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Accounting for Macro-Finance Trends: Market Power, Intangibles, and Risk Premia

ABSTRACT Real risk-free interest rates have trended down over the past 30 years. Puzzlingly, in light of this decline, (1) the return on private capital has remained stable or even increased, creating an increasing wedge with safe interest rates; (2) stock market valuation ratios have increased only moderately; (3) and investment has been lackluster. We use a simple extension of the neoclassical growth model to diagnose the nexus of forces that jointly accounts for these developments. We find that rising market power, rising unmeasured intangibles, and rising risk premia play a crucial role, over and above the traditional culprits of increasing savings supply and technological growth slowdown.

During the past 30 years, most developed economies have experienced large declines in risk-free interest rates and increases in asset prices such as housing or stock prices, with occasional sudden crashes. At the same time, except for a short period in the 1990s, economic growth, in particular productivity growth, has been rather disappointing, and investment has been lackluster. Earnings growth of corporations has been strong, however, leading in most countries to an increase in the capital share and to stable or slightly rising profitability ratios. Making sense of these trends is a major endeavor for macroeconomists and for financial economists.

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Given the complexity of these phenomena, it is tempting to study them in isolation. For instance, a large body of literature has developed that tries to understand the decline in risk-free interest rates. But studying these trends independently may miss confounding factors or implausible implications. For instance, an aging population leads to a higher savings supply, which might well explain the decline in interest rates. However, a higher savings supply should also increase capital accumulation—that is, investment, and hence reduce profitability. Similarly, it should also increase stock prices, as the discount rate falls. Hence, a potential driver that is compelling judged by its ability to explain a single trend may be implausible overall, because it makes it harder to account for the other trends.

Another way to highlight these tensions is to note that the stable profitability of private capital and declining risk-free rate lead to a rising spread, or wedge, between these two rates of return. What gives rise to this spread? A narrative that has recently attracted significant interest is the possibility of rising market power. However, rising risk premia could also account for the wedge. The only way to disentangle these potential causes is to consider additional implications—for instance, everything else being equal, rising market power should imply a lower labor share, and rising risk premia should be reflected in lower prices of risky assets such as stocks.

These simple observations motivate our approach. We believe that a successful structural analysis of the past 30 years should account for these trends *jointly.* A novel feature of our analysis is that we aim to account both for macroeconomic trends and finance trends. The first step of our paper is to document a set of broad macro and finance trends that we believe are of particular interest. We focus on six indicators: economic growth, risk-free interest rates, profitability, the capital share, investment, and valuation ratios (such as the price-dividend or price-earnings ratio).

The paper's second step is to develop an accounting framework to disentangle several potential drivers of these trends. We focus on five narratives that have been put forward to explain some or all of these trends. The first narrative is that the economy experienced a sustained growth decline, owing to lower population growth, investment-specific technical progress, or productivity growth. The second narrative is that the savings supply has increased, perhaps owing to population aging (or to the demand of emerging markets for a store of values). The third narrative involves the rising market power of corporations. The fourth narrative focuses on technological change resulting from the introduction of information technology, which may have favored capital or skilled labor over unskilled labor, or the rise of hard-to-measure intangible forms of capital. And the fifth narrative, which we emphasize, involves changes in perceived macroeconomic risk, or tolerance of it.

Our approach is simple enough to allow for a relatively clear identification of the impact of these drivers on the facts that we target. Here, our contribution is to propose a simple macroeconomic framework—a modest extension of the neoclassical growth model—that accounts for the "big ratios" familiar to macroeconomists as well as for the "financial ratios" of financial economists. Our model does this in a way that allows for interesting types of feedback between macroeconomic and financial variables. For example, the investment-output ratio is affected by market power and macroeconomic risk, as well as savings supply and technological parameters. At the same time, our framework preserves the standard intuitions and results of macroeconomists and financial economists, and hence is a useful pedagogical device.[1]

In our baseline estimation, we abstract from intangibles. Our main empirical result here is that the rising spread between the return on capital is the risk-free rate, which is driven mostly by a confluence of two factors: rising market power *and* rising macroeconomic risk. This rising macroeconomic risk in turn implies that the equity premium, which previous researchers have argued fell in the 1980s and 1990s, may have risen since about 2000. This higher risk is also an important driver of the decline of risk-free rates. We also find little role for technical change. Moreover, we show how previous researchers, who have used models without risk, have attributed too big a role to rising market power. When we incorporate intangibles, we see that a significant increase in their unmeasured component can help explain the rising wedge between the measured marginal product of capital and the risk-free rate. Interestingly, we find that intangible capital reduces the estimated role of market power in our accounting framework, while preserving the role of risk. Overall, our estimates offer a more nuanced understanding of the drivers of investment, profitability, and valuation ratios.

