)\,P} = \frac{(1-\tau_d)(1-\tau_c)\left(F(\boldsymbol{K},L)-\delta\boldsymbol{K}-\frac{w}{P}L\right)}{\kappa+\boldsymbol{r}} \tag{31}$$

Lemma 5. *Tobin's Q at the Steady State is:*

$$\boldsymbol{Q(r,K)} = \frac{1-\tau_d}{1-\tau_g}\left(1+\frac{1}{\xi}\frac{1-\tau_c}{\boldsymbol{K}}F(\boldsymbol{K},L)\left(\frac{1-\tau_g}{\kappa+\boldsymbol{r}}\right)\right) \tag{32}$$

Note that, as explained earlier, as $\xi \to \infty$ (perfect competition), Tobin's Q would simply be $\frac{1-\tau_d}{1-\tau_g}$.

6 Taxes and Market Power

Our hypothesis, as we have laid down in section 4, is that the U.S. economy has transited from an equilibrium characterized by a low Tobin's Q, low equity returns and a high labor share, to an equilibrium characterized by a high Tobin's Q, high equity returns and a low labor share. We argue that this increase in Tobin's Q has been brought about by changes in tax policy and the increase in market power that we described in section 3.2. In this section, we evaluate the impact of each tax or friction in isolation on Tobin's Q and the equilibrium of the economy. For the graphical analysis of the arguments that follow we refer the reader to section 11.6 in the appendix.

Dividend taxes τ_d enter the financial price schedule 31, but do not affect the demand for physical capital 30. As it is portrayed in figure 18 in the appendix, an increase in the dividend taxes shifts the equity price schedule to the left, creating a wedge between physical capital and equity, driving Tobin's Q down. Note that dividend taxes enter linearly in equation 32, so that the wedge is constant along the physical capital and the equity price curves. Panel A in figure 18 is the capital market equilibrium in terms of the aggregate supply of the "transformed" variable a_{it} against the real price of equity $\frac{v_t}{P_t}$, while panel B plots the same equilibrium in terms of the aggregate supply of stocks s_{it}, which we have normalized to 1. The shift of the equity price schedule to the left corresponds to a downward shift of the aggregate demand of stocks. In general equilibrium, capital moves along the physical capital schedule and capital intensity is higher after the introduction of the dividend tax. For this reason, Anagnostopoulos et al. (2012) argue that capital intensity was expected to fall after the dividend tax reduction in the 2003 JGTRRA reform. The presence of market power would amplify this general equilibrium effect because τ_d also interacts with the monopoly rent (see equation 29).

The next figure concerns the impact of markups. Monopoly power affects both the demand for physical capital 30 and the financial price schedule 31. An increase in the markup reduces the demand for physical capital but increases the financial valuation of the firm, as it captures the present discounted sum of expected higher profits due to increased market power. Therefore, monopoly power causes a shift of the capital demand schedule, and yet a another shift of the equity price schedule. In other words, the equilibrium capital-to-output ratio is reduced because of a partial equilibrium effect of monopoly power on the capital demand schedule, and further reduced because of a general equilibrium effect given the increase in Tobin's Q. The first effect is standard but, to our knowledge, the second effect has never been considered in the literature. Interestingly, Tobin's Q itself depends on the level of capital. There is a second (minor) general equilibrium effect because the asset supply schedule is also affected by a change in markups, as they change the relationship between equity returns and the wage rate. The effects of a 5% increase in the markup are shown in figure 19 in the appendix. In the market for stocks, the markup increase shifts the demand curve upwards

The capital gains tax τ_g affects Tobin's Q through three different mechanisms. These effects are depicted in figure 20 in the appendix, comparing a 0 vs a 20% capital gain tax under perfect and monopolistic competition. Under perfect competition, it first creates a wedge between the financial valuation of the firm and its physical capital, by increasing Tobin's Q. On the other hand, the capital gains tax also increases the cost of capital and this has a direct effect on the capital demand schedule, shifting the curve inwards and dragging with it the equity price schedule. Note as well that this changes the elasticity of both curves, rendering them more elastic to equity return changes. Under competitive markets (markup equal to one), capital gains taxes solely operate through these mechanisms, as in Anagnostopoulos et al. (2012). Note that they already imply both a partial equilibrium (through the shift in physical capital schedule) and a general equilibrium (through Tobin's Q) effect on the capital-to-output ratio. However, since τ_g also affects the user cost of capital through the subjective discount factor $\tilde{r}$, it has a third effect under monopolistic competition, as it modifies how households also value the monopoly rent. For this reason, in the presence of monopoly power, a capital gain tax also reduces Tobin's Q, and this effect partially offsets the shift produced by the first mechanism. This explains why in figure 20, the outwards shift of the equity value schedule under monopolistic competition is more moderate.[32]

The costs of portfolio diversification κ and the corporate tax rate τ_c have similar qualitative effects (although the marginal effect of κ is much larger as it operates on stocks rather than flows). As can be grasped from equation 32, neither κ nor τ_c affect Tobin's Q under perfect competition. However, they do shift the capital demand and equity curves (see equations 30 and 31). Firstly, as can be seen in figure 21 in the appendix, the financial friction κ (in our model, analogous to a wealth tax) has a direct effect on the capital demand schedule since it increases the user cost of capital, shifting this curve and dragging the equity price schedule with it. But it also has another effect that depends on the degree of market power, because it affects how firms value future profits and households value future dividends. This effect is observed in figure 21: when there is monopolistic competition, Tobin's Q falls when κ increases.

The effects of a corporate tax, depicted in figure 22 in the appendix, are similar to those of the portfolio fee: under perfect competition, τ_c reduces capital demand but does not affect Tobin's Q. Under monopolistic competition, however, τ_c interacts with the monopoly rent reducing its capitalized value. This is clearly inferred from the monopoly rent term in equations 29 and 32. In this case, τ_c reduces Tobin's Q and, as a consequence, its negative impact on capital is mitigated. The opposite is expected to happen when τ_c falls: capital demand increases but so does the monopoly rent, which increases Tobin's Q and, through general equilibrium, diminishes physical capital. Eventually, the negative general equilibrium effect could be as strong as the positive partial equilibrium effect. In that case, the usual positive effects on capital formation associated to lowering the corporate tax rate would vanish.

7 Calibration and Results

In this section, we test the behavior of our model against the data. For this purpose, we evaluate two steady states calibrated respectively to match data averages from 1970-1980, before we see any significant change in taxes, and from 2000-2010, when the big ratios seem to have already stabilized after the transition. The transition of the economy from one steady state to the other is characterized by changes in five variables: three tax rates (τ_d, τ_g, τ_c), the cost of financial diversification (κ), and the degree of market power ($\frac{\xi}{\xi-1}$). The first four of these are taken as exogenous values. We begin by discussing the calibration

[32]Note that the effects of the capital gain tax also rely on our modelling strategy where, for tractability reasons, we have ignored equity repurchases. In the presence of equity repurchases we expect the strength of the first mechanism to be lower. For this reason, we consider that the impact of τ_g on Tobin's Q is an upper bound.

in detail. Table 2 summarizes the values that remain constant across different calibrations.

Table 2: Baseline Calibration

	Parameter	Value
Discount Factor	β	0.918
Risk Aversion	μ	1.5
Solow Residual	A	0.645
Capital Weight	ϕ	0.4
Capital-Labor Elasticity	σ	0.7
Depreciation Rate	δ	0.10
Firm's discount friction	$\bar{\gamma}$	0.596
Income Process		
Labor Productivities	$\{\epsilon_1, \epsilon_2, \epsilon_3\}$	{1,5.29,46.55}
Transition Matrix	$\Pi(\epsilon' \vert \epsilon)$	$\begin{bmatrix} .992 & .008 & 0 \\ .009 & .980 & .011 \\ 0 & .083 & .917 \end{bmatrix}$

For the tax rates and the portfolio cost parameter, we input the data discussed in section 3.2 and summarized in table 1. We deal with markups in the following way. As in Caballero et al. (2017), we assume that steady state 1 (average 1970-1980) is characterized by perfect competition, such that the markup is equal to one (i.e., $\xi = \infty$). In steady state 2 (average 2000-2010), we calibrate the markup in order to match equity Tobin's Q for that period (Q=1.01) given the response of the model to the new tax and portfolio cost values. This strategy gives a markup estimate similar to the values found by Caballero et al. (2017), who use an accounting framework.[33] Note that the only constraint that we impose for the calibration of the markup is that it matches Tobin's Q, but in principle this could be any value. The fact that the calibration delivers an estimate in line with the data reinforces our confidence in our model.

We use the technology parameters to match the capital-to-output ratio in steady state 1. In particular, we use the Solow Residual A, the capital weight in the production function ϕ and the depreciation rate δ for this purpose. We do not use the Capital-Labor elasticity of substitution σ precisely because we want to show that it is perfectly possible to simultaneously model a declining labor share and an increasing market value of wealth with values of this parameter that are in line with empirical evidence. We take the value from Oberfield and Raval (2014), who find that σ has been stable since 1970 at about 0.7.[34]

[33]In particular, our markup calibration is 1.0975 for the decade 2000-2010. Caballero et al. (2017) find a markup of 1.067 for the period 2000-2007 and 1.119 for the period 2008-2015 (with an elasticity of substitution between capital and labor σ equal to 0.8).

