Kaldor and Piketty's Facts: The Rise of Monopoly Power in the United States*

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Abstract

The macroeconomic data of the last fifty years have overturned at least two of Kaldor's famous stylized growth facts: constant interest rates, and a constant labor share. At the same time, the research of Piketty and others has introduced several new and surprising facts: an increase in the financial wealth-to-output ratio in the US, an increase in measured Tobin's Q, and a divergence between the marginal and average returns on capital. In this paper, we argue that these trends can be explained by an increase in market power and pure profits in the US economy—that is, the emergence of a non-zero-rent economy—along with forces that have led to a persistent long-term decline in real interest rates. We make three parsimonious modifications to the standard neoclassical model to explain these trends. Using recent estimates of the increase in markups and the decrease in real interest rates, we show that our model can quantitatively match these new stylized macroeconomic facts.

Keywords: monopoly power, secular stagnation, labor share, Tobin's Q

JEL Classification: D42, E43, E22, E21

1. Introduction

The goal of this paper is to give a unified explanation of five puzzling trends in the US macroeconomic data. We pursue the hypothesis that an increase in monopoly profits and a decline in the natural rate of interest have been key drivers of these trends. To that end, we build a quantitative model of the US economy that includes imperfect competition, barriers to entry, the trading of pure profits, and realistic asset pricing. We then explore how the economy responds to changes in market power and interest rates, and find that our model is able to quantitatively match all of these trends.

First, we briefly describe the five macroeconomic trends that motivate our research, leaving a full discussion to section 2. We term these "puzzling facts" (or simply "puzzles"), following the tradition in

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the macroeconomic literature that describes as puzzles basic features of the data that are inconsistent with the canonical neoclassical model, such as the equity premium puzzle or the international portfolio puzzle. Throughout the paper we reference the five puzzling facts by their number in bold.

(**P1**) *An increase in the financial wealth-to-income ratio despite low savings rates, with a stagnating capital-to-income ratio.* To paraphrase Thomas Piketty, wealth is back in the United States. Household financial wealth, measured by the market value of housing and business assets, has increased from 250 percent of income in 1970 to over 400 percent in 2018. The new wealth was not accumulated by traditional savings. In fact, savings rates have generally decreased since the 1970s. The financial wealth is not embodied in new productive capital goods. The ratio of the replacement value of capital goods to output has remained relatively constant over the period. This is puzzling because in the perfect-competition neoclassical model, wealth is accumulated by savings and the market value of wealth cannot diverge in the long run from the replacement value of the capital stock.

(**P2**) *An increase in Tobin's Q to a level permanently above 1.* Rather than through savings, wealth was largely accumulated through capital gains in the stock and housing markets. The value of the S&P 500 index increased by 8 percent per year from 1970 to 2018, while the replacement value of its productive capital stock did not increase nearly as fast. This has led to an increase in Tobin's Q—the ratio of the market value of corporations to the replacement cost of their capital stock—of public corporations from approximately 1.4 in 1970 to 1.9 in 2018. This is a puzzling fact because the standard neoclassical model implies that Tobin's Q should be 1 in the long run.

(**P3**) *A decrease in the real rate of interest, while the measured average return on capital has been relatively stable.* Real interest rates have decreased substantially since the 1970s. However, the lower return is not mirrored in the average return on corporate capital—a measure of the profitability of firms—which has stayed constant. This is a puzzling fact because in the neoclassical model, the interest rate and the return on capital should move in tandem.

(**P4**) *A decrease in both the labor share and the capital share.* A growing body of evidence suggests that the same period has seen a marked decrease in competition, an increase in concentration (see Dorn et al. (2017) and Grullon et al. (2016), for example), a decline in business dynamism (Decker et al. (2016)), and an increase in profits (see, for example, Barkai (2016), Barkai (2018), and Chen et al. (2017)). A growing literature has connected these trends to a decline in the labor share.[1] In our analysis, following Barkai (2016), Karabarbounis and Neiman (2014), and Rognlie (2016), we also directly estimate the capital share of income and find that this share has been declining as well. We interpret the large and growing residual share of income as the pure-profit share.[2] This is a puzzling fact because in the standard

[1]This decline is documented in Karabarbounis and Neiman (2014) and Elsby et al. (2013).

[2]For a different interpretation of the residual share, see Karabarbounis and Neiman (2018), who call the residual share "factorless income."

neoclassical model, there is no residual income share, let alone a growing one.

(**P5**) *A decrease in the investment-to-output ratio, even given historically low borrowing costs and a high value of empirical Tobin's Q.* The lower interest rates (**P3**) have not led to a boom in investment; in fact, the investment-to-output ratio has been sluggish for two decades, despite the high level of Tobin's Q (**P2**).[3] This is a puzzling fact because in the standard model, low interest rates and a high Tobin's Q should lead to a boom in investment.

These are not your father's growth facts. The changes over the past fifty years have overturned at least two of Kaldor's famous stylized facts: constant interest rates, and a constant labor share. With Kaldor's constants in doubt, it is necessary to thoroughly reexamine the usefulness of the perfect-competition neoclassical model for explaining the macroeconomic data of the modern economy; recall that one of the main triumphs of the neoclassical model is its ability to generate Kaldor's growth facts. More broadly, the neoclassical growth model cannot address many of the changes that have occurred over the past fifty years, discrepancies that have become increasingly clear with the work of Piketty and others and through careful study of the Integrated Macroeconomic Accounts, which were first published in 2006.

We hypothesize that two forces are driving these broad macro trends: (i) an increase in monopoly profits, and (ii) a decrease in the natural rate of interest. We model these forces through parsimonious modifications of the neoclassical model. We depart from perfect-competition and posit that market power allows firms to make pure profits. There are barriers to entry, which prevent competition from driving these profits to zero. Crucially, claims to the (nonzero) pure profits are traded and priced, and the ratio of the market value of firms (which includes the rights to pure profits) to the replacement value of the productive capital stock (Tobin's Q) is permanently above one. We model a decline in the natural rate of interest through a time-varying utility wedge.[4]

We briefly sketch how our modifications to the neoclassical model solve the five puzzles. An increase in market power leads to an increase in pure profits and thus an increase in stock prices (**P1**). This leads to an increase in Tobin's Q (**P2**) and financial wealth. With an increase in markups, the pure-profit share increases and the labor and capital shares both decrease (**P4**). Markups also lead to an increase in the wedge between the marginal product of capital and the rental rate, decreasing investment (**P5**).

An increase in pure profits tends to drive up the average return on capital. To generate the constant average return we see in the data, we need a decline in interest rates, which pushes down the average return. In our model, the two forces roughly cancel each other out and lead to a constant average return (**P3**). The decline in interest rates also increases the present discounted value of profits, which further contributes to an asset price boom and an increase in wealth-to-income and Tobin's Q (**P1** and **P2**).

[3]See Gutiérrez and Philippon (2017) and Gutiérrez and Philippon (2016).

[4]This is a reduced-form way of modeling factors that affect the natural rate of interest in an OLG setting, such as changes in fertility and mortality. In previous work (Eggertsson et al. (2017)), we modeled these factors in detail in the context of a large-scale quantitative OLG model; for simplicity, in this paper we work with a representative-agent model.

Both changes in markups and interest rates are necessary parts of our explanation of the five puzzles. By itself, a secular decline in real interest rates could account for a higher wealth-to-income ratio (**P1**). The key challenge, however, is that a fall in real interest rates should have triggered an investment boom (**P5**), which did not happen, and should furthermore have led to a fall in the overall return to capital, which similarly is not seen in the data (**P3**). A secular increase in market power works as a counterforce in a straightforward way to rationalize these developments. An increase in market power is also necessary in order to explain the divergence between wealth and capital and to generate a level of Tobin's Q permanently above one.

A key theoretical innovation of the model is the trading of the rights to the pure profits of imperfectly competitive firms. The large previous literature on DSGE models with imperfect competition distributes pure profits to individuals and neglects their asset-pricing implications. This innovation is crucial in order to accurately model what is in fact measured in the data. To the extent that the stock price of Google or Facebook on the NASDAQ reflects its monopoly rents rather than the replacement value of its capital stock, it is necessary to price these assets.

A related innovation is our calculation of the equity premium to include shares of monopolistic firms. The previous literature calculates the equity premium based on the return of capital goods only. But it is difficult to generate large fluctuations in the price of capital goods because capital is a reproducible asset; absent adjustment costs, one unit of consumption good can be converted to one unit of the capital asset, anchoring its price to the replacement cost.[5] Pricing the shares of monopoly firms solves the problem, as these firms are nonreproducible in the short run, which allows their price to oscillate.

Another contribution of this paper is to clarify the measurement and theory of a number of important concepts. With our model in hand, we can make subtle but important distinctions: between financial wealth and productive capital, measured labor share (which includes bargaining rents) and economic labor share, productive and nonproductive intangible investment, empirical Tobin's Q and theoretical Tobin's Q, the capital and profit shares, the equity premium on profits and the equity premium on capital, and the marginal and average returns.

These theoretical innovations are grounded empirically by integrating standard data moments with the wealth and balance sheet data from the Integrated Macroeconomic Accounts. In this paper, we are interested in matching historical movements of financial moments such as the wealth-to-income ratio and Tobin's Q, as well as the traditional quantity moments such as productive capital and investment. We further integrate advances from the finance literature into our model to match key moments such as the equity premium, connecting our paper to the recent growing literature on macro-finance as in Bansal and Yaron (2004), Barro (2006), Nakamura et al. (2013), and Croce (2014).

[5]While adding adjustment costs and increasing the degree of risk aversion can ameliorate this problem, the values typically need to be larger than plausible estimates.

We quantitatively test the extent to which our model can match the changes seen in US data. To do so, we estimate the change in markups in the US over the past fifty years from aggregate macroeconomic data, using methods from a burgeoning literature that estimates markups. Using our estimated change in markups from 1970 to the present, along with a decline in the equilibrium real rate of 2 percentage points, our model is able to quantitatively account for the five facts. That we can match a wide variety of financial and real puzzles is a key success of the model, and not a foregone conclusion since (i) we are only inputting two changes (markups and interest rates) to explain the five puzzles (ii) the changes in interest rates and markups are estimated independently of the five puzzles. The results of the quantitative exercise lend support to the notion that rising markups and lower interest rates are two fundamental developments needed to understand the major trends in the US economy for the past 50 years.