The rest of the paper is organized as follows. Section I discusses the related literature. Section II documents the main trends of interest.

1. Our model, of course, needs to contend with the usual disconnect between macroeconomics and finance—that is, the equity premium puzzle—and hence requires high risk or high risk aversion to generate plausible quantitative implications. Although we do not address the excess volatility puzzle in this paper, the framework can be extended, as done by Gourio (2012), to fit this as well.

Section III presents our model. Section IV explains our empirical methodology and identification. Section V presents the main empirical results. Section VI discusses extensions and robustness. Finally, section VII reviews some outside evidence on the rise in the equity premium, markups, and intangibles. Section VIII concludes.

I. Literature Review

Our paper, given its broad scope, makes contact with many other studies that have separately tried to explain one of the key trends that we document. (In section VII, we discuss in more detail the relation of our results to the recent literature on market power, intangibles, and risk premia.)

First, a large body of literature studies the decline of interest rates on government bonds. James Hamilton and others (2016) provide a long-run perspective, and discuss the connection between growth and interest rates. Łukasz Rachel and Thomas Smith (2017) provide an exhaustive analysis of the role of the many factors that affect interest rates. The role of demographics is studied in detail by Carlos Carvalho, Andrea Ferrero, and Fernanda Nechio (2016); and by Etienne Gagnon, Benjamin Johannsen, and David López-Salido (2016). Marco Del Negro and others (2017) emphasize, as we do, the role of the safety and liquidity premia. Ben Bernanke (2005) and Ricardo Caballero and others (2008) emphasize the role of safe asset supply and demand. Our analysis incorporates all these factors, though in a simple way.

Second, a large body of literature documents and tries to explain the decline of the labor share in developed economies. Michael Elsby, Bart Hobijn, and Ayşegül Şahin (2013) document the facts and discuss various explanations using U.S. data, while Loukas Karabarbounis and Brent Neiman (2014) study international data and argue that the decline is driven by investment-biased technical change. Matthew Rognlie (2015) studies the role of housing. A number of other researchers discuss the impact of technical change for a broader set of facts (Acemoglu and Restreppo, forthcoming; Autor and others 2017; Kehrig and Vincent 2018).

The most closely related papers are by Caballero, Emmanuel Farhi, and Pierre-Olivier Gourinchas (2017); Caballero and Farhi (2018); and by Magali Marx, Benoît Mojon, and François Velde (2018)—as well as the contemporaneous work by Gauti Eggertsson, Jacob Robins, and Ella Wold (2018). Marx and colleagues also find, using a different methodology, that an increase in risk helps explain the rising spread between the marginal product of capital (*MPK*) and the risk-free rate. They do not explicitly target the evolution of other variables, such as investment or the price-dividend ratio. Conversely, Eggertsson, Robins, and Wold (2018) target some of the same big ratios that we study, but there are differences in methodology and results. Methodologically, our approach uses a simple standard model, which allows a closed-form solution and clear identification. Substantively, we find a more important role for macroeconomic risk, whereas they contend that a rising savings supply and rising market power are the main driving forces.

II. Notable Macroeconomic and Finance Trends

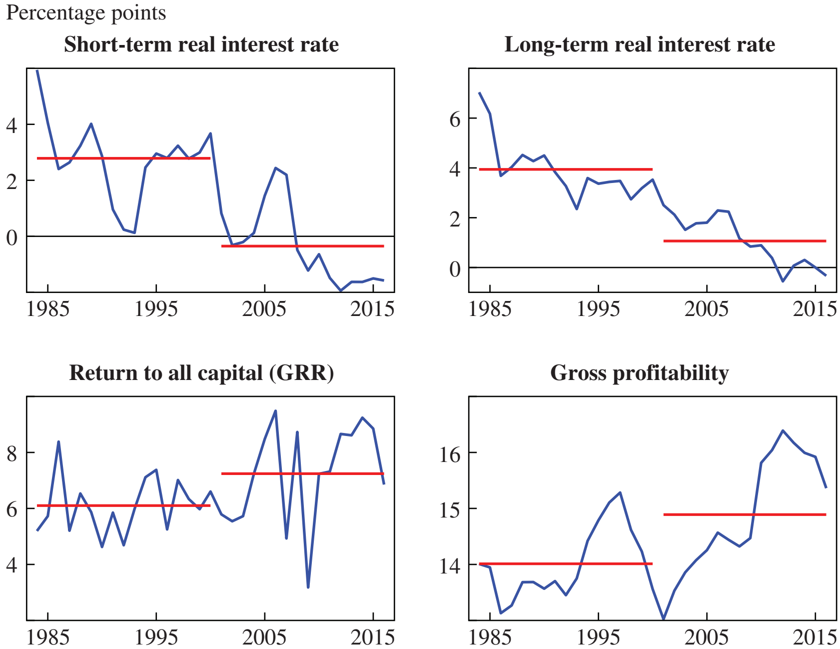
This section presents simple evidence on the trends affecting some key macroeconomic and finance moments. We focus on six groups of indicators: interest rates on safe and liquid assets, such as government bonds; measures of the rate of return on private capital; valuation ratios (that is, price-dividend or price-earnings ratio for publicly listed companies); private investment in new capital; the labor share; and growth trends. We first present simple graphical depictions, then add statistical measures.