[34]Oberfield and Raval (2014) estimate the aggregate elasticity for the US manufacturing sector. Other

Given our assumption that the markup is one in the first steady state, our model would generate a Tobin's Q equal to the ratio of one minus dividend taxes over one minus capital gains taxes. However, if we take average tax rates in the period 1970-1980, this ratio is .74, while average Tobin's Q is .44. We solve this discrepancy by adding a friction such that the value of Tobin's Q in steady state 1 is given by:

$$Q^* = \frac{1-\tau_d}{1-\tau_g}\bar{\gamma}$$

In section 9 we explain how this friction can be interpreted as a reduced form that captures the idea of short-termism: a mechanism that creates a wedge between the households' and the firm's subjective discount factor.

The technology parameters affect not only the demand for capital and the price of equity schedules; since they change the relationship between equity returns and the wage rate, they shift the asset supply curve as well. We therefore use the preference parameters to locate the asset supply curve such that it crosses the equity price schedule to match the data of equity returns in steady state 1. This requires a fairly low subjective discount factor of $\beta = 0.918$ for an annual frequency, which corresponds to a discount factor in the quarterly frequency of 0.979. We also need to adjust the curvature of the utility function, and we set the Risk Aversion parameter to $\mu = 1.5$.

The share of public expenditure g is set by calibration to match the average during the period (27% of output). As in Anagnostopoulos et al. (2012), we adjust the labor tax τ_l to balance the fiscal budget. The idiosyncratic income process is taken from Davila et al. (2012).

As explained, we target capital-to-output, Tobin's Q and equity returns in steady state 1, and Tobin's Q in steady state 2. Note that we haven't targeted the labor share in steady state 1, and nevertheless we are able to match it endogenously fairly well. We input the tax rates, the portfolio cost and the markup changes and we let the model speak. Table 3 compares how the model fares against the data. Our model correctly predicts an increase in the equity-to-output ratio, in equity returns and in the (after tax) dividends-to-output ratio, and a decrease in the capital-to-output ratio and the labor share.

Trend changes in aggregates and prices are well captured by our model. The equity-to-output ratio went from average values of 0.99 in 1970-1980 to average values of 2.12 in 2000-2010. Our model's equity-to-output is 1.01 in steady state 1 and 2.01 in steady state

studies report estimates for the aggregate economy, ranging from 0.4 to 0.7. See Leon-Ledesma et al. (2010) and Chirinko and Mallick (2017).

Table 3: Data vs Model

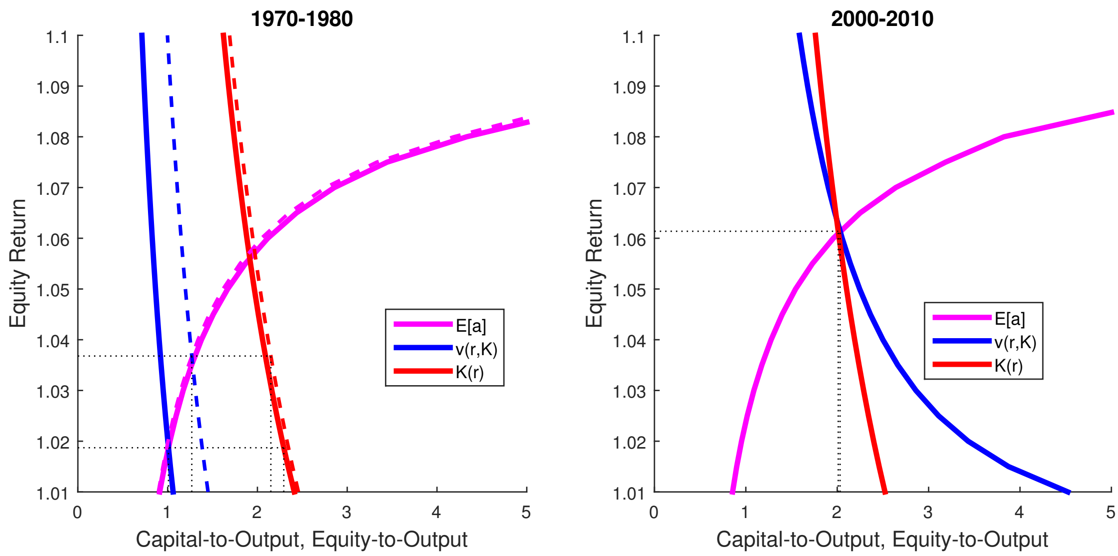
Variable	Data 1970-1980	Model SS1	Data 2000-2010	Model SS2
Dividend Tax Rate τ_d	40.13%	40.13%	10.95%	10.95%
Capital Gains Tax τ_g	18.91%	18.91%	10.09%	10.09%
Corporate Tax τ_c	35.38%	35.38%	23.28%	23.28%
Portfolio Cost κ	2.26%	2.26%	0.99%	0.99%
Labor Tax τ_l	-	30.71%	-	34.57%
Markup $\frac{\xi}{\xi-1}$	-	1	-	1.10
Equity-Output Ratio $\frac{E}{Y}$	0.99	1.01	2.12	2.03
Capital-Output Ratio $\frac{K}{Y}$	2.29	2.29	2.11	2.01
Tobin's $Q = \frac{E}{K}$	0.44	0.44	1.01	1.01
Equity Return r	1.91%	1.87%	5.01%	6.14%
Labor Share $\frac{wL}{Y}$	64.27	66.18	61.39	58.52
Dividend-Output Ratio $\frac{d}{Y}$	7.13	4.21	8.06	14.60

2. On the other hand, our model's equity returns grow more than the data average over the period. We could say that in terms of equity our model quantitatively underpredicts the change in aggregates and it overpredicts the change in prices. On the other hand, the capital-to-output ratio and the labor share fall slightly more in our model than in the data. Bearing in mind our earlier discussion on price effects of the capital-to-output ratio in the decade 2000-2010 and the fact that end-of-period values for the labor share are fairly closer to our results, we are confident that our quantitative computations are reliable. Finally, we compare the (after-tax) dividend-to-output ratio in our model to the data's (after-tax) profit share. There is a conceptual difference between the two, given that the profit share accounts for retained earnings before investment, while in our model all profits are reinvested or distributed among stockholders, and model dividends account only for the latter. Still, the dividend-to-output ratio is quite close to the end-of-period values for the profit share for 1980 and 2010 that we reported in table 1.

Capital market equilibria for the two steady states are depicted in figure 9. One of the main contribution of our framework to existing literature consists in explicitly modelling how monopoly rents affect Tobin's Q and the rest of the aggregates in general equilibrium. By allowing for monopoly rents, our model also delivers a series of second order effects of taxes and costs on Tobin's Q that hadn't been previously accounted for. To highlight the quantitative importance of our contribution, Panel A in 9 shows two steady states. The thick continuous lines depict steady state 1, matched to 1970-1980 data averages. In the second steady state in panel A (thin dashed lines), dividend and capital gains taxes are at their 2000-2010 level but market power is kept at its 1980 level (competitive markets). Recall that without monopoly rents, Tobin's Q would only be the ratio of one minus dividend tax over one minus capital gains tax (times the short-termism friction) and any

Tobin's Q shift is purely proportional. In panel B we add the effect of the changes in market power, κ and τ_c. We see that the effect of monopoly power in rising equity and contracting capital is quantitatively very important: capital-to-output falls to 2.01 in the new steady state.

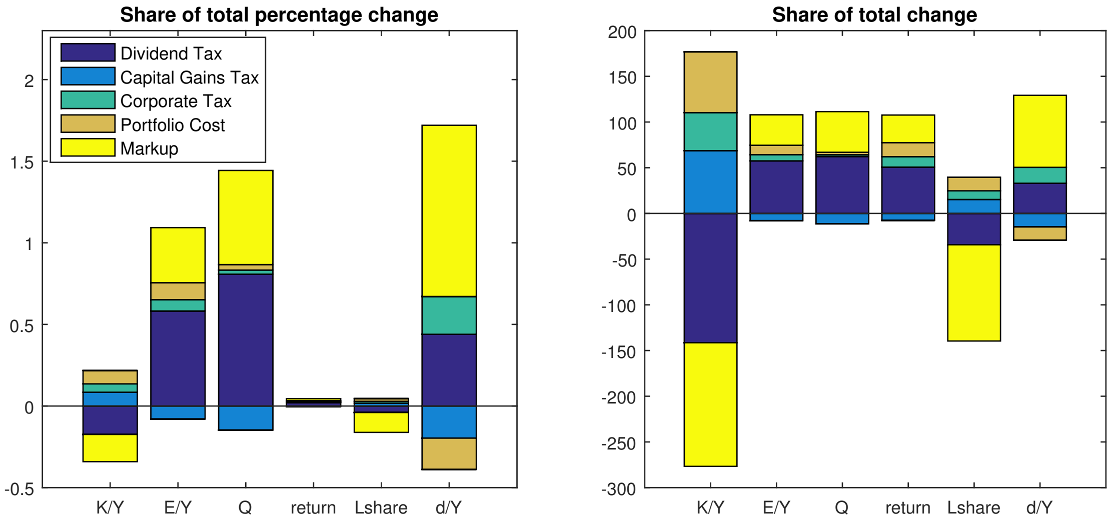
Figure 9: Capital Market Equilibrium for Steady States 1 and 2



In order to gain better understanding of the impact of each of these changes in taxes and market power on Tobin's Q, the labor share of output and aggregate ratios, we perform a decomposition analysis. Figure 10 evaluates quantitatively the contribution of each of the mechanisms to macro-economic changes from one steady state to the other. As expected, dividend taxation and monopoly power explain most of the change. In particular, monopoly rents account for most of the marked surge in dividends and the fall in the labor share. This shows in a straightforward way the impact of monopoly power on the factorial distribution of income. Our model indicates that it is quantitatively important. We underline that this is not only due to an increase in profits, but also through its effect on decreasing investment and the capital-to-output ratio, which fall substantially due to the markup rise.