The primary goal of this paper is to pursue the hypothesis that changes in monopoly profits and interest rates have been the main drivers of a variety of macroeconomic changes over the past fifty years.[6] We do not, however, claim that ours is the only explanation for the five stylized facts and that other forces are not at work. There are several compelling competing hypotheses that have been put forward: (i) an increase in the risk premium of capital (ii) unmeasured intangible capital (iii) an increase in the capital-to-output ratio, along with an elasticity of substitution greater than one (iv) a decrease in the bargaining power of labor. Many of these explanation are complementary to ours. Our model, for example, generates an endogenous increase in the equity premium. In addition, many forms of intangible capital—such as investments in brand equity, advertising, and marketing—are closely related to the rise in economic rents.

In order to draw policy conclusions, it is necessary to study in more detail the reasons underlying the increase in monopoly power in the US. This is important to assess whether the increase in market power is a malignant or benign development—for example, whether it is due to technological change or to lax antitrust enforcement. Such an exploration is beyond the scope of our paper. Instead we focus purely on the macroeconomic effects of an increase in monopoly power, and do not take a stand on the underlying cause. An important takeaway is that the rise in monopoly power is needed to explain a host of macroeconomic developments in recent decades that otherwise may appear puzzling. Accordingly, the stakes are high in understanding the underlying forces behind this macroeconomic phenomenon, which has important policy implications for capital taxation, antitrust enforcement, and optimal redistributive policies.

1.1. Literature

For each of the five puzzling facts listed above, there is a growing literature documenting and proposing explanations for it. Conceptually, our paper is distinct in that it considers a unified explanation of all

[6] We also explore their ability to explain developments in the decade leading up to 1970.

five puzzles, and is the first to connect changes in wealth and Tobin's Q with an increase in markups. Other papers generally focus on one or two of our five facts: Gutiérrez and Philippon (2016) focus on investment and Tobin's Q, Barkai (2016) on factor shares and investment, Caballero et al. (2017) on the average return and labor share, Piketty and Zucman (2014) on the wealth-to-output ratio, Autor et al. (2017) on the fall in the labor share, Gomme et al. (2015) on the average return, De Loecker and Eeckhout (2017) on the rise of markups.

Theoretically, we provide new comparative-static results on the impact of markups and changes in interest rates on the five puzzles. Our model includes a combination of (i) a general equilibrium model with long-run productivity risk and (ii) the pricing of the rights to pure profits, which leads to a value of Tobin's Q permanently above one. Our model produces a result that, to the best of our knowledge, has not been discussed before: a risk premium on pure profits that is greater than the risk premium on productive capital. The addition of entry and exit firm dynamics allows us to closely tie our model to the data on the market valuation of equities.

Three contemporaneous papers are closest to ours. Farhi and Gourio (2018) also focus on explaining a similar set of facts in a general equilibrium model. The main theoretical difference in the papers is how risk is modeled. Farhi and Gourio employ a "capital quality shock", which is assumed to be equal to the productivity shock, and do not employ capital adjustment costs. This innovation allows for greater tractability of the model, but at a potential cost of accuracy: the price-dividend ratio and all other ratios are constant, and capital and final goods firms have the same return. In contrast, our paper uses capital adjustment costs and long-run productivity risk as in Bansal and Yaron (2004), which produces different risk premia for capital and final goods firms. Another major difference is in the type of quantitative exercise. Whereas we calibrate our model once to our initial steady state then only modify markups and interest rates, Farhi and Gourio recalibrate their full model, changing 9 parameters, separately for the different time periods.

Brun and Gonzalez (2017) explore many of the same facts and connect them to an increase in Tobin's Q and monopoly rents. However, the modeling approaches and implications are different: (i) Brun and González (2017) emphasize the evolution of capital taxation and its impact on Tobin's Q and profits; (ii) our model uses a representative-agent framework with long-run risk, while Brun and González (2017) use a Bewley-Aiyagari heterogeneous-agent model. Kurz (2017) likewise emphasizes many of the same facts, with the following differences: (i) he focuses on the effect of changes in information technology on the rise of monopoly power; (ii) he does not capitalize monopoly profits in his model and does not focus on asset-pricing moments.

Stiglitz (2016) and Stiglitz (2015) are concerned with many of the same macroeconomic facts as this paper, such as the divergence between financial wealth and capital, which they connect to an increase in rents that are capitalized in financial assets. These papers do not incorporate a general equilibrium model. Caballero et al. (2017) focus on understanding changes in the average return and factor shares, and they explain them through a combination of rents, increases in risk premia, and technical change. The main differences with our analysis are that they use an accounting framework rather than a general equilibrium model. Barkai (2016) studies the increase in the profit share and decline in investment in the context of a general equilibrium model and provides a general proof for movements in the relative capital/labor share. The main difference with our analysis is that Barkai (2016) does not study changes in wealth, Tobin's Q, or the average return. Karabarbounis and Neiman (2018) focus on changes in factor shares and argue that the measured increase in the residual profit share is caused by changes in risk premia.

2. Five Macroeconomic Puzzles

This section summarizes the five puzzles, which relate to the the long-run evolution of the US economy over the past half century. Our focus is not on macroeconomic trends that can be explained by business cycle developments, such as those that may have resulted from the rise and fall of inflation in the late 1970s and early 1980s. For this reason we focus on key macroeconomic statics in the US in 1970 (before the Great Inflation) and 2018 (before the COVID-19 crisis). The horizontal lines in the below figures denote the long-run eleven-year means we use in our quantitative evaluation: 1965–75 and 2008–18.

Puzzle 1: Increasing wealth-to-output ratio. The wealth-to-output ratio in the US has increased substantially, from around 250 percent in 1970 to over 400 percent in 2018, as illustrated in the left panel of figure 1. Household wealth is taken from the distributional national accounts (see Piketty et al. (2017)).[7]

The puzzle lies in the fact that while the wealth-to-output ratio has increased, the ratio of capital to output has been stagnant; in the standard neoclassical model, wealth and capital are equal.[8] In addition, this increase in wealth has taken place despite a decline in the private savings rate, as illustrated in the right panel of figure 1.[9] Since the wealth was not accumulated by savings, it must have been accumulated by capital gains. But this does not solve the puzzle; it simply shifts it. What is the source of these capital gains?[10]

[FIGURE 1 ROUGHLY HERE]

[7]It consists of housing wealth, equities, fixed-income assets, business assets, and pensions, less liabilities. For computational details, see Piketty et al. (2017).

[8]Output is gross domestic product (BEA Account Code: A191RC). Capital refers to the value of private capital as measured by the BEA in the fixed-asset tables: Current-Cost Net Stock of Fixed Assets: Private (K1PTOTL1ES000).

[9]The saving rate is the net private saving rate, and it includes both personal and corporate savings (BEA Account Code: W986RC).

[10]Robbins (2019) studies the time series of capital gains in the United States and finds a structural break in the series around 1980: pre-1980 capital gains are small in magnitude, while post-1980 capital gains are large, averaging over 8 percent of GDP.

The trends in wealth and capital are not being driven purely by housing. In appendix figure 6, we decompose the increase in the wealth share into six components. Although the ratio of the value of housing to income has indeed increased, most of the increase in wealth has come from other assets.

Puzzle 2: Increasing Tobin's Q. Empirical measures of Tobin's Q have increased significantly since 1970. Tobin's Q measures the market value of corporations relative to the replacement cost of their capital. We follow Hall (2001) and Gutierrez and Philippon (2016) in calculating Tobin's Q according to formula (1). V^e denotes the value of equities, as measured in the financial accounts. Corporate liabilities L and financial assets FA are also from the financial accounts. Inventories and the value of corporate capital $P_K K$ are taken from the Bureau of Economic Analysis (BEA).[11] We follow Gutierrez and Philippon (2016) in also calculating an alternative Tobin's Q that excludes miscellaneous liabilities and financial assets, as given by formula (2).

$$Q_1 = \frac{V^e + (L - FA) - Inventories}{P_K K} \tag{1}$$

$$Q_2 = Q_1 + \frac{A^{misc} - L^{misc}}{P_K K} \tag{2}$$

Figure 2 depicts our measures of Tobin's Q and shows a striking increase. Even using our most conservative estimate, Tobin's Q has increased substantially since 1970, implying a large increase in the market value of capital relative to the replacement cost of capital.

Tobin's Q as calculated using macro data is often found to be below one for extensive periods, as is also the case in figure 2. This implies that firms are valued at less than the replacement cost of their capital, which is somewhat at odds with economic theory and may be driven by mismeasurement of the capital stock in the macro data (Piketty and Zucman (2014)).

[FIGURE 2 ROUGHLY HERE]

Measures of Tobin's Q using micro data find qualitatively similar results. The right panel of figure 2 depicts the mean Tobin's Q of publicly listed corporations using Compustat data. There has been a large increase in this measure since 1970, and Q has been substantially above one for most of the period. This large increase is a puzzle from the standpoint of standard models of capital-adjustment costs, which predict that the value of Tobin's Q should be one in the long run.

Puzzle 3: Declining interest rates, constant return on business capital. The natural rate of interest has decreased substantially since 1970. Figure 3 shows estimates of R^* from Holston et al. (2017). Other

[11] The value of equities source series ID is LM103164103.Q. The source ID numbers for L and F are FL104190005.Q and FL104090005.Q respectively. Nonfinancial corporate capital has source ID k1pnofi2es000.

measures of corporate borrowing costs such as bank lending rates have also decreased. Borrowing costs are a measure of the marginal return on capital since economic theory tells us that corporations should invest until the marginal product of capital is equal to the interest rate.

The puzzle is that while the period has seen a significant decline in the marginal return of capital as measured by corporate bond markets, measures of the profitability of firms that correspond to the business return of capital have not declined nearly as much; in the standard neoclassical model, they should be equal. We follow Gomme et al. (2011) and Gomme et al. (2015) in calculating the business return on capital, which we term the "average return." The exact definition is given in equation (3). We use data from the corporate sector of the national accounts. The numerator is a measure of corporate profits. We start with gross corporate value added and subtract payments to labor, depreciation, and taxes.[12] The denominator is a measure of the value of the corporate capital stock, using data from the BEA.

$$AR = \frac{GVA - wL - \delta P^K K - Tax}{P^K K} \tag{3}$$

The average return on capital is depicted by the blue line in figure 3. The trend of the average return has not followed the decrease seen in interest rates, especially since 1970.