Our focus is on the United States, but we believe that these facts also hold for other developed economies and hence may reflect worldwide trends.[2] Like many macroeconomic studies, we mostly consider the post-1984 period, which is associated with low and stable inflation together with relative macroeconomic stability (the “Great Moderation”). We present the changes in the simplest possible way, by breaking our sample equally in the middle, that is, at the millennium. However, we also briefly discuss the longer-range trends and present continuous indicators using moving averages.

One important decision is whether to study the entire private sector or to exclude housing and focus, for instance, on nonfinancial corporations. On one hand, the savings of households include all assets, in particular housing; on the other hand, the housing sector may need to be modeled differently, or we might want to explicitly recognize the heterogeneity of capital goods. In this section, we present indicators that cover both, but our estimation targets cover the entire private sector. For the most part, the trends that we document are apparent both for nonfinancial corporations and in the aggregate.

2. See, for instance, Marx, Mojon, and Velde (2018) for euro area trends.

Figure 1. U.S. Rates of Return, 1984–2016[a]



Sources: See the online appendix, section 1, for all data sources.

a. The top left panel displays the difference between the 1-year Treasury bill rate and the median 1-year-ahead Consumer Price Index (CPI) inflation expectations from the Survey of Professional Forecasters (SPF). The top right panel displays the difference between the 10-year Treasury note rate and the median 10-year-ahead CPI inflation expectations from the SPF. The bottom left panel presents the estimate of the pretax return on all capital from Gomme, Ravikumar, and Rupert (2011; GRR). The bottom right panel presents our measure of gross profitability, the ratio of 1 minus the labor share to the capital-output ratio. The horizontal lines represent the mean in the first and second halves of the samples—1984–2000 and 2001–16, respectively.

II.A. Graphical Evidence

We summarize the evolution of the six groups of indicators as six facts.

Fact 1: Real risk-free interest rates have fallen substantially. The top panels of figure 1 present proxies for the 1-year and 10-year real interest rates by subtracting inflation expectations from nominal Treasury yields.[3]

3. We use median consumer price inflation expectations from the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters (SPF). Very similar results for the trend are obtained if one uses the mean expectation rather than the median; or the Michigan Survey of Consumers rather than the SPF. For the 1-year rate, one can also replace expectations with ex-post inflation or lagged inflation. For the 10-year rate, one can also use the Treasury Inflation-Protected Securities yield where available (that is, after 1997).

As many researchers have noted before, there has been a strong downward trend in these measures since 1984. The short-term rate exhibits clear cyclical fluctuations, while the long rate has a smoother decline. Table 1 shows that the average 1-year rate falls from almost 2.8 percent in the first half of our sample (1984–2000) to almost –0.3 percent in the second half of our sample (2001–16). The long-term rate similarly falls, from 3.9 percent in the first half to 1.1 percent in the second half.

Fact 2: The profitability of private capital has remained stable or increased slightly. In contrast, there is little evidence that the return on private capital has fallen; if anything, it appears to have increased slightly. Paul Gomme, B. Ravikumar, and Peter Rupert (2011), using data from the National Income and Product Accounts, construct a measure of the aggregate net return on physical capital—roughly, profits over capital. The bottom left panel of figure 1 depicts their series. The rising spread between their measure, which can be thought of as a proxy for the marginal product of capital, and the interest rate on U.S. Treasuries, is an important trend to be explained for macroeconomic and financial economists.

Gomme, Ravikumar, and Rupert (2011) construct their series using detailed data from the National Income and Product Accounts and other sources, but one can construct a simple approximation using the ratio of operating surplus to capital for the nonfinancial corporate sector; table 1 shows that this ratio is also stable, and if anything increases slightly. In our estimation exercise, we focus on gross profitability, and, to ensure consistency between our measures, we construct it simply as the ratio of the profit-output ratio that we use (that is, 1 minus the labor share) to the capital-output ratio. For this measure, which is depicted in the bottom right panel of figure 1, the overall level is higher, in part because it is gross rather than net; but the trend is similar to the measure used by Gomme and colleagues.