The dramatic fall in dividend income taxation τ_d has also had a quantitatively important macro-economic impact. It explains almost half of the fall in the capital-to-output ratio, and half of the increase in equity-to-output, Tobin's Q and returns. On the other hand, the fall in the capital gains tax τ_g has had the opposite effect, raising capital-to-output and the labor share, and reducing equity-to-output, Tobin's Q, returns and dividends. As expected, the fee on portfolio management κ and the corporate tax rate τ_c have had

Figure 10: Decomposition Analysis



The decomposition is done as follows. A new steady state is computed for every variable change in isolation. A percentage change is computed for every new aggregate with respect to steady state 1. Additionally, since the markup amplifies some of the mechanisms, new steady states are computed changing jointly each variable and the markup. A second percentage change is computed with respect to the steady state with only the markup change. Both percentages are added to make up for the total effect of each mechanism.

similar effects, both qualitatively and quantitatively.

8 Welfare Analysis

This section evaluates the welfare implications of the changes so far discussed. We have seen that the reduction in capital taxation and the increase in monopoly power has increased factorial inequality. We consider several utilitarian measures of welfare and study how these changes have affected them both in aggregate terms, and in terms of how the welfare gain/loss has been distributed across agents with different asset holdings and productivity realizations.

The stochastic labor income process remains the same throughout the exercise, but the wage rate falls significantly with capital and the tax on labor income increases.[35] From steady state 1 to steady state 2, the before-tax wage rate falls by 17.6% and the labor tax increases almost 4%, such that the effective wage falls by 22.2%. Although the frequency of a zero-income event is zero and borrowing is not permitted, which jointly guarantee

[35]Recall that the labor income tax is endogenously adjusted to balance the fiscal budget. Since government revenues from capital income fall significantly, the labor income tax has to increase. However, note that it is a proportional tax, so it affects all agents equally

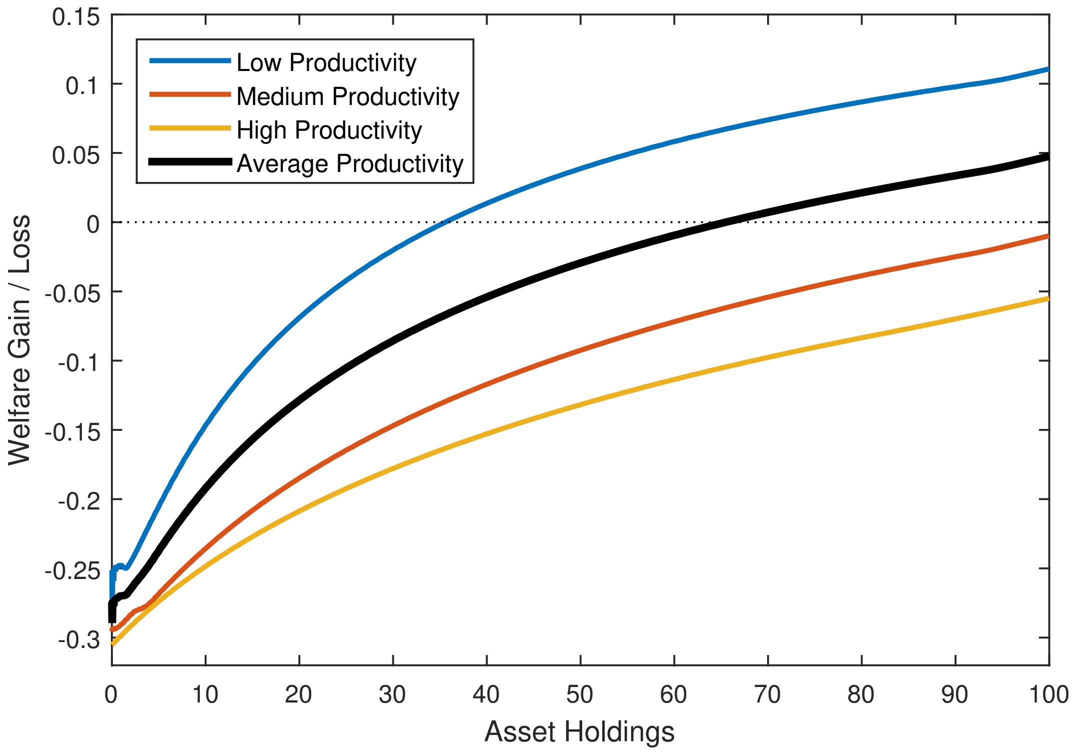
positive consumption, the lower effective wage rate and the persistence of the low productivity state are enough to push agents to save away from levels of consumption where the marginal utility is high. Against the worsening of labor earnings, the increase in equity returns is high, and forward-looking agents respond optimally by holding more equity. In an infinite horizon setting, these changes decompress the distribution of asset holdings. This behavior is typical of this type of models populated with infinitely-lived ex-ante homogeneous forward-looking agents. The initial distribution, the effect on impact of shocks and the transition are eventually wiped out in the new steady state.

Despite the decrease in wealth inequality, in our exercise the distribution of consumption slightly worsens in steady state 2. Aggregate consumption stays almost constant, as output decreases with capital but also investment does. The Gini Index for consumption slightly growth from .595 to .613. This increase seems to be due to movements in the middle rather than the top of the distribution. Welfare criteria are usually utilitarian, and given that our agents only value consumption, these criteria will move in line with consumption.

Following Domeij and Heathcote (2004), we analyze three measures of welfare. The average welfare gain Δ is the percentage increase in consumption in the no-reform case that gives the same utility as when reform is implemented. We decompose these welfare gains into an aggregate $\hat{\Delta}$ and a distributional $\tilde{\Delta}$ component, where the former is the change in aggregate consumption and the latter takes into account how this aggregate change is distributed. The changes in taxation and monopoly power of the past decades have resulted in an average welfare loss of about 0.75% in consumption terms. This welfare loss is the average of increasing aggregate welfare (+1.52%) due to the increase in aggregate consumption, and a decrease in distributional welfare (-2.25%) due to the regressive nature of the changes. The increase in factorial inequality is the explanation behind these results, given that for asset-poor agents labor income makes up for the majority of their income, while asset-rich agents benefit from the increase in equity prices.

Figure 11 makes this regressiveness explicit. We plot the welfare gain or loss by productivity state and asset holdings. In terms of productivity states, agents whose productivity is highest are relatively worse off when wages (the term that interacts with labor efficiency) decrease. The increasing curves mean that households with fewer asset holdings have suffered the biggest welfare loss, while agents with high asset holdings have experienced a welfare gain. Although general equilibrium movements change the actual distribution over these asset holdings between the two steady states, poor agents in the same asset position are clearly worse off in steady state 2.

Figure 11: Welfare Gain/Loss by asset holdings and income shock



The figure plots the percentage difference in the value functions $V^{SS1}(a', \epsilon)$ and $V^{SS2}(a', \epsilon)$ for each asset holdings a and each labor efficiency realization ϵ that summarize the value of the optimal consumption/saving behavior in the steady state, converted to consumption terms. For details see Domeij and Heathcote (2004).

9 The Role of Corporate Short-termism

This paper addresses the rise of Tobin's Q, the decline of investment and the rise of inequality through changes in capital taxation and monopoly markups. We have shown that these mechanisms are quantitatively very important, but we are aware that the trends we have identify may also be partially explained by alternative factors. One such factor could be the increasing focus of firms on shorter time horizons, which may have contributed to weak investment. In this section we use our model to asses this possibility.