[FIGURE 3 ROUGHLY HERE]

Puzzle 4: Decreasing labor share and capital share. It is well known that the labor share has decreased over the past fifty years in the US, and our analysis of the data confirms this. Figure 4, using data from the national accounts, shows that the labor share was around 64 percent in the early 1970s and fell to around 58 percent by the end of our sample.[13] The decline in the labor share in the US is not due solely to housing. If we restrict our attention to the corporate sector, we see the decline as well. Nor is the decline entirely explainable by an increase in intellectual property capital. Even with the revisions to the national accounts to include intangible capital, the income share of invested capital did not increase over the period. The decline in the labor share is also robust to measures that take into account the rise of S corporations (see Zidar et al. (2017)).

Most analyses of factor shares only separate income into two factors, labor and capital. Since labor income is observed in the data while capital income is not, the capital share is usually calculated as the residual of the labor share. Computing the capital share this way shows an increase over the period.

Rather than calculating the capital share indirectly as a residual, we can try to calculate it directly. To do so, we first need to estimate total capital income—the value of the capital stock times the rental

[12]The numerator is measured as net value added (BEA Account Code: A457RC) less labor expenditures (BEA Account Code: A460RC).

[13]The labor share is measured as compensation to labor (BEA Account Code: A460RC) relative to gross value added (BEA Account Code: A455RC).

rate of capital. In this procedure, we follow Barkai (2016). Since most firms own rather than rent their capital, we cannot observe a rental rate of capital. Instead, we must estimate it. Economic theory gives an arbitrage condition for the rental rate r^K, given by equation (4). The rental rate must equal the risk-free rate r^{rf} plus the risk premium r^{rp} minus expected inflation $E(\pi)$ plus the capital depreciation rate. In addition, if the price of capital is not equal to the price of output, the rental rate on capital must account for expected price gains from holding capital $E(g_{P^K})$.

$$r^K_{PG} = P^K \left(r^{rf} + r^{rp} - E(\pi) + \delta + (1-\delta)E(g_{P^K})\right) \tag{4}$$

We use the return on the three-month Treasury bill to proxy for the risk-free rate. As our measure of the risk premium, we use the spread between the rate of return on corporate BAA bonds and long-term Treasury bonds. Expected inflation is approximated by a five-year moving average of realized inflation. Finally, the relative price of capital P^K is calculated using the price deflator for investment and the price deflator for consumption. To proxy for expected capital price gains we calculate the five-year moving average of realized price gains. We calculate the rental rate under four different assumptions: BAA risk premium and no capital price gain, BAA risk premium with capital price gains, no risk premium and no capital price gain, and no risk premium with capital price gains. Our baseline estimate is an average of these four estimates.

Using the rental rate on capital, we calculate the capital share as capital income over total income, the labor share as labor income over total income, and the tax share as taxes on production over income. Finally, there is a residual share of income that is not accounted for by labor, capital, or taxes. Figure 4 shows that, along with the labor share, the capital share has also declined over time, from 17 percent in 1970 to 15 percent in the present. The main driver of this decline has been a decrease in the risk-free interest rate, which has driven down the rental rate of capital; the capital-to-output ratio has been relatively stable (see figure 1).

In 1970 there was a moderate amount of residual factor income; labor, capital, and taxes accounted for 90 percent of national income. However, because of the decline in the labor and capital shares, the residual share increased to 19 percent by 2018. In other words, there is now a large amount of "missing" factor income that does not go to labor or capital. As we argue below that this missing factor is pure profits, we refer to this residual share as the profit share.

[FIGURE 4 ROUGHLY HERE]

Puzzle 5: Low investment despite low r and high Tobin's Q. As the work of Gutiérrez and Philippon (2016) shows, several measures of investment have been trending down since the 1970s. In figure 5 we plot net investment as a share of GDP.[14] This decrease in investment is somewhat puzzling, given historically low interest rates and high levels of Tobin's Q, both of which should lead to higher investment (see, for example, Hayashi (1982).)

[FIGURE 5 ROUGHLY HERE]

3. Model

The core of our model is a DSGE economy with long-run productivity risk. To this base, we add three elements that allow us to explain the five puzzling facts. We focus our exposition on these modifications of the standard neoclassical model, leaving the full description of the model's equations and first-order conditions to section 1 of the appendix.

3.1. Market Structure

We hypothesize that an increase in pure profits is a key force behind the five puzzles. We introduce profits into our model economy in the simplest possible manner: through Dixit-Stiglitz monopolistic competition. This is the first key departure of our model from neoclassical theory. The pure profits are distributed to the holders of securities that hold the rights to the pure profits. The value of these securities forms the wedge between financial wealth and capital and helps explain **P1** and **P2**.

There is a unit mass of monopolistically competitive final-goods firms that differentiate an intermediate good and resell it to consumers. The final-good composite is the CES aggregate of these differentiated final goods, which are indexed by i: $Y_t = \left[\int_0^1 y_t^f(i)^{\frac{\Lambda_t - 1}{\Lambda_t}} di\right]^{\frac{\Lambda_t}{\Lambda_t - 1}}$.

Final-goods firms set prices in each period and face a demand curve of the form $y_t^f(i) = Y_t\left(\frac{p_t(i)}{P_t}\right)^{-\Lambda_t}$, where P_t is the nominal price index of the final-good aggregate and Λ_t is a time-varying measure of a firm's market power.[15] An increase in Λ_t decreases a firm's market power and lowers equilibrium markups.

Each final-goods producer uses y_t^m of intermediate goods to produce output, according to a linear technology function $y_t^f = y_t^m$. A final-goods firm chooses real prices $\frac{p_t(i)}{P_t}$ and $y_t^f(i)$ to maximize real profits, subject to the production constraint. The marginal cost of producing a unit of final good is the price of the intermediate good $\frac{p_t^{int}}{P_t}$.

The optimality condition for the real price of the firm's good is a time-varying markup μ_t over marginal cost (which is the price of the intermediate good): $\frac{p_t(i)}{P_t} = \frac{\Lambda_t}{\Lambda_t - 1}\frac{p_t^{int}}{P_t} = \mu_t \frac{p_t^{int}}{P_t}$. Since the price of the intermediate good is the same, all final-goods firms make the same pricing decisions, and thus $p_t(i) = P_t$, yielding $\frac{p_t^{int}}{P_t} = \frac{1}{\mu_t}$.

[14] We use nonresidential net fixed investment (BEA Account Code: A593RC1).

[15] The price index for the final aggregate is given by $P_t = \left(\int_0^1 p_t(i)^{1-\Lambda_t} di\right)^{\frac{1}{1-\Lambda_t}}$.

Market power in our model is determined by the CES elasticity Λ_t, which determines the level of markups in our economy. We posit that $\frac{\Lambda_t}{\Lambda_t - 1}$—that is, markups μ_t—follow an AR(1) process given by

$$ln(\mu_t) = (1 - \rho_\mu) ln(\bar{\mu}) + \rho_\mu ln(\mu_{t-1}) + \epsilon_t^\mu. \tag{5}$$

The long-run level of markups in the economy is given by $\bar{\mu}$. An increase in the long-run level of markups allows us to explain an increase in the profit share and a decrease in the labor and capital shares (**P4**).

The second key element of our model is that there are barriers to entry for final-goods firms. There are two types of barriers to entry in our model. First, final-goods firms hold the unique rights to the specific variety of good they produce. This ensures that entry of new firms does not drive price to equal marginal cost and thus profits to zero. Second, we assume that the supply of final-goods firms is fixed in the short run. Individuals cannot create new final-goods firms, and thus these firms are nonreproducible. The next section shows that, in the long run, the barriers to entry are not permanent, and firms will eventually go out of business.

Due to these barriers to entry, there can be nonzero pure profits in the economy; final-goods firms make aggregate profits $\Pi_t = \frac{\mu_t - 1}{\mu_t} Y_t$. The profit share of income in the economy is given by $PS_t = \frac{\mu_t - 1}{\mu_t}$.

Pure profits are distributed to shareholders of final-goods firms, who own the rights to the economic rents, as dividends. Aggregate dividends distributed to shareholders at time t are thus given by $d_t^f = \Pi_t$. Since all firms make identical profits, each firm receives an equal fraction of aggregate dividends. As will be seen, the securities that hold the rights to the pure profits of final-goods firms are priced and traded, which allows the value of wealth to diverge from that of capital (**P1** & **P2**).

3.1.1. Firm Entry and Exit Dynamics

Although there are high barriers to entry for final-goods firms, these barriers are not permanent: all final-goods firms in our economy will eventually go out of business and be replaced by new firms. We include exogenous firm exit as in Melitz (2003). Firm exit in our model affects the value of the securities that hold the rights to the pure profits of firms. Including firm exit allows us to better match the level of financial wealth in the economy and thus quantitatively explain **P1** and **P2**.

We assume that between period $t-1$ and t a final-good firm has a probability Δ_t of exiting the market. Thus, of all the firms that are extant at time $t-1$, only $(1-\Delta_t)$ will survive to period t, a smaller fraction $(1 - \Delta_t) \cdot (1 - \Delta_{t+1})$ will survive to period $t+1$, and an ever-diminishing percentage $\prod_{n=t}^{s} (1 - \Delta_n)$ will survive to period s. When a firm exits, shareholders are wiped out.[16] The information on whether a

[16] From the point of view of an investor in these securities, the churning of firms is somewhat analogous to the depreciation of capital. An individual buys securities, receives a return, and some of the security "depreciates" through the bankruptcy of the underlying firms.

firm goes out of business is revealed at the end of period $t-1$, before asset decisions are made for the next period.

Entry in our model is also exogenous. Each period a mass Δ_t of new firms enters, replacing the firms that have exited. New IPO securities are issued at the end of time $t-1$ that give the rights to these firms' profits; this corresponds to, for example, when Google was floated for the first time on the stock exchange.

3.1.2. Asset Pricing

The third key element of our model is that the firms that make monopoly profits are traded. There are securities markets in which the rights to the future profits of final-goods firms are bought and sold. The trading of these securities leads to a divergence between financial wealth and productive capital (**P1**) and allows Tobin's Q to diverge permanently from one (**P2**).

At the end of period $t-1$, securities S_t^f are traded for each firm, which give the rights to all future dividends d_t^f of these firms for as long as they survive. Investors do not buy shares of individual final-goods firms, which are infinitesimally small. They instead buy positive fractions of the continuum of firms. Since the continuum spans from zero to one, in every period a single share of securities S_t^f is outstanding. By the law of large numbers, for every mass of shares an individual purchases, exactly Δ_{t+1} percent of the underlying firms will go out of business between periods t and $t+1$.