Short-termism usually refers to the excessive focus of corporate managers and investors on short-term results at the expense of long-term growth. Although short-termism and shareholder value maximization are not the same,[36] an increasing number of observers trace the rise of short-termism back to the transformation of U.S. corporate governance

[36] An excessive focus on short-term goals could destroy shareholder value if firms discount the future more than shareholders.

model that began in the late 70s - early 80s, often referred to as "the shareholder revolution." We do not want to review here the extensive literature that exists on the changes in the U.S. corporate setting that might have facilitated the transition towards such a model.[37] But there is empirical evidence that the U.S. corporate sector has become increasingly short-term oriented. In a recent paper, Sampson and Shi (2017) show that discounting by firms has intensified economy-wide over the period 1980-2013 and that market impatience correlates with firm-specific corporate governance characteristics, like the time horizon of executive compensation and the degree of institutional ownership.[38]

We model the role of short-termism like Sampson and Shi (2017), with a small friction in the firm's discount factor that makes them more patient than households. We assume this is a reduced form that captures agency problems between the CEO and the stockholders of the firm. Similar specifications have been used by Korinek and Stiglitz (2009) and Chetty and Saez (2010).[39]

Accounting for this friction, the problem of the firm in recursive formulation would change to:

$$V\left(K_j\right) = \max_{K_j', L_j} \left\{ \frac{1-\tau_d}{1-\tau_g} \frac{d_j}{P} + \gamma \frac{V\left(K_j'\right)}{1+\frac{\kappa+r'}{1-\tau_g}} \right\} \tag{33}$$

where $\gamma \in [1,\, 1+\frac{\kappa+r'}{1-\tau_g})$ reflects agency considerations. Note that if $\gamma = 1$, the problem of the firm is consistent with the problem of the shareholders. We consider $\gamma = 1$ is an appropriate lower bound for γ because in that case the firm would be maximizing standard shareholder value (the firm would be using the stochastic discount factor of the unconstrained shareholders). Furthermore, we assume that γ has to be lower than $1+\frac{\kappa+r'}{1-\tau_g}$. If $\gamma = 1+\frac{\kappa+r'}{1-\tau_g}$, the discount factor of the firm would be equal to one and the optimal behaviour of the firm would be to increase investment without limit. Note that a decline in γ, that brings the firm's objective closer to the standard shareholder value case, can be interpreted as an increase in corporate short-termism.

The first order condition with respect to capital yields:

[37] For an historical analysis of the rise of shareholder value as a principle of corporate governance in the United States, see Lazonick and Sullivan (2000) and Davis (2009). For a discussion on the macroeconomic effects of short-termism, see Mason (2017).

[38] Changes in Tobin's Q due to short-termism, understood as increasing shareholder value maximization, are probably closer to the hypothesis that Piketty and Zucman (2014) proposed to explain cross-country differences in Tobin's Q. They argue that Tobin's Q is relatively higher in some countries because shareholders' rights are more protected.

[39] Our reduced-form friction is the market discount term that Sampson and Shi (2017) estimate to assess the evolution of economy-wide short-termism.

$$P'\left(1+\frac{\kappa+r'}{1-\tau_g}\right)=\gamma\left[\left(\frac{\xi-1}{\xi}\right)p'_jF_K\left(K'_j,L'_j\right)(1-\tau_c)+P'(1-\delta)+P'\tau_c\delta\right]$$

Re-arranging and assuming a "no-bubble condition", we get the following expression for the firm's capital demand schedule:

$$K_{jt+1}=\sum_{k=1}^{\infty}\left(\frac{\gamma^k}{\prod_{l=1}^{k}(1+\tilde{r}_{t+l})}\frac{d_{jt+k}}{P_{t+k}}-\frac{\gamma^k}{\xi}(1-\tau_c)\frac{p_{jt+k}}{P_{t+k}}\frac{F(K_{jt+k},L_{jt+k})}{\prod_{l=1}^{k}(1+\tilde{r}_{t+l})}\right)$$

On the other hand, while the expression for the real price of equity remains the same, its dependency on dividends causes a shift in this curve as well, yielding a non-monotonic equity price schedule and the following expression for the Tobin's Q:

$$Q_t=\frac{1-\tau_d}{1-\tau_g}\left(1+\frac{1}{\xi}\frac{1-\tau_c}{K_{jt+1}}\sum_{k=1}^{\infty}\frac{p_{jt+k}F(K_{jt+k},L_{jt+k})\gamma^k}{P_{t+k}\prod_{l=1}^{k}(1+\frac{\kappa+r_{t+l}}{1-\tau_g})}+\frac{1}{K_{jt+1}}\sum_{k=1}^{\infty}\frac{d_{t+k}\left(1-\gamma^k\right)}{P_{t+k}\prod_{l=1}^{k}(1+\frac{\kappa+r_{t+l}}{1-\tau_g})}\right)$$

In the steady state, these equations boil down to:

$$\mathbf{K(r)}=\left(-\frac{\phi}{1-\phi}+\frac{1}{1-\phi}\left(\frac{1}{\phi}\frac{\xi}{\xi-1}\left(\delta+\frac{1-\gamma+\tilde{\mathbf{r}}}{\gamma(1-\tau_c)}\right)\right)^{\sigma-1}\right)^{-\frac{\sigma}{\sigma-1}}L \tag{34}$$

for capital, and:

$$\mathbf{Q(r,K)}=\frac{1-\tau_d}{1-\tau_g}\left(\frac{1-\gamma+\tilde{\mathbf{r}}}{\gamma\tilde{\mathbf{r}}}+\frac{1}{\xi}\frac{1-\tau_c}{\tilde{\mathbf{r}}}\frac{F(\mathbf{K},L)}{\mathbf{K}}\right) \tag{35}$$

for Tobin's Q. Equation 35 shows how the market discount term γ affects Tobin's Q. In particular, steady state Q depends negatively on γ: Q is lower when the firm is more patient (higher γ) and higher when the firm is more short-term oriented (lower γ). Note that when γ decreases, the discount factor of the firm gets closer to the stochastic discount factor of shareholders and we are closer to the standard shareholder value maximization case.

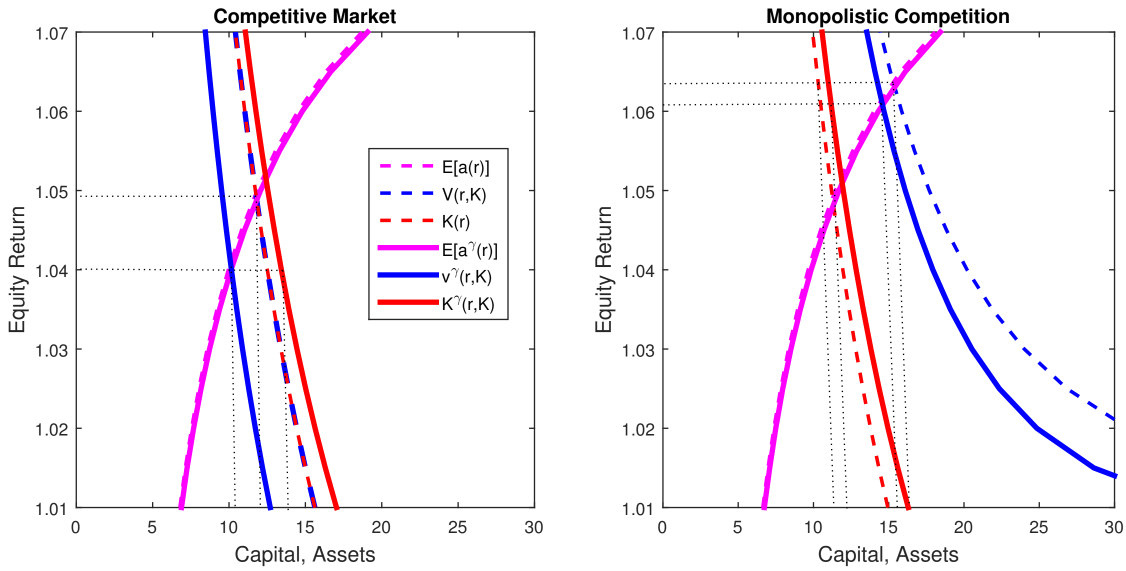
For illustration purposes, figure 12 plots the effects of having a market discount term γ larger than one (that is, the firm becoming more patient). To guarantee the monotonicity of the equity price schedule, we impose that:

$$\gamma(\tilde{r})=\frac{1+\tilde{r}}{1+\bar{\gamma}\tilde{r}} \tag{36}$$

This assumption does not change the interpretation of γ (which equals one when $\bar{\gamma}$=1) and guarantees that equity price schedule is decreasing along the whole domain of r. We also use this strategy in the calibration section 7 where we calibrate the constant $\bar{\gamma}$ to match the value of Tobin's Q in 1980.

Panel A plots the effects under perfect competition and no taxes. The friction creates a wedge between capital demand, which shifts to the right, and the price of equity, which shifts to the left. The result is a lower Q and a new equilibrium characterized by lower equity returns and higher capital stock. In Panel B we can see the same effect under monopolistic competition. The price of equity is now larger than the demand for capital due to the capitalized value of the monopoly rents, but the effect of a higher γ is the same: the equity price and the capital demand shift in opposite directions, reducing Tobin's Q again.

Figure 12: Firm's Discount Factor $\gamma = 1.01$



The example of figure 12 shows that short-termism has aggregate effects that might be indistinguishable from those created by monopoly markups. For any initial value of Q, when γ falls, equity value increases and capital demand decreases, leading to a higher Q, higher equilibrium equity returns and lower investment. In fact, even if they imply different shifts in the demand curves, changes in γ might have similar equilibrium effects to changes in dividend income taxation. This implies that the welfare effects of short-termism will be similar to those of markups and dividend income taxes.[40]

[40]Hart and Zingales (2017) defend that corporations should not maximize shareholder value, but shareholder welfare. Although they consider a wider notion of welfare, this results arises naturally from our from model because shareholders do not internalize the effect that short-termism has on wages.

Our conclusion from this section is that we should be careful not to conflate mechanisms that render similar aggregate effects. In this sense, part of the perceived increase in short-termism might be due to the rise of markups or the decrease of dividend income taxation. In any case, short-termism is undoubtedly also empirically relevant, and we leave a further investigation of this mechanism for future research.

10 Conclusion

The publication of Piketty (2014)'s outstanding work, and his conclusion that increasing wealth-to-income ratios were not accompanied by decreasing returns, yielding the prospect of a society dominated by capital and high inequality, produced a heated political and academic debate. The debate took on several controversies about Piketty's assumptions, notably, the value of the elasticity of substitution between capital and labor, and his assimilating the concept of capital to that of wealth. In this paper we revise the latter assumption and show that by building a model that distinguishes between productive capital and financial wealth, we can jointly explain increasing wealth-to-income and equity returns with a stagnation of the productive sector of the economy, and with it the labor share, with values of the elasticity of substitution below one.

Equating wealth and capital precludes the distinction between movements in the valuation of financial assets and changes in the productive capacity of the economy. We show that valuation effects cannot be neglected because they do not cancel in the long run. We argue that the secular shift in the difference between equity values and capital, and the corresponding upsurge in Tobin's Q, are explained by deep changes in the structure of capital taxation and the rise of market power, which can be traced back to the early 1980s.

In our model, monopoly rents and the decrease in taxes and financial frictions increase the difference between the market valuation of wealth and the replacement cost of capital. Our key message is that these changes do not only represent a nominal shift in relative asset prices, but have also general equilibrium effects, and crowd-out real investment. These general equilibrium effects produce a pre-distributive allocation between the financial market and the productive economy that benefits the wealthy asset holders at the expense of poorer households, whose income depends mostly on labor.

Finally, our approach is compatible with alternative theories about the evolution of the labor share and the capital-output ratio. Mechanisms that shift the supply of savings, or that shift the demand for capital without increasing Tobin's Q can easily be embedded in our model. Importantly, one such mechanism is the decline of the relative price of capital goods, whose impact on the labor share has been studied by Karabarbounis and Neiman (2014). Nevertheless, given our results and the ability of our model to explain several stylized facts, we believe that drivers that have boosted asset prices relative to productive capital have played a more dominant role.

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11 Appendix

11.1 Derivation of Equations 28 and 29

Tobin's Q is given by the following equation:

$$Q_t = \frac{1-\tau_d}{1-\tau_g}\left(1 + \frac{1}{\xi}\frac{1-\tau_c}{K_{jt+1}}\sum_{k=1}^{\infty}\frac{p_{jt+k}F(K_{jt+k},L_{jt+k})}{P_{t+k}\prod_{l=1}^{k}(1+\frac{\kappa+r_{t+l}}{1-\tau_g})}\right)$$

Proof. Define for simplicity $1+\tilde{r}_{t+1} = 1+\frac{\kappa+r_{t+1}}{1-\tau_g}$. Multiply both sides of the FOC 23 by K_{t+1}:

$$\begin{aligned} K_{t+1}P_{t+1}\left(1+\tilde{r}_{t+1}\right) = &\left(\frac{\xi-1}{\xi}\right)p_{jt+1}F_K\left(K_{jt+1},L_{jt+1}\right)\left(1-\tau_c\right)K_{t+1} \\ &+ P_{t+1}\left(1-\delta\right)K_{t+1} + P_{t+1}\tau_c\delta K_{t+1} \end{aligned}$$

Given constant returns to scale

$$F(K,L) = F_K(K,L)K + F_L(K,L)L$$

and plugging in the FOC for labor 21, we get:

$$\begin{aligned} F_K(K_{jt+1},L_{jt+1})K_{jt+1} &= F(K_{jt+1},L_{jt+1}) - F_L(K_{jt+1},L_{jt+1})L_{jt+1} \\ &= F(K_{jt+1},L_{jt+1}) - \frac{\xi}{\xi-1}\frac{w_{t+1}}{p_{jt+1}}L_{jt+1} \end{aligned}$$

Multiplying both sides by $\left(\frac{\xi-1}{\xi}\right)p_{jt+1}$,

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

and using the flow and funds constraint of the firm:

$$K_{t+1}P_{t+1}\left(1+\tilde{r}_{t+1}\right) = d_{jt+1} + P_{t+1}K_{jt+2} - \frac{1}{\xi}\left((1-\tau_c)p_{jt+1}F(K_{jt+1},L_{jt+1})\right)$$

Re-arranging terms, we get the following recursive expression for the replacement cost of capital:

$$K_{jt+1} = \frac{d_{jt+1}}{(1+\tilde{r}_{t+1})P_{t+1}} - \frac{1}{\xi}\left(\frac{1-\tau_c}{1+\tilde{r}_{t+1}}\right)\frac{p_{jt+1}}{P_{t+1}}F(K_{jt+1}, L_{jt+1}) + \frac{K_{jt+2}}{1+\tilde{r}_{t+1}}$$

Using forward substitution and the transversality condition

$$\lim_{k\to\infty} \frac{1}{\prod_{l=1}^{k}(1+\tilde{r}_{t+l})} K_{jt+1+k} = 0 \tag{37}$$

we get expression 28 for the replacement cost of capital:

$$K_{jt+1} = \sum_{k=1}^{\infty}\left(\frac{1}{\prod_{l=1}^{k}(1+\tilde{r}_{t+l})}\frac{d_{jt+k}}{P_{t+k}} - \frac{1}{\xi}(1-\tau_c)\frac{p_{jt+k}}{P_{t+k}}\frac{F(K_{jt+k}, L_{jt+k})}{\prod_{l=1}^{k}(1+\tilde{r}_{t+l})}\right) \tag{38}$$

Note that equation 39 is

$$\frac{v_{jt}}{P_t} = \frac{1-\tau_d}{1-\tau_g}\sum_{k=1}^{\infty}\frac{1}{\prod_{l=1}^{k}(1+\frac{\kappa+r_{t+l}}{1-\tau_g})}\frac{d_{jt+k}}{P_{t+k}} \tag{39}$$

Then we get Tobin's Q, which is the ratio $\frac{v_{jt}}{P_t K_{t+1}}$.

■

11.2 The Household Problem

The household's policy functions are solved, for any given interest and wage rates, price level and labor tax rate, using Value Function Iteration with Carroll (2006)'s Endogenous Grid Point method. It works as follows: we set a fixed grid on cash-on-hand, $m_i = (1+r_t)a_i + (1-\tau_l)w_t\epsilon_i$, such as $\mathcal{M} = \{m_1, ..., m_N\}$. In particular, we set an equally spaced 50-point grid from 0 to 7 and we square it, so as to have a highly densed grid in regions where the consumption policy function is less linear, and a sparser grid where it is more linear. We set another grid on the choice of assets, a', such as $\mathcal{A} = \{a'_1, ..., a'_I\}$, with $a_1 = 0$. To intialize the algorithm, we guess an initial value function and a consumption policy function for each point in our cash-on-hand grid, for example $c^0(m,\epsilon) = m$ and $v^0(m,\epsilon) = u(m)$. Then:

1. For every grid point on the asset grid, a'_i, $i = 1, ..., I$, and for every possible realization of the productivity shock ϵ_h, $h = 1, 2, 3$, we compute next period's cash-on-hand:

$$m'_{ih} = (1+r)a'_i + (1-\tau_l)w\epsilon'_h$$

2. For each of these next period's cash-on-hand and productivity shock, we compute next period's consumption choice by interpolation using the previous iteration's policy function guess:
$$c'_{ih} = c^{k-1}(m'_{ih}, \epsilon'_h)$$

3. For each of the current productivity states ϵ_j, $j = 1, 2, 3$, we compute expected marginal utility next period:
$$E_{ij}[u'(c')] = \sum_{h=1}^{3} \pi(\epsilon'_h|\epsilon_j)\,(c'_{ih})^{-\mu}$$

4. And using the Euler Equation and the Budget Constraint, we find current period's consumption choice and cash-on-hand:
$$c_{ij} = (\beta(1+r)E_{ij}[u'(c')])^{-\frac{1}{\mu}} \qquad \text{and} \qquad m_{ij} = c_{ij} + a'_i$$

5. The points in $\{m_{ij}, c_{ij}\}$ define jointly a consumption choice as a function of a level of cash-on-hand and a productivity shock, which can be used to interpolate a new consumption policy function corresponding to our initial cash-on-hand grid, $m_n \in \mathcal{M} = \{m_1, ..., m_N\}$: $c^k(m_n, \epsilon_j)$. For every m_n and ϵ_j, we update the value function:
$$v^k(m_n, \epsilon_j) = \frac{\left(c^k(m_n, \epsilon_j)\right)^{1-\mu}}{1-\mu} + \beta \sum_{h=1}^{3} \pi(\epsilon_h|\epsilon_j) v^{k-1}(m_n, \epsilon_h)$$

6. Repeat steps (1)-(5) until the value function converges, i.e. $|v^k(m,\epsilon) - v^{k-1}(m,\epsilon)| < 0.00001$.

7. The savings policy function can be found by substracting the consumption policy function from the cash-on-hand grid: $a(m_n, \epsilon_j) = m_n - c(m_n, \epsilon_j)$.