The price of these securities S_t^f is given by the present discounted value of the dividends the shares receive:

$$X_{t-1}^f = E_{t-1}\left[\sum_{s=t}^{\infty} m_s d_s^f \prod_{n=t+1}^{s} (1-\Delta_n)\right]. \tag{6}$$

In this equation, m_t is the stochastic discount factor that is determined in equilibrium by the optimal asset choice of households. Note that future dividends are discounted by two factors: $(1-\Delta)$, taking into account that some firms will go out of business; and the stochastic discount factor, taking into account that future dividends must be discounted by the riskiness of these profits and the time value of money.

3.1.3. Intermediate-Goods Firms

Production is fairly standard; the only twist on a purely neoclassical model is the presence of the markup wedge μ_t between the marginal product of capital and the rental rate; an increase in this wedge is our main explanation for why investment has decreased (**P5**).

A representative intermediate-goods firm uses labor L_t and capital K_t to produce output Y_t^m according to the production function $Y_t^m = \left(\alpha K_t^{\frac{\sigma-1}{\sigma}} + (1-\alpha)(A_t L_t)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$, where σ is the production elasticity of substitution and A_t the level of labor-augmenting productivity.

The intermediate-goods firm distribute the excess of its profits over retained investment as a dividend

$d_t^i S_t^i = \frac{1}{\mu_t} Y_t^m - w_t L_t - I_t$. Investment increases the firm's future stock of capital according to

$$K_{t+1} = \Phi(I_t/K_t)K_t + (1-\delta)K_t, \quad (7)$$

where δ is the rate of depreciation and adjustment costs $\Phi(\cdot)$ are a positive concave function. Following Jermann (1998), we use an adjustment-cost function given by $\Phi(I_t/K_t) = \frac{a_1}{1-\xi}\left(\frac{I_t}{K_t}\right)^{1-\xi} + a_2$.

The first-order conditions from the firm's problem are derived in section 1 of the online appendix. Note that markups μ_t create a wedge between the marginal product of capital and the rental rate. As markups increase, the increased wedge will cause investment to decrease (**P5**).

3.2. Long-Run Risk

The value of securities S_t^f (and thus financial wealth, **P1** & **P2**) depends upon the rate at which pure profits are discounted and thus depends upon the equity premium. In order to match the equity premium in the data, we follow the macro-finance literature and include long-run productivity risk in our model, as in Bansal and Yaron (2004) and Croce (2014). There are two sources of uncertainty in productivity growth: an i.i.d short-run shock that is standard in RBC models (ϵ_a), and a long-run component (ϵ_x) that leads to small but persistent movements in long-run growth. Let A_t denote the level of labor-augmenting productivity and lowercase letters denote log units. The growth rate of productivity is given by

$$\Delta a_{t+1} = \zeta + x_t + \sigma_a \epsilon_{a,t+1} \quad (8)$$

$$x_t = \rho x_{t-1} + \sigma_x \epsilon_{x,t} \quad (9)$$

$$\begin{bmatrix} \epsilon_{a,t+1} \\ \epsilon_{x,t+1} \end{bmatrix} \sim \;\; iid\; N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho_{xa} \\ \rho_{xa} & 1 \end{bmatrix}\right). \quad (10)$$

Here x_t is the long-run risk of productivity growth and $\epsilon_{a,t+1}$ is the short-run risk.

3.3. Household Preferences

Preferences are fairly standard: representative households have preferences of the Epstein and Zin (1989) variety, which allows us to more easily match the equity premium. The economy consists of a unit mass of identical infinitely lived agents. Utility is given by

$$V_t = \left[(1-\beta)\left(c_t^{\nu}(A_{t-1}(1-L_t))^{1-\nu}\right)^{\frac{1-\gamma}{\theta}} + \beta D_t \left(E_t V_{t+1}^{1-\gamma}\right)^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\gamma}}, \quad (11)$$

where the time discount factor is β, ν is a weight determining the average share of total hours worked, γ is the risk-aversion parameter, and θ is a parameter defined as $\theta = \frac{1-\gamma}{1-\frac{1}{\psi}}$. In this expression, ψ is the elasticity of intertemporal substitution. The main advantage of using Epstein-Zin utility is that there is no longer a link between the intertemporal elasticity of substitution and the coefficient of risk aversion, which makes it easier to match the equity-risk premium (and quantitatively explain **P1** & **P2**). If $\gamma = 1/\psi$, the utility collapses to the CRRA variety. As in Croce (2014), leisure utility is scaled by productivity.

The term D_t is an additional wedge between utility in period $t+1$ and in period t, beyond the time discount rate β. We use this wedge as a reduced-form way of modeling factors that affect the real interest rate in an OLG model, such as changes in demographics, which we have modeled in detail in previous work (see Eggertsson et al. (2017)). While an OLG structure would allow us to fully endogenize the decline in natural interest rates, for simplicity and ease of exposition we have chosen here to work with a representative-agent model. D_t is a lever we use in our quantitative exercises to decrease the long-run real interest rate and thus match **P3**.

Individuals maximize this utility subject to a series of budget constraints,

$$\begin{aligned} c_t + X_t^i S_{t+1}^i + X_t^f S_{t+1}^f = {} & w_t L_t + d_t^i S_t^i + d_t^f S_t^f \\ & + \Delta_{t+1} X_t^f + (1-\Delta_t) X_t^f S_t^f + X_t^i S_t^i. \end{aligned} \tag{12}$$

On the left-hand side of the budget constraint, individuals use their income to purchase either consumption, shares of intermediate-good firms ($X_t^i S_{t+1}^i$), or shares of final-goods firms ($X_t^f S_{t+1}^f$). On the right-hand side of the budget equation, agents receive income from a variety of sources: labor income $w_t L_t$, dividends from intermediate-goods firms $d_t^i S_t^i$, dividends from final-goods firms $d_t^f S_t^f$, IPO-issued securities of final-goods firms $\Delta_{t+1} X_t^f$, the remaining share value of final-goods firms $(1-\Delta_t) X_t^f S_t^f$, and the remaining share value of intermediate-goods firms, $X_t^i S_t^i$.

3.4. Equilibrium and Solution

An equilibrium is a set of quantities and prices such that individuals maximize utility subject to budget constraints, intermediate- and final-goods firms maximize profits subject to production constraints, and markets clear. While this model is not stationary, we can make it so by applying a standard transformation: divide all quantities (except labor) by A_{t-1}, and likewise for wages and the price of securities X_t^i and X_t^f. Section 1.6 of the online appendix contains the full definition of equilibrium and lists all of the equations of the model. A steady-state equilibrium is the same as the above equilibrium definition, except that all variables are constant rather than subscripted by time. Section 1.9 of the online appendix also contains the steady-state equations of the model.

We solve the model using a second-order perturbation method and the software Dynare (Adjemian et al. (2011)); a period in our model is a month. We solve the model around the nonstochastic steady state. Caldara et al. (2012) show that perturbation methods are well suited for solving DSGE models with recursive preferences and long-run risk, with accuracy that is competitive with Chebyshev polynomials and value-function iteration. After solving the model, we compare the theoretical moments generated by the model with data moments.

4. Characterizing the Puzzles

In this section, we derive model statistics that correspond to the data moments of our five puzzles. These statistics are the main objects of our theoretical and quantiative analysis below, and will also illustrate how our theory differs in key ways from the neoclassical model. For each macro-statistic, we also derive steady-state equations, which are useful in the comparative-statics analysis.

P1: Increasing ratio of financial wealth to output, constant capital-to-output ratio. We measure financial wealth in our model in a way that corresponds to the measurement in the US Financial Accounts. In the Financial Accounts, wealth is defined as the market value of stocks and bonds; thus we define financial wealth W_t as equal to the combined value of securities and capital: $W_t = X_t^f + q_t K_t$. We immediately see from this equation a key difference between our model and the neoclassical: when there are nonzero pure profits in the economy, the value of financial wealth may diverge from the value of the capital stock.

We now derive the steady-state security price X^f as a percentage of output. In a balanced-growth equilibrium, the ratio of dividends to output is given by $\frac{d}{Y} = PS$. In addition, dividends grow at the same rate as output; thus future dividends must be adjusted for productivity growth. Thus, using the formula for the sum of a geometric series, we have

$$\frac{X^f}{Y} = \sum_{s=0}^{\infty} \frac{PS(exp(\zeta))^s (1-\Delta)^s}{(1+r)^s} = \frac{PS}{1 - \frac{exp(\zeta)(1-\Delta)}{1+r}}. \tag{13}$$

The r in this expression is the steady-state real interest rate.

Given the steady-state real interest rate, it is easy to characterize the capital-to-output ratio. The f.o.c. of intermediate-goods firms yields $r = \frac{F_K}{\mu} - \delta$, which allows us to calculate the steady-state capital-to-labor ratio; combining this with the steady-state labor-to-output ratio yields the steady-state capital-to-output ratio.

P2: Increasing Tobin's Q. Empirical Tobin's Q is defined both in the Financial Accounts and in our model as the ratio of the market value of wealth to the value of capital goods:

$$Q = \frac{W_t}{K_t} = \frac{X_t^f + q_t K_t}{K_t}. \tag{14}$$

We immediately see from this equation a second way in which our model differs from the neoclassical: with nonzero pure profits, Tobin's Q can be permanently above one.

P3: Declining interest rate, constant average return. The average return on capital is measured in the data as GDP minus depreciation minus payments to labor, divided by the replacement value of capital: $AR_t = \frac{Y_t - w_t L_t - \delta K_t}{K_t}$. In the steady state, the average return is equal to

$$\text{AR} = r + \frac{\Pi}{K} = r + \frac{PS}{\frac{K}{Y}}. \tag{15}$$

We see from this equation that with pure profits, the average and marginal returns on capital can diverge. In the neoclassical model, they are the same.

The stationary discount rate is

$$m = \beta D \cdot exp(\frac{-1}{\psi}\zeta). \tag{16}$$

The risk-free interest rate is $r = \frac{1}{m} - 1$.

P4: Increasing profit share, declining labor share. We measure the labor share as payments to labor ($LS_t = \frac{w_t L_t}{Y_t}$), the capital share as the return on productive capital ($KS_t = \frac{r_t^K q_t K_t}{Y_t}$), and the profit share as the residual ($PS_t = 1 - LS_t - KS_t$). In the neoclassical model, the profit share is zero.