11.3 Aggregate Asset Supply

The aggregate asset supply function for the household sector is given by $\mathbb{E}[a] = \int a(m,\epsilon)d\Phi(m,\epsilon)$. There are different ways to compute this object. We choose to compute:
$$\mathbb{E}[a(r_{t+1})] = \int a(m,\epsilon)\Phi(m,\epsilon)d(m,\epsilon)$$

To find the probability density function of agents across levels of cash-on-hand and productivity endowments, we use Heer and Maussner (2009)'s 5.2.3 algorithm.

11.4 General Equilibrium Algorithm

Since we have a system of two markets, a good market and a capital market, if one clears so does the other, by Walras' Law. Therefore we can safely focus on finding the equilibrium in one of the markets; in our case, this is the capital market. Moreover, the model is solved in real terms, while the price level P_t and nominal variables remain undetermined (we assume on variety in order to prevent that aggregate prices depend on the number of varieties). The capital market in our model is characterized by 3 equations: the aggregate asset supply by households, $\mathbb{E}[a(r_{t+1})]$, the firm's capital demand, $K(r_{t+1})$, and the real value of the firm in the financial market $v(r_{t+1}, K(r_{t+1}))$. The interest rate is determined in the financial market, at the intersection between the household sector supply of assets $\mathbb{E}[a(r_{t+1})]$ and the financial value of the firm, $v(r_{t+1}, K(r_{t+1}))$.

Therefore, the capital market clears at:

$$\mathbb{E}[a(r_{t+1})] = \int a'(m, \epsilon | r_{t+1}) d\Phi(m, \epsilon) = Q(r_{t+1}, K_{t+1}) K_{t+1}$$

Note that the dividend tax τ_d, the capital gains tax τ_g, the corporate tax τ_c and the share of public expenditure g are set by calibration, while the labor tax τ_l is adjusted every period to balance the fiscal budget. The model is solved in real terms, while the price level P_t and nominal variables remain undetermined.

To find the point of intersection that clears the capital market, we implement a bisection method. We proceed as follows: we set a lower and an upper bound on interest rates, $\{\underline{r}, \bar{r}\}$, such that $\underline{r} < \bar{r}$, making sure that $\mathbb{E}[a(\underline{r})] < v(\underline{r}, K(\underline{r}))$ while $\mathbb{E}[a(\bar{r})] > v(\bar{r}, K(\bar{r}))$. Then

1. We choose a new interest rate $r_{\text{new}} = \frac{\underline{r}+\bar{r}}{2}$
2. For this new interest rate r_{new} we compute:
   - Aggregate Capital $K(r_{\text{new}})$ and the wage rate $w(r_{\text{new}})$ using the firm's First Order Conditions (quote equations), and dividends $d(r_{\text{new}}, K(r_{\text{new}}))$ using the firm's financing constraint.
   - The Real Financial Price of Equity $v(r_{\text{new}}, K(r_{\text{new}}))$
   - The new labor tax rate τ_l using the government's budget constraint
   - Given the new wage and labor tax rates, the Aggregate Asset Supply $\mathbb{E}[a(r_{\text{new}})]$ with the methods described in sections (A) and (B).
3. We update the bounds in the following manner:

- If $\mathbb{E}[a(r_{\text{new}})] < v(r_{\text{new}}, K(r_{\text{new}}))$, we update the lower bound, $\underline{r} = r_{\text{new}}$ and go back to step (1)
- If $\mathbb{E}[a(r_{\text{new}})] > v(r_{\text{new}}, K(r_{\text{new}}))$, we update the upper bound, $\bar{r} = r_{\text{new}}$ and go back to step (1)

4. We continue until we find the r^* that clears the market, i.e. $|\mathbb{E}[a(r^*)] - v(r^*, K(r^*))| < 0.00001$

11.5 Welfare Analysis

This section follows Domeij and Heathcote (2004) closely.

The **average welfare gain** Δ is the % increase in consumption in the no-reform case that gives the same utility as when reform is implemented:

$$\int_X \sum_{t=0}^{\infty} \sum_{\epsilon^t \in E^t} \beta^t u(c_t^R(\epsilon^t|X_0))\mu^t(X_0, \epsilon^t) d\psi(X_0)$$

$$= \int_X \sum_{t=0}^{\infty} \sum_{\epsilon^t \in E^t} \beta^t u((1+\Delta)c_t^{NR}(\epsilon^t|X_0))\mu^t(X_0, \epsilon^t) d\psi(X_0)$$

We decompose welfare changes into:

- An **aggregate component**: welfare changes because reform affects the time series of aggregate variables
$$(1 + \Delta^a) = \frac{C^R}{C^{NR}}$$
- A **distributional component**: welfare changes because reform involves a redistribution of resources
$$(1 + \Delta) = (1 + \Delta^a)(1 + \Delta^d)$$

11.6 Figures

Figure 13: Net Investment-Physical Capital Ratio vs Tobin's Q, 1947-2015

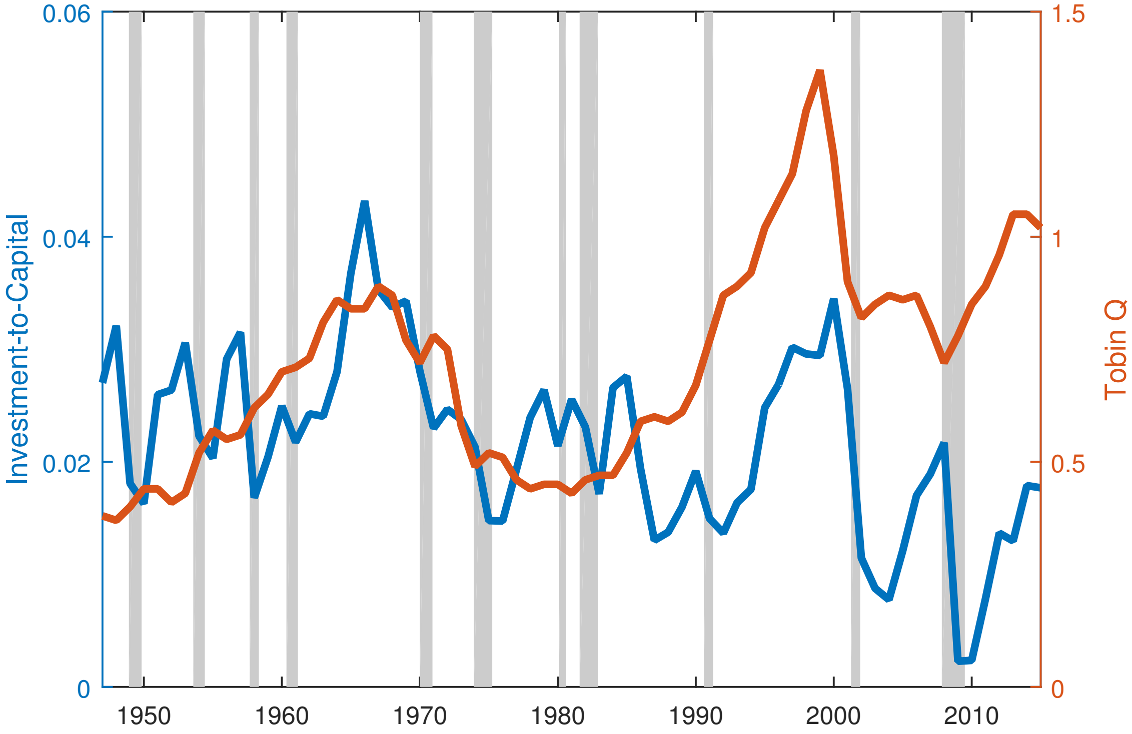

Figure 14: Nominal Investment to Gross Output, Non-Financial Corporate Sector. Source: BEA tables