P5: Declining investment. In a stationary equilibrium, the capital-to-output ratio is constant, and thus investment must be exactly enough so that capital grows with output; that is, it grows at the rate of productivity growth plus depreciation. Thus, in the steady state, the ratio of investment to output equals

$$\frac{I}{Y} = [exp(\zeta) - 1 + \delta]\frac{K}{Y}. \tag{17}$$

Finally, we characterize the equity premium in our model, because our quantitative results will produce interesting endogenous movements in this moment. Since there are two assets in our model (intermediate and final goods firms), we calculate two equity premia, as well as the equity premium on the return from holding both types of assets together, in proportion to their values. The returns in our model are calculated as follows. The risk-free return is given by $R_t = \frac{1}{E_t[m_{t+1}]}$, the expected return on the final-goods firm is given by $E_t[R^f_{t+1}] = E_t\left[\frac{d^f_{t+1} + (1-\Delta_{t+1})X^f_{t+1}}{X^f_t}\right]$, and the return on the intermediate-goods firm is given by $E_t[R^i_{t+1}] = E_t\left[\frac{d^i_{t+1} + q_{t+1}K_{t+2}}{q_t K_{t+1}}\right]$. The combined return is the total return from holding the total value of intermediate- and final-goods firms:

$$E_t[R^c_{t+1}] = E_t\left[\frac{d^f_{t+1} + (1-\Delta_{t+1})X^f_{t+1} + d^i_{t+1} + q_{t+1}K_{t+2}}{X^f_t + q_t K_{t+1}}\right]. \tag{18}$$

The equity premium for all three of these assets is then calculated as the expected return minus the risk-free rate, adjusted for leverage. In line with Croce (2014), we use a leverage ratio of two.

We are not aware of any previous work that distinguishes between the equity premium on profits and the equity premium on productive capital, although the distinction is important for our results. Our empirical results below show that the equity premium on securities is substantially higher than the equity premium on productive capital. As discussed in detail in section 6.6, because there are barriers to entry, final-goods firms are nonreproducible assets, and thus their prices can fluctuate widely in response to changes in pure profits. In contrast, productive capital is reproducible, and thus the price of capital q has only moderate fluctuations (due to the presence of adjustment costs). As a direct result, in moving from an economy in which the value of securities is high relative to the value of the capital stock, the equity premium will increase.[17]

5. A Qualitative Solution to the Puzzles

We hypothesize that a permanent increase in markups along with a decrease in the real interest rate can solve the five puzzles. We now examine the impact of both changes on our five stylized facts of interest. We compare analytic comparative statics in the (nonstochastic) steady state of our model, which allows us to unambiguously sign the derivatives.[18] Our results show that the proposed mechanisms can *qualitatively* solve the five puzzles that are the subject of this paper. In the succeeding sections, we test whether our mechanisms can *quantitatively* solve them, comparing differences in the full stochastic economy.

5.1. Comparative Statics of Market Power and Interest Rates

We examine the change in steady-state model moments in response to small changes in the steady-state level of markups ($\bar{\mu}$) and the interest rate. We model the decrease in interest rates in a reduced-form way through an increase in the utility wedge D. Two key examples we have in mind behind the increase in D are a decrease in population growth and a decrease in the mortality rate.

Proposition 1. *The following comparative-static results hold:*

1. $\frac{\partial \frac{K}{L}}{\partial \bar{\mu}} < 0$, $\frac{\partial \frac{K}{Y}}{\partial \bar{\mu}} < 0$. ***(P1)*** *An increase in steady-state markups will lead to a decrease in the capital-to-labor ratio and the capital-to-output ratio.*
2. $\frac{\partial Q}{\partial \bar{\mu}} > 0$. ***(P2)*** *An increase in steady-state markups will lead to an increase in empirical Tobin's Q.*
3. $\frac{\partial AR}{\partial \bar{\mu}} > 0$. ***(P3)*** *An increase in steady-state markups will lead to an increase in the average return on capital.*

[17]This result should be tempered somewhat by the fact that we may be missing a key element. As Larry Summers (2017) points out, as equity prices rise, firms become less levered.
[18]However, this comes at a cost— there is no risk premium in the nonstochastic steady state.

4. $\frac{\partial PS}{\partial \bar{\mu}} > 0$. ***(P4)*** *An increase in steady-state markups will lead to an increase in the pure-profit share.*
5. $\frac{\partial LS}{\partial \bar{\mu}} < 0$, *if* $\sigma \leq 1$. ***(P4)*** *An increase in steady-state markups will lead to a decrease in the labor share if production is Cobb-Douglas or the production elasticity of substitution is less than one.*
6. $\frac{\partial \frac{\bar{I}}{Y}}{\partial \bar{\mu}} < 0$. ***(P5)*** *An increase in steady-state markups will lead to a decrease in the investment-to-output ratio.*

Proof: See section 2 of the online appendix.

Proposition 2. *The following comparative-static results hold:*

1. $\frac{\partial \frac{W}{Y}}{\partial D} > 0$. ***(P1)*** *An increase in D will lead to an increase in the wealth-to-output ratio.*
2. $\frac{\partial \frac{K}{Y}}{\partial D} > 0$, $\frac{\partial \frac{K}{L}}{\partial D} > 0$. ***(P1)*** *An increase in D will lead to an increase in the capital-to-output ratio and the capital-to-labor ratio.*
3. $\frac{\partial AR}{\partial D} < 0$. ***(P3)*** *An increase in D will lead to a decrease in the average return on capital.*
4. $\frac{\partial LS}{\partial D} > 0$ *if* $\sigma < 1$. ***(P4)*** *An increase in D will lead to an increase in the labor share if $\sigma < 1$. If $\sigma > 1$, $\frac{\partial LS}{\partial D} < 0$.*
5. $\frac{\partial KS}{\partial D} < 0$ *if* $\sigma < 1$. ***(P4)*** *An increase in D will lead to a decrease in the capital share if $\sigma < 1$. If $\sigma > 1$, $\frac{\partial KS}{\partial D} > 0$.*
6. $\frac{\partial \frac{I}{Y}}{\partial D} > 0$. ***(P5)*** *An increase in D will lead to an increase in the investment-to-output ratio.*

Proof: See section 2 of the online appendix.

5.2. An Illustrative Example

Propositions 1 and 2 show that an increase in markups and a decline in interest rates can potentially explain several of the puzzles. We discuss here the intuition with an illustrative example. We consider a special case of the model with Cobb-Douglas production and no productivity growth, which yields simple closed-form solutions.

Consider a permanent increase in markups μ and a decline in the natural rate of interest r.

(**P1**): Under Cobb-Douglas production, we can write the wealth-to-output ratio as

$$\frac{W}{Y} = \frac{X^f + X^i}{Y} = \underbrace{\frac{\frac{\mu-1}{\mu}}{r+\Delta}}_{\frac{X^f}{Y}} + \underbrace{\frac{\frac{\alpha}{\mu}}{r+\delta}}_{\frac{X^i}{Y}=\frac{K}{Y}}. \tag{19}$$

An increase in markups increases the profits of final-goods firms and thus the value of those firms, $\frac{X^f}{Y}$, as reflected in the first term in equation (19). The increase in the security value then leads to an increase in the wealth-to-output ratio. The drop in the interest rate r leads to a further increase in $\frac{X^f}{Y}$ as the present discounted value of profits increases.

A decline in interest rates would usually lead to an increase in $\frac{K}{Y}$, the second term of equation (19). However, this is offset by the increase in markups, leading to an ambiguous effect on overall capital. An increase in markups and a decline in interest rates can thus lead to an increasing ratio of wealth to income but a constant ratio of capital to income.

(**P2**): Steady-state empirical Tobin's Q equals

$$Q = \frac{W}{K} = \frac{X^f + X^i}{K} = \underbrace{\frac{(\mu-1)\alpha^{-1}(r+\delta)}{r+\Delta}}_{\frac{X^f}{Y}\frac{Y}{K}} + \underbrace{1}_{\frac{X^i}{K}=\frac{K}{K}}. \tag{20}$$

It follows immediately from the first term in equation (20) that as long as $\mu > 1$, $Q > 1$. In other words, as long as there is any monopoly power at all, empirical Tobin's Q will be greater than one. For the same reason, an increase in markups will lead to an increase in Q. The effect of interest rates on Q depends on the relative size of δ and Δ: as long as $\delta > \Delta$, Q will increase if interest rates decline. However, this result is more ambiguous in the general model.

(**P3**): The average return on capital can be written as

$$\begin{aligned} AR = \frac{Y - wL - \delta K}{K} &= \underbrace{r}_{\text{marginal ret. on K}} + \underbrace{\frac{PS}{K/Y}}_{\text{Profit sh. / cap-output ratio}} = \\ &= (1 + \frac{\mu-1}{\alpha})r + \frac{\mu-1}{\alpha}\delta. \end{aligned} \tag{21}$$

Equation (21) shows that if μ is increasing and r is decreasing, the average return can remain constant.

(**P4**): The capital share (KS) and the labor share (LS) can be expressed as

$$KS = \frac{(r+\delta)K}{Y} = \frac{1}{\mu}(1-\alpha) \tag{22}$$

$$LS = \frac{wL}{Y} = \frac{1}{\mu}\alpha \tag{23}$$

with the profit share $PS = 1 - KS - LS = \frac{\mu-1}{\mu}$. An increase in μ will decrease both the labor and capital shares and increase the profit share.

(**P5**): The investment-to-output ratio can be expressed as

$$\frac{I}{Y} = \frac{\alpha\delta}{\mu(r+\delta)}. \tag{24}$$

From equation (24), a decline in r would usually cause investment to increase. However, an increase in μ generates a wedge between the marginal product of capital and the rental rate, causing a decline in investment and potentially offsetting the decline in interest rates. The relative size of the forces is a quantitative question explored in section 6. We note that markups only have a moderate effect on K/Y (and hence I/Y), with an elasticity (under Cobb-Douglas) of -1.

6. A Quantitative Solution to the Puzzles

We now test the hypothesis that changes in markups and interest rates can quantitatively explain the five puzzling facts outlined in the introduction. While the analytic comparative statics of section 5 suggest that our model can qualitatively match the puzzles, we now investigate the magnitudes. To do so, we cannot rely purely on steady-state results since in a steady state there is no equity premium. Instead, we compare moments of the stochastic economy, focusing on the period from 1970 to the present.