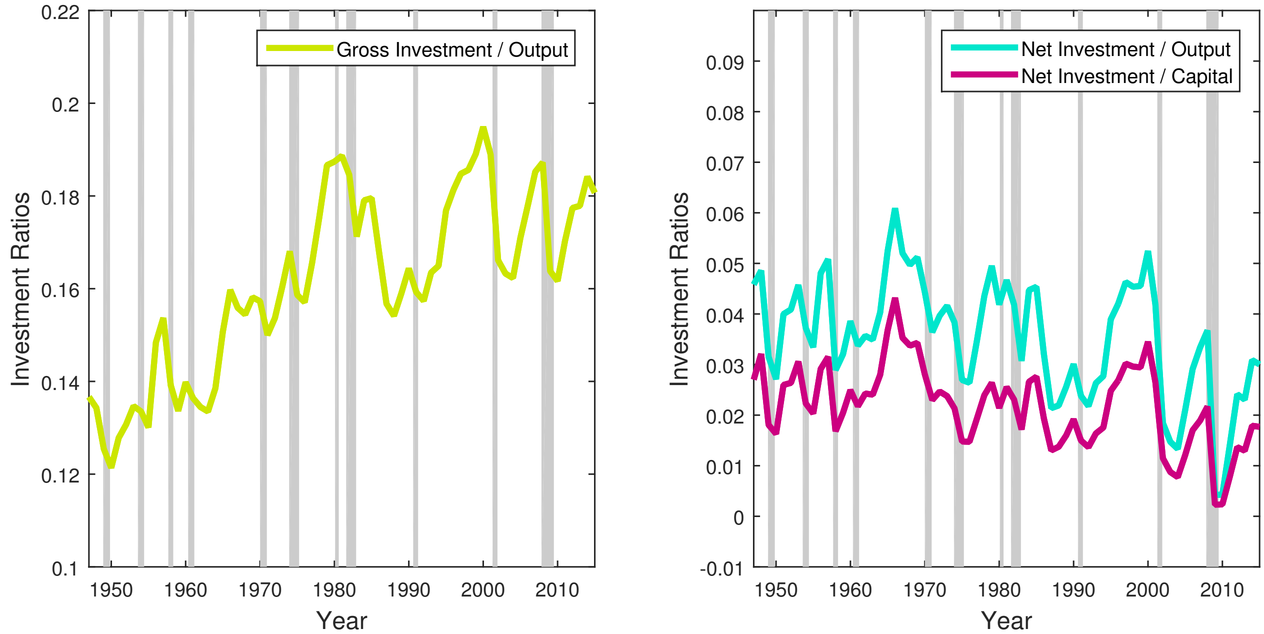

Figure 15: Non-financial Corporate log(K/Y) in chained 2009 dollars. Source: BEA, tables 1 and 4

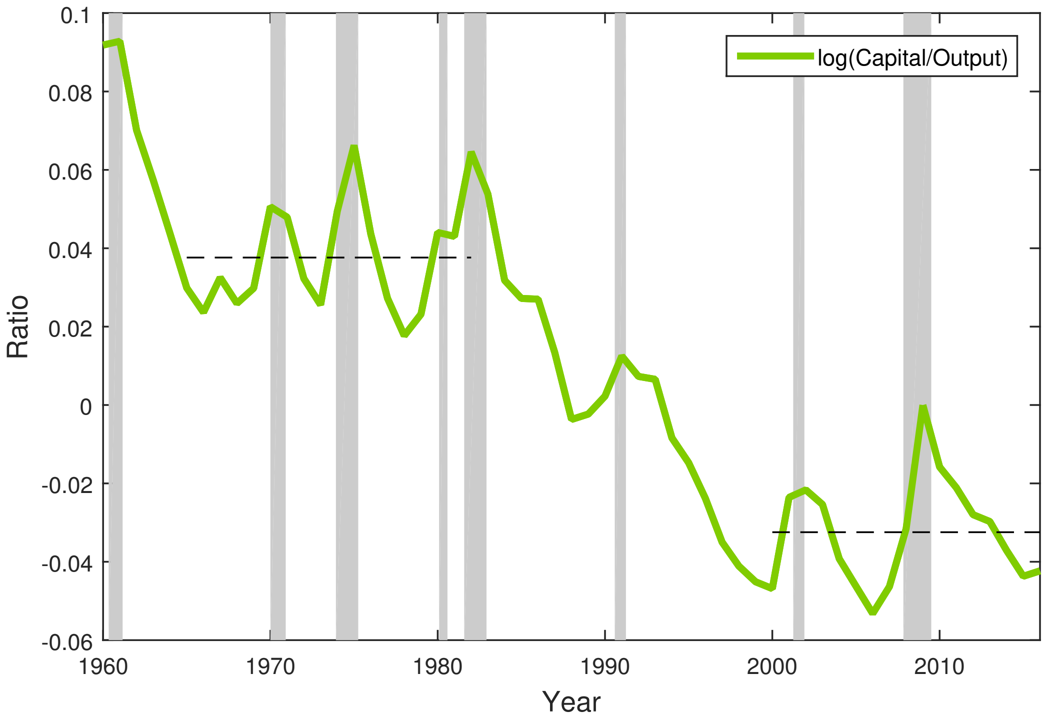

Figure 16: Non Financial vs Total Corporate sector Equity, Liabilities and Financial Assets

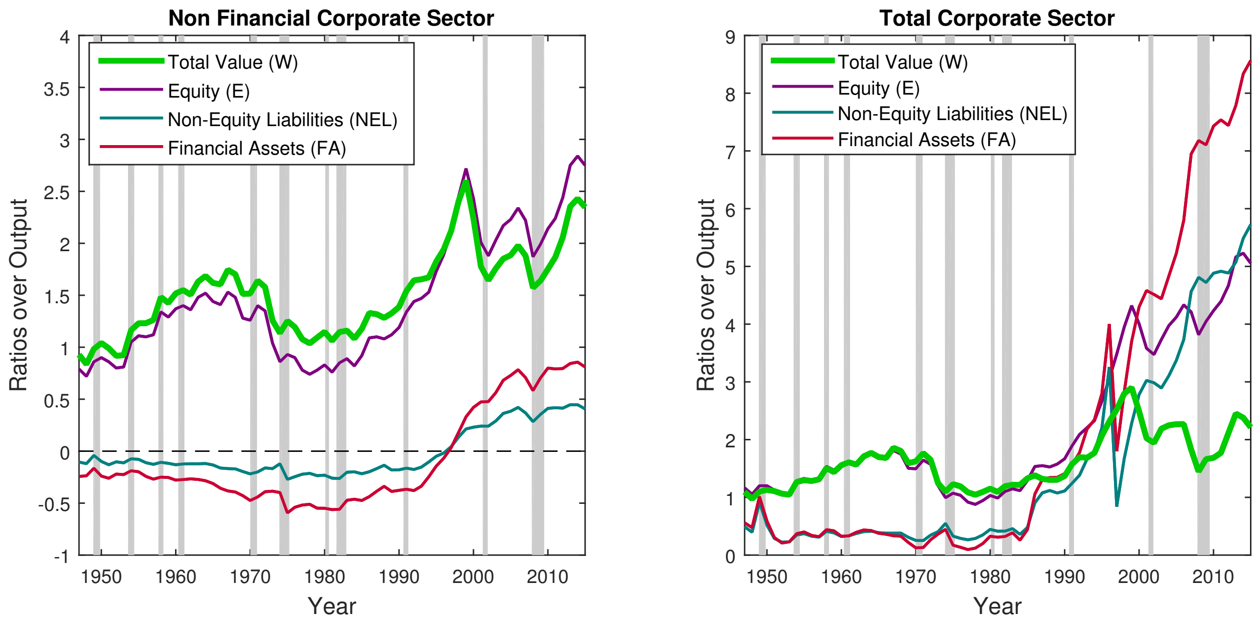

Figure 17: Net Equity Returns, Gross Returns and successive adjustments for Inflation, Taxes and Costs (%), 1960-2012

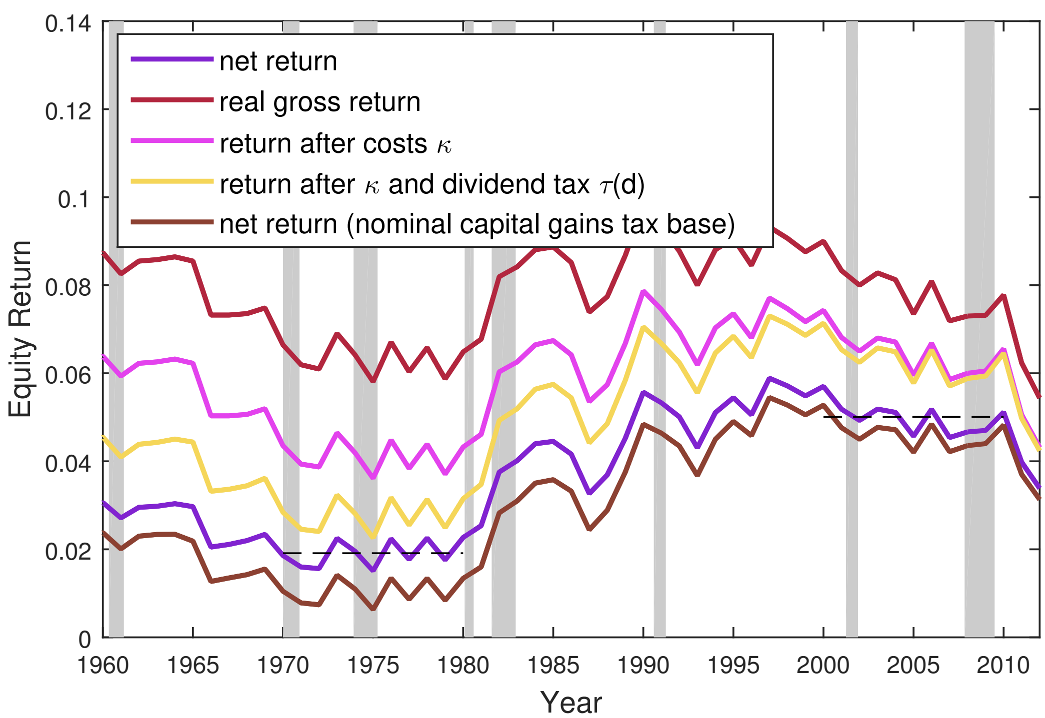

Figure 18: Dividend Tax $\tau_d = 20\%$

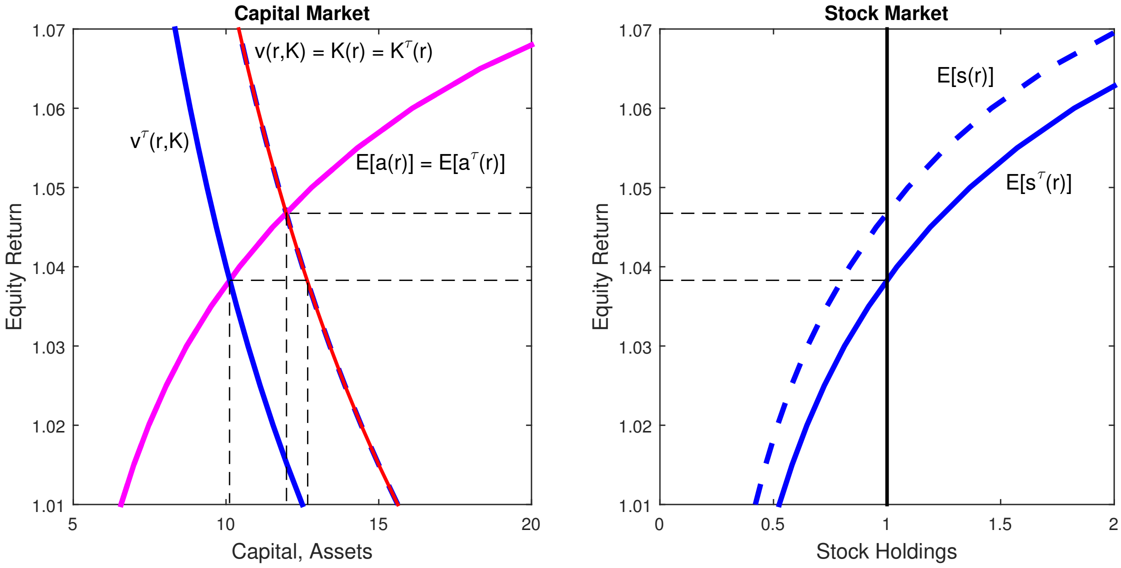

Figure 19: Markup $\frac{\xi}{\xi-1} = 1.05$

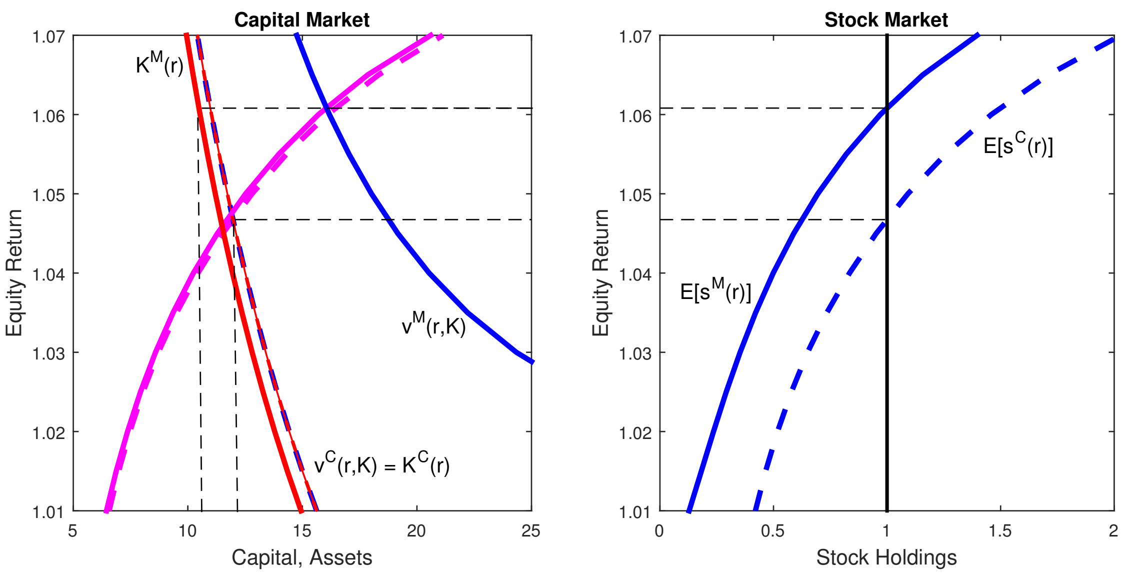

Figure 20: Capital Gains Tax $\tau_g = 20\%$

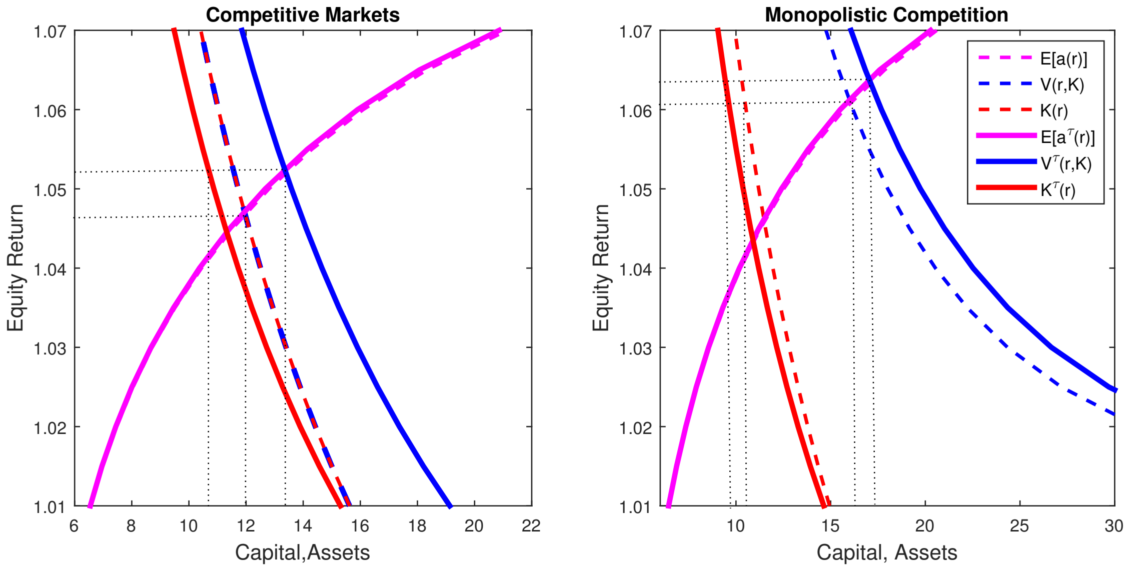

Figure 21: Portfolio Costs $\kappa = 0.5\%$

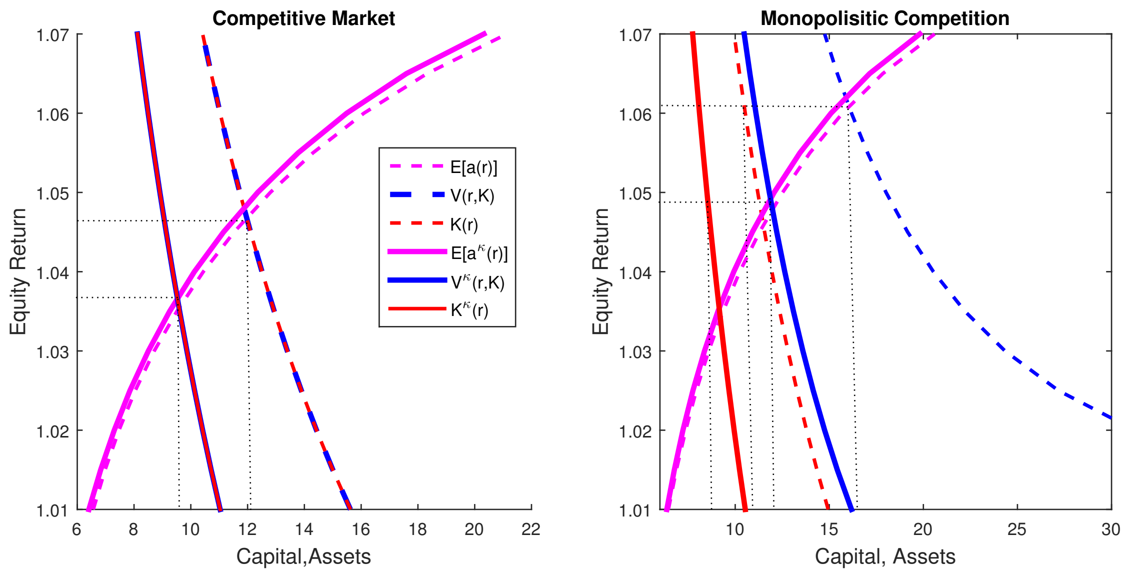

Figure 22: Corporate Tax $\tau_c = 20\%$