We chose 1970 as the initial stochastic steady state largely because this year corresponds to the period before the onset of the Great Inflation, a period of great volatility for inflation and the real interest rate. By choosing 1970 as a comparison point, we estimate a moderate decline in interest rates of 2 percent over the period and thus avoid exaggerating the movement in the real interest rate. Our choice of 1970 rather than 1980 also affects our estimated increase in markups, as markups reached their nadir in 1980.

The five puzzles all involve *changes* in macroeconomic quantities. For this reason, we judge our quantitative results on the grounds of whether changes in our model moments match changes in the data moments. We first calibrate our model to US data in 1970 (matching levels only). We then solve the model and compute moments of interest by calculating theoretical moments from the second-order approximation of the model's solution. We then change the long-run level of markups and interest rates from their 1970 level to their 2018 level, calculating the model's moments for each change. We then compare changes in our model moments between the two time periods with changes in the data moments.

6.1. Quantitative Calibration

There are three categories of parameters: (i) the long-run level of markups and interest rates; (ii) parameters taken from the data and literature; and (iii) parameters chosen to match 1970 data moments through minimizing an objective function.

6.1.1. Estimating Changes in Markups and Interest Rates

We estimate markups using aggregate macroeconomic data, exploiting the fact that under constant returns to scale (CRS) production, markups are proportional to the profit share of the economy. In this technique we follow Barkai (2016). In particular, under CRS, markups equal the inverse of the share of production not accounted for by pure profits:

$$PS = \frac{\mu - 1}{\mu} \implies \mu = \frac{1}{1 - PS}. \tag{25}$$

As discussed in section 2, we estimate the profit share from the data by taking the residual share of output after subtracting labor and capital income. Using the results from section 2, we find a moderate increase in markups over the period, from 1.12 in 1970 to around 1.22 in 2018. Table 1 compares our estimates with others in the growing literature and shows that our results (ERW) lie at the midpoint of previous results. We use these alternative markup estimates below as robustness checks to our baseline results.

[TABLE 1 ROUGHLY HERE]

We use a conservative estimate of the decline in the natural rate of interest; results in the literature vary somewhat widely. Holston et al. (2017), using the Laubnach-Williams model, estimate a decline of ≈ 3.5 percentage points, from 3.91 percent in 1970 to 0.43 percent in 2018. Del Negro et al. (2017), using DSGE and time-series analysis, estimate a decline of 1–1.5 percentage points, from 2–2.5 percent to 1–1.5 percent. For our baseline analysis, we use a decline of 2 percentage points, from 3 percent in 1970 to 1 percent in 2018.

6.1.2. Other Parameters

Parameters from category (ii), those taken from the literature, are displayed in table 2. We take the rate of productivity growth ζ from Fernald (2012). We use the estimates of Croce (2014) to calibrate our long-run and short-run productivity risks. The elasticity of substitution in production σ is from Antras (2004). Following Croce (2014), we choose ξ to match the variability of investment to output, and we find $\xi = 0.12$.

[TABLE 2 ROUGHLY HERE]

We choose the remaining parameters (with the exception of the AR(1) parameters, which are estimated separately) to match six key moments of the US economy in 1970. All data moments are calculated as eleven-year moving averages around 1970. The first four moments are standard in the DSGE literature: a real interest rate of 3.0 percent, a capital-to-output ratio of 2.01, a labor share of 70.7 percent, and a share of hours worked of 18 percent. In light of our above theoretical and empirical analysis, we add a new moment to the calibration: a wealth-to-output ratio of 2.60. Finally, given our goal of matching financial moments, we calibrate our model to match an equity premium of 4.71 percent.[19] The parameters chosen this way are the rate of time preference β, the capital-production coefficient α, the depreciation rate δ, the firm exit rate Δ, the labor-supply coefficient ν, and the risk-aversion parameter γ.

[19]This is chosen, following the macro-finance literature, to match the post-war equity premium on stocks from CRSP, as reported in Croce (2014).

There is no one-to-one mapping between these remaining parameters and the targets, hence we jointly choose all parameters to match the model output to the targets. Nevertheless, each of the parameters above corresponds relatively closely with one of the key moments we are trying to match. The rate of time preference β is closely related to the real interest rate: as β increases, the real interest rate falls. The capital-share parameter α and depreciation rate δ determine the labor share and the capital-to-output ratio. The rate of firm exit Δ has a large effect on the wealth-to-output ratio. The parameter ν determines the number of hours worked. Finally, the risk-aversion parameter γ is the most important determinant of the equity premium.

[TABLE 3 ROUGHLY HERE]

We minimize a weighted sum of the squared differences between our model moments and the 1970 data moments. Table 3 displays the parameter values, while table 4 shows the resulting model moments and compares them with the data. With the parameters selected by our minimization, the model moments match those in the data.

We separately estimate the AR(1) parameters for markups, ρ_μ and σ_μ (the standard deviation of the error ϵ_t^μ). To do so, we detrend our baseline markup series and estimate $\rho_\mu = 0.97$ and $\sigma_\mu = 0.005$ via OLS.

The parameters in table 3 fall squarely within the range of parameter values in the macro-finance literature, in particular with previous calibrations/estimations of DSGE models with recursive preferences and/or long-run productivity risk. Our β of 0.9950 is quite close to the value of 0.9957 in Croce (2014), 0.997 in Van Binsbergen et al. (2012), and 0.9606 in Rudebusch and Swanson (2012). Our capital-elasticity parameter α, set at 0.30, is similar to the capital-share parameters in the existing literature (0.34 in Croce (2014), 0.3 in Van Binsbergen et al. (2012), 0.33 in Rudebusch and Swanson (2012)). Our estimated coefficient of risk aversion, γ =9.68, is in line with Croce (2014) and Vissing-Jørgensen and Attanasio (2003). We are able to match the equity premium with such a small coefficient of risk aversion because of the presence of long-run risk in our model. In models without this feature, the estimated coefficients are much higher.

Our estimated monthly firm exit rate of 0.61 percent yields a yearly rate of 7.32 percent. This is below the range used in the small quantitative literature on firm entry and exit, but above some recent estimates from the business-dynamism literature. For example, data from Decker et al. (2016) show the average employment-weighted firm exit rate is around 2.75 percent. Without further changes to the model, our relatively high exit rate is necessary to match the data on the wealth-to-income ratio, as higher exit rates depress equity valuations. Using a value of 2.75% with our current calibration yields a wealth-to-income ratio of 2.8 and an equity premium of 6.74%. Under this calibration, we would have to adjust other levers to better match the data: lower risk, lower markups, or higher real interest rates.

[TABLE 4 ROUGHLY HERE]

6.2. Quantitative Results: Overall Hypothesis

We begin with a test of our overall hypothesis: whether changes in markups and interest rates can explain the five macroeconomic puzzles. Table 5 shows the combined effects of changing markups, productivity growth, and discount rates from their steady-state values in 1970 to their 2018 values. The first column lists the macroeconomic moment of interest. The second column displays the calculated change in model moments between 1970 and 2018. The third column lists the change in the data moments. Overall, our model does a good job of solving the five macroeconomic puzzles: the changes in the model moments that correspond to the puzzles are similar in magnitude to the data moments.

[TABLE 5 ROUGHLY HERE]

We discuss each puzzle result in turn. (**P1**) Our model produces, in line with the data, an increase in the wealth-to-output ratio, with a relatively stable capital-to-output ratio. Our model's increase in the wealth-to-output ratio of 0.74 is reasonably close to the increase seen in the data, 1.1, while the increase in the capital-to-output ratio is also comparable. (**P2**) Our model also does a good job of matching Tobin's Q: 0.20 compared with 0.26 in the data.

(**P3**) In line with the puzzle, our results show a nearly constant average return and a declining real interest rate. (**P4**) The model does a good job of matching the increase in the profit share and the declines in the labor and capital shares; however, the ability of the model to match the magnitude of the profit-share decline should not be surprising, since the change in markups was estimated explicitly to match the movement in this moment. Still, the relative declines of the capital and labor shares also fit the data well. (**P5**) Our model produces a decline in investment, despite a high Tobin's Q and low real interest rate.

We note that the model is able to successfully match the moderate increase in K/Y, despite the 66 percent decline in interest rates (from 3% to 1%). The intuition behind this result can be seen in equation (19): the elasticity of K/Y to a change in the rental rate of capital is -1,[20] but under our calibration the 66% fall in interest rates only corresponds to a 22% fall in the rental rate due to the presence of depreciation. The impact on K/Y of changing interest rates only is shown in appendix table 4, showing a moderate increase of .4. In addition, since in our quantitative model $\sigma < 1$, capital and labor are complements, and the elasticity of K/L to a change in the rental rate will be even lower: this is shown in online appendix equation (61).

Although the model is successful in matching changes in K/Y, the model's decline in I/Y is not nearly as dramatic as the 4.09 p.p. decrease seen in the data. The reason why we cannot simultaneously

[20]Under Cobb-Douglas production.

match the increase in capital and decline in investment stems from equation (17). In a steady state, a decline in investment can come from either a decline in productivity growth, a decline in the depreciation rate δ, or a decline in K/Y. Since K/Y is increasing and δ is unchanged, the only thing generating a decline in investment is the lower productivity growth rate. Since our calibration implies only a modest decrease in trend productivity growth of 0.4 p.p., this is not sufficient to generate a decline in I/Y commensurate with the data.

The ability to quantitatively match the five puzzling facts over the past fifty years is a key mark of success for the model, and the result is not at all obvious a priori. The increase in markups was estimated independently of the changes in wealth and Tobin's Q, but it still manages to get the magnitudes right. Likewise, the change in interest rates was estimated independently of the average return but can still match the puzzling fact. The fact that only two inputted changes can match such a wide variety of economic trends, with few contradictory implications, lends strong support to the hypothesis that interest rates and markups have played key roles in driving these important economic trends. It also suggests that any model that aims to understand changes in financial wealth must take into account the capitalized value of monopolistic firms.

In the following two sections, we discuss the impact of changes in markups and interest rates separately for our five puzzles of interest. We will see that both changes are needed in order to match the macroeconomic data.

6.3. Quantitative Results: Markups

Results from changing only markups are reported in appendix table 1. Increasing markups only gives us an increase in the wealth-to-output ratio and an increase in Tobin's Q. The main problem with only increasing markups is that it leads to a large increase in the average return—much larger than that seen in the data. The increase in markups has little effect on interest rates. Although the supply of assets increases because of the increase in security values, in a representative-agent economy this is almost exactly counteracted by an increase in demand, and interest rates do not change. This result shows that although an increase in markups can explain the divergence between the average return and the interest rate, it cannot by itself generate a constant average return.

The increase in markups naturally leads to an increase in the profit share and a corresponding decrease in both the labor and capital shares. Because of the increase in the wedge between the marginal product of capital and the rental rate, investment declines moderately.

Quantitatively, changes in markups alone can go a long way towards explaining several of the five puzzling facts. The large increase in the average return predicted by the model is one exception to this; however, a decline in interest rates offsets this force, driving down the average return.

6.4. Quantitative results: interest rates

We further decompose the results shown in table 5. We consider two channels which lead to a decline in interest rates: (i) a decline in productivity growth and (ii) a reduced form increase in the utility wedge D. We decrease the productivity growth rate (the parameter ζ), from 1.53% per year in 1970 to its value of 1.1% in the present. We increase D such that the combined effect of the changes in μ, ζ, and D lead to a decrease in interest rates over the time period of 2%, which is in line with the data.

The results of increasing D are shown in appendix table 2. With lower interest rates, there is a decrease in the average return (**P3**), and an increase in investment (**P5**). There are also moderate changes in the labor and capital share, wealth-to-output, and capital-to-output. The results of changing productivity growth only are shown in appendix table 3. A decline in productivity growth leads to a decline in the real interest rate of 0.22 p.p. – not enough to match the full decrease seen in the data. With slower productivity growth, there is also a decline in the average return on capital.

6.5. Other Markup Estimates

In appendix tables 5–8, we include results of other markup estimates in the literature—those in Nekarda and Ramey (2013), De Loecker and Eeckhout (2017), Gutierrez (2017), and Hall (2018). The results of the estimates in Nekarda and Ramey (2013) and Hall (2018) are quite similar to our baseline results since the increases in markups are similar in magnitude.

The results of the De Loecker and Eeckhout (2017) estimates are much larger in magnitude than our baseline results. For instance, we estimate larger increases in the pure profit share and in Tobin's Q than what we see in the data. This is unsurprising, given that they estimate a massive increase in markups, from 18 percent in 1980 to 67 percent in 2015. A natural question, then, is whether anything in our model could square these numbers with the data. The answer is, tentatively, yes. If the increase in markups was also accompanied by other forces that caused gross profits to decrease, this would have tended to decrease the effects. Two examples of such forces are changes in labor bargaining power and unmeasured intangible capital.

6.6. Excess Returns of Final-Goods Firms

Table 5 displays a surprising result: an increase in markups causes an increase in the equity premium of 2.38 p.p.. As discussed in section 4, this is due to a composition effect. The risk premium on pure profits is greater than the risk premium on productive capital. Appendix table 9 provides a breakdown of the equity premium between the different firm types, showing a high risk premium of 14.32% for final-goods firms, and a *negative* risk premium for capital.

As the value of final-goods firms increases relative to that of capital—that is, as Tobin's Q increases—the combined equity premium from holding profits and capital will increase. There are only small changes in the returns on the different assets. Appendix table 9 provides the full decomposition of the change in equity premium. The weighted average equity premium is 2.85% in 1970, increasing to 4.78% in 2018.[21] If we calculate the average equity premium in 2018 holding weights constant at their 1970 levels, the equity premium *falls* to 2.73%. The increase in the equity premium is thus fully explained by the composition effect.

We now further discuss the reason why the risk premium on final-goods firms, ER^f, is higher than the risk premium on intermediate-goods firms, ER^i. Excess returns for an asset, following Cochrane (2009), can be written as $E_t[r_{t+1} - r_t^f] \approx -cov_t(m_{t+1}, r_{t+1})$. Because $ER^f > ER^i$, R^f must (negatively) covary more with m than R^i does. Assets must offer a higher equity premium when their returns move in a direction opposite to that of the discount factor.

To explore why R^f has such a high (negative) covariance with m, we consider an impulse response function of the key model moments to a shock to long run productivity ϵ_x. This is shown in appendix figure 7. Following a positive shock to long run productivity, the stochastic discount factor m falls, as both consumption growth and the continuation value of lifetime utility V_t increase. The return on final goods firms is large and positive, due to the effect of higher future profits on the current price of the assets. The return on intermediate goods firms, however, is *negative.* Under the current calibration, when there is a positive shock to long run productivity the income effect is stronger than the substitution effect, thus consumption rises and investment falls. The fall in investment leads to a fall in Tobin's Q, and a negative return on intermediate-goods firms.

The returns of final-goods firms show larger fluctuations than the returns on physical capital because the supply of final-goods firms is fixed in the short run. A key assumption of our analysis is that there are significant barriers to entry for final-goods firms. Thus, in contrast to productive capital, the securities that represent the rights to pure profits are nonreproducible assets. When pure profits increase, the price of these securities increases significantly. When the productivity of capital increases, firms can simply produce new capital to take advantage of this increased productivity. We should thus expect the price of final-goods firms to be more volatile than that of intermediate-goods firms and thus yield a greater risk premium.

It is well known since Jermann (1998) that capital adjustment costs are necessary in order to generate a realistic equity premium in production economies. In the absence of adjustment costs, agents optimally choose to smooth their consumption (especially with high risk aversion), which decreases the volatility of the stochastic discount factor. Relatedly, without capital adjustment costs, the price of capital, q, does not fluctuate, and thus the only source of fluctuations of returns is the productivity of capital. The higher the adjustment costs, the higher the capital risk premium. The existing literature generally needs high adjustment costs and high risk aversion to match the equity premium. With our addition of traded

[21] Note that due to covariances between returns and the relative sizes of the asset classes this weighted average is somewhat different than the equity premium of holding both assets simultaneously, as reported in our calibration.

monopolistic final-goods firms, we can have both lower adjustment costs and lower risk aversion.

6.7. Extension to the 1960s

Recent literature has emphasized that profit shares not only are high in the present, but were also high in the 1960s. Karabarbounis and Neiman (2018), using a similar method to our equation (4), estimate profit shares going back to 1960. Using these estimated profit shares, they argue against the claim that profit shares have risen in the US, because (i) their estimated profit shares were *higher* in 1960 than in 2015 and (ii) they do not find any corroborating evidence that profits were high in the 1960s. Barkai and Benzell (2018) also estimate profit shares and find them to have been high in the 1960s.

In appendix figure 5, we estimate markups going back to 1960. Our calculation differs from that of Karabarbounis and Neiman (2018) in that we estimate capital shares using risk premia from BAA and AAA bonds. We find a moderate increase in markups over this period, from 15 percent in 1960 to 21 percent in 2018—smaller than in our estimation from 1970 to 2018 but still significant.

For robustness, we repeat our previous simulation exercise using 1960 as the starting point instead of 1970. We simulate the model in 1960 and in 2018 and calculate the difference in model means between the two periods. Once again we change markups, productivity growth, and discount rates to match the changes between the periods. We do not reestimate the model; rather, we employ the same calibration as in section 6.1. The results are reported in appendix table 10, and they show that the model generally matches the data over this extended period. Overall, we interpret these findings as suggesting that our results are robust to the exact starting date.

Instead of using 1960 as an alternative starting point for the quantitative experiment, we could interpret the evolution of markups as implying a U-shaped pattern, with moderately high markups in 1960 that then decline and bottom out in 1980, before increasing thereafter. Some additional evidence supports a U-shaped pattern. A few studies that look at competition, entry, and mergers and acquisitions going back to the 1960s also find a (inverted) U shape. Karahan et al. (2019) report establishment entry rates going back to 1965. Their entry rate estimate is low in 1965, increases up until 1980, and then declines thereafter. Grullon et al. (2016) examine HHI indexes of publicly traded firms going back to 1972 and find a similar U shape: concentration declines from 1972 until the early 1990s, before dramatically increasing to the present. Finally, Brennan (2016) examines a measure of mergers and acquisitions and also finds a U shape, with high activity in the late 1960s and early 1970s, followed by low activity in the 1980s and early 1990s, followed by a dramatic increase to the present.

7. Conclusion

The analysis of this paper relies heavily on our estimates of the level of pure profits and markups in the US economy. Unfortunately, there is a great deal of uncertainty around these estimates. To estimate pure profits, we need a good measure of both the capital stock and the risk premium in the economy. To estimate markups directly, we need an estimate of marginal costs, which has always been difficult. With these caveats in mind, we discuss some implications of our results.

There are important welfare implications of an increase in market power. Markups create distortions in product markets, and recent research suggests the welfare costs of markups are high—on the order of 7.5–40 percent of GDP (see Edmond et al. (2018) and Baqaee and Farhi (2017)). These theoretical results contrast with the classic estimates of Harberger (1995), who suggests the cost of monopolistic distortions is only 0.1 percent of GDP. In addition, an increase in markups can lead to lower investment. Markups generate wedges between the marginal product of labor and the wage and between the marginal product of capital and its rental rate. With higher labor wedges, the wage is lower and thus labor supply is lower, decreasing output. With higher capital wedges, there is lower investment and a lower capital-to-output ratio, which also lowers output. There are also important indirect costs of monopoly power. As emphasized by Tullock (1967) and Krueger (1974), if firms compete for monopoly profits through rent-seeking behavior, in general the welfare loss is larger than in the absence of such competition.

The increase in market power also has implications for income inequality. With higher pure profits, workers receive a lower share of output and capitalists a higher share. Since individuals with higher incomes receive a larger percentage of their income as capital income, and the poorest individuals generally do not hold financial assets, this mechanism will tend to increase income inequality. Inequality may also interact with changes in labor bargaining power. Although it is unclear that the overall level of labor bargaining power has decreased, there is some evidence that with the fall of unionization and the rise of outsourcing the bargaining power of the poorest workers has fallen. Meanwhile, the bargaining power of the highest-educated superstars and CEOs may have increased. If CEOs are taking a larger portion of the profits and workers a smaller portion, this will also tend to increase income inequality. An increase in monopoly rents also has implications for wealth inequality. We have seen how an increase in pure profits leads to a boom in stock prices since equities hold the residual rights to corporate profits. Since those with the highest level of wealth tend to hold a greater fraction of their wealth in equities, and those with lower wealth tend to hold a greater portion in housing, an increase in monopoly rents will tend to increase wealth inequality.

The increase in market power has important implications for corporate tax policy. Standard economic theory tells us that taxing pure profits is generally a good idea (Guo and Lansing (1999)), while taxing capital income may not be a good idea (Judd (1985)). As shown by Guo and Lansing (1999), the optimal tax on corporate profits depends on the relative size of capital income to pure profits. Even in an economy with a moderate profit share, relatively high levels of corporate income taxes are optimal, especially with interest deductibility and accelerated depreciation. Traditional thinking posited that profits were small; a common citation is Basu and Fernald's (1997) estimate of 3 percent of GDP. With a profit share of

15–20 percent, as our analysis suggests, a higher level of corporate taxes may be optimal.

Our model is also a theory of wealth accumulation in the US and thus can directly address some of the questions raised in Piketty's *Capital in the 21st Century.* A major criticism of Piketty's theory of wealth accumulation is that the return on capital, the r in $r - g$, is assumed to be constant even as capital increases. With a standard neoclassical production function, however, as capital increases, the marginal product of capital and the return on capital must decrease. Thus there would seem to be a natural force that tends to counteract the increase in wealth. The analysis in this paper suggests a possible reconciliation between the view of Piketty and the views of the neoclassicals. With an increase in monopoly profits, there can be an increase in wealth without a corresponding decrease in the average return on capital.

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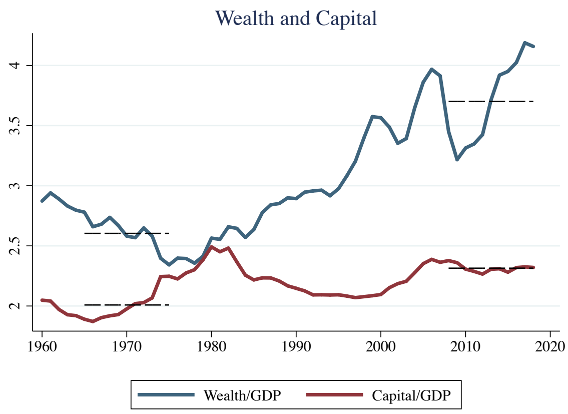
8. Figures



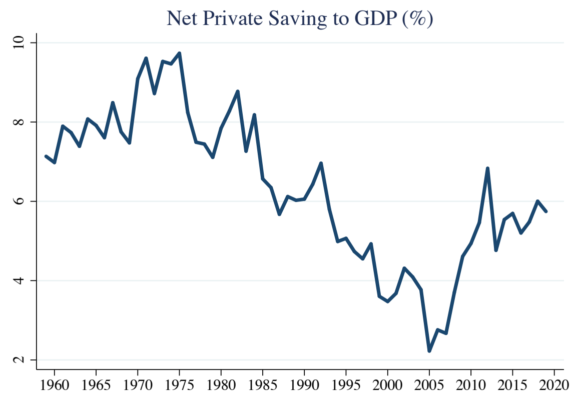
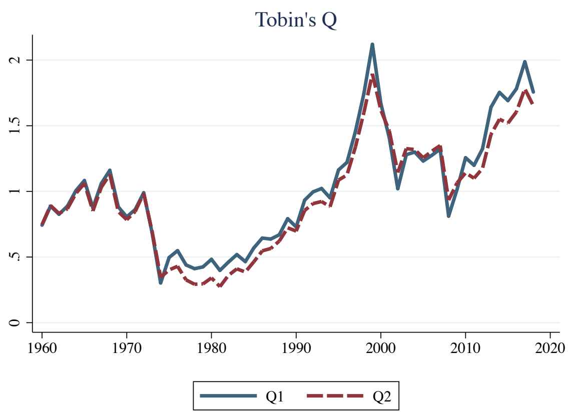


Figure 1: Wealth and capital as a share of GDP



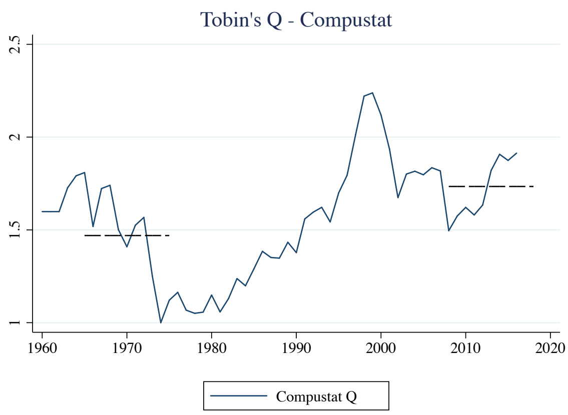


Figure 2: Tobin's Q. Left: financial accounts and BEA data. Right: Compustat

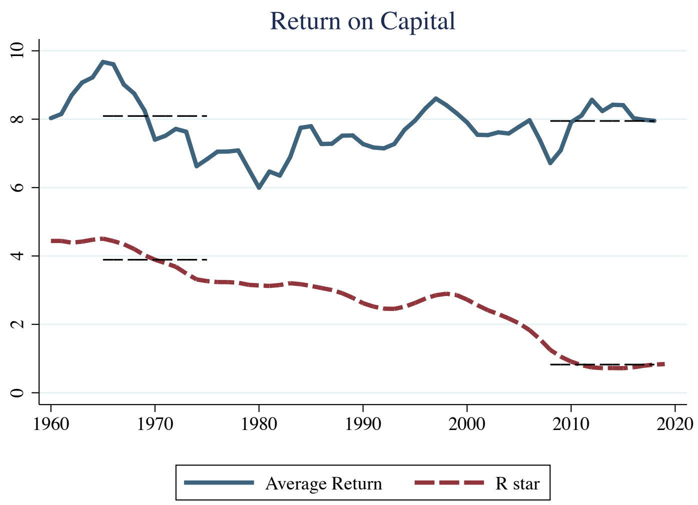


Figure 3: Average return on capital and R* (Holston et al. 2017)

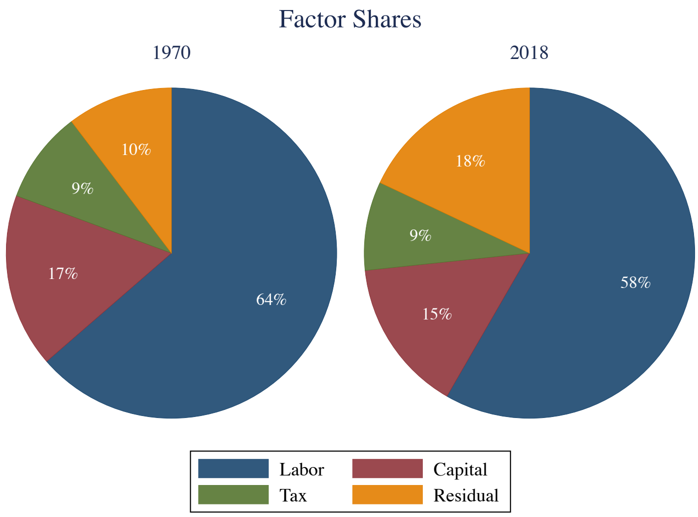


Figure 4: Factor shares

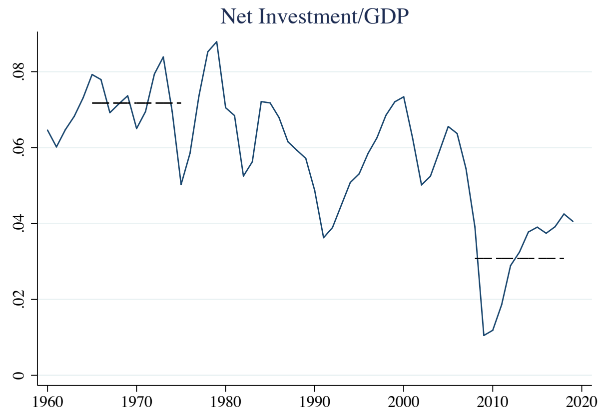


Figure 5: Net investment as a share of GDP

9. Tables

Table 1: Markup estimates

Estimate	Year range	μ *pre*	μ *post*	$\Delta\ \mu$
Barkai (2017)	1984-2015	1.025	1.21	.19
Nakarda & Ramey (2013)	1970-2014	.95	1.07	.12
De Loecker & Eeckhout (2017)	1980-2014	1.18	1.67	.49
Traina (2018)	1980-2014	1.10	1.15	.05
Gutierrez (2017)	1980-2014	1.15	1.21	.06
Hall (2018)	1988-2015	1.12	1.27	.15
ERW (2018)	1970-2018	1.12	1.22	.12

Table 2: Parameters taken from the data and related literature

Panel A: Data	*Symbol*	*Value*	*Source*
Productivity growth (/yr)	ζ	1.53%	Fernald (2012)
Panel B: Related literature			
Long-run risk persistence	ρ	.98	Croce (2014)
Long-run risk std. dev.	σ_x	.0010	Croce (2014)
Short-run risk std. dev.	σ_a	.01	Croce (2014)
Production substitution elasticity	σ	0.90	Antras (2004)
Adjustment costs	ξ	.12	Croce (2014)

Table 3: Calibrated parameter results

Parameters chosen to match targets	*Symbol*	*Value*
Capital-production elasticity	α	0.30
Depreciation rate	δ	0.0050
Firm exit rate	Δ	0.0061
Rate of time preference	β	0.9950
Risk aversion	γ	9.68
Hours supplied	ν	0.21
AR(1) persistence	ρ_μ	0.97
AR(1) error variance	σ_μ	.005

Table 4: 1970 calibration results

Targets	*Model*	*Data*	*Source*
Real interest rate	3.00%	3.00%	Federal Reserve
Wealth-to-output ratio	2.60	2.60	Financial Accounts
Capital-to-output ratio	2.01	2.01	NIPA
Labor share	70.74%	70.74%	Elsby (2013)
Equity premium	4.71%	4.71%	Croce (2014)
Labor supply	0.18%	0.18%	Croce (2014)

Table 5: Quantitative results: changes in markups, productivity growth rates, interest rates

Moments	Δ *Model*	Δ *Data*
Wealth-to-output ratio (**P1**)	0.74	1.10
Capital-to-output ratio (**P1**)	0.23	0.31
Tobin's Q (**P2**)	0.20	0.26
Real interest rate (**P3**)	$-2.00\,pp$	$-2.00\,pp$
Average return (**P3**)	-0.16	-0.14
Profit share (**P4**)	$7.45\,pp$	$7.66\,pp$
Labor share (**P4**)	$-5.64\,pp$	$-5.51\,pp$
Capital share (**P4**)	$-1.18\,pp$	$-2.15\,pp$
Investment-to-output ratio (**P5**)	$-0.57\,pp$	$-4.09\,pp$
Equity premium	$2.38\,pp$	$0-2\,pp$