Fact 3: Valuation ratios are stable or have increased moderately. The top two panels of figure 2 present measures of valuation ratios for the U.S. stock market. The top left panel shows the ratio of price to dividends from the Center for Research in Security Prices, while the top right panel shows the price-operating earnings ratio for the Standard & Poor's 500 Index (S&P 500).[4] The latter is essentially trendless, while

4. We focus on operating earnings that exclude exceptional items such as write-offs and hence are less volatile. In particular, total earnings were negative in 2008:Q4 because banks marked down the values of their assets substantially.

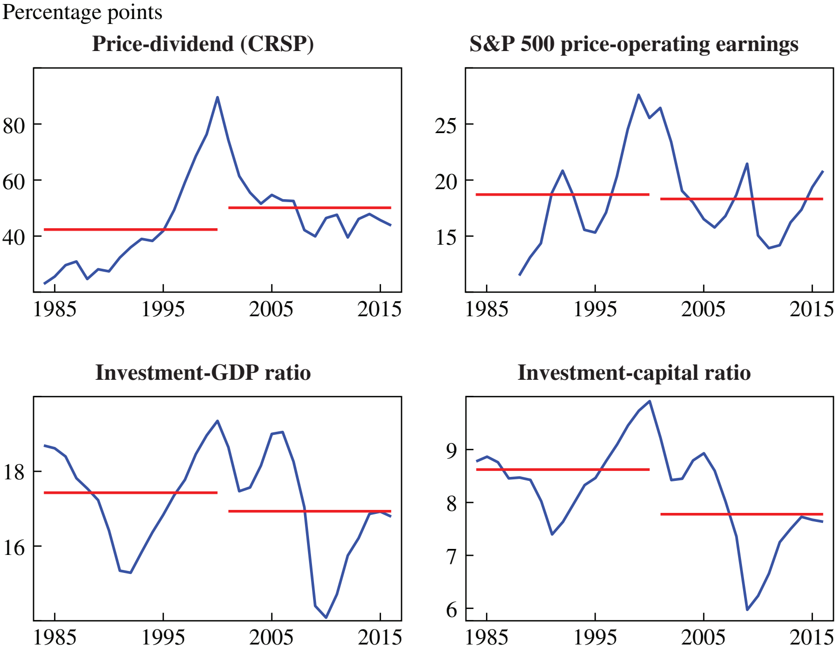
Table 1. Macroeconomic and Financial Trends[a]

		Averages						Trend	
Group	*Variable*	*1984–2000*	*SE*	*2001–16*	*SE*	*Difference*	*SE*	*Coefficient*	*SE*
Real interest rate	One-year maturity*	2.79	.45	–.35	.59	–3.14	.75	–.17	.02
	Ten-year maturity	3.94	.41	1.06	.46	–2.88	.69	–.18	.01
	AA rate	4.69	.48	1.09	.57	–3.6	.8	–.21	.02
	Ten-year adjustment for term premium	1.52	.26	–.09	.35	–1.61	.4	–.08	.02
Return on capital	GRR: all, pretax	6.1	.2	7.24	.45	1.14	.45	.07	.02
	GRR: business, pretax	8.59	.32	10.46	.62	1.87	.62	.11	.03
	Nonfinancial corporations, GOS/NRK	7.59	.34	7.87	.36	.27	.51	.04	.01
	Gross profitability* (see text)	14.01	.26	14.89	.49	.88	.6	.07	.02
Valuation ratios	Price-to-dividend ratio* CRSP	42.34	8.56	50.11	3.4	7.78	8.39	.67	.36
	Price-operating earnings, S&P 500	18.7	2	18.31	1.09	–.39	1.75	.03	.12
	Price-smoothed earnings, Shiller	22.07	4.41	24.36	1.25	2.29	4.5	.33	.17
Investment	Investment share of GDP	17.43	.53	16.93	.65	–.5	.76	–.04	.04
	Nonresidential investment share of GDP	12.94	.40	12.79	.18	–.15	.43	0	.02
	Investment capital ratio: all*	8.1	.25	7.23	.35	–.88	.38	–.04	.02
	Investment capital ratio: nonresidential	10.95	.39	10.2	.24	–.76	.4	–.03	.02
Capital-output	Fixed assets	2.13	.03	2.28	.03	.15	.04	.01	0
	Real index (BLS)	1.06	.02	1.18	.01	.13	.02	.01	0
Labor share	Nonfarm business (BLS) gross	62.07	.31	58.56	1.01	–3.51	1.11	–.21	.04
	Nonfinancial corporations, gross*	70.11	.34	66.01	1.21	–4.1	1.29	–.24	.05
Growth	Output per worker	1.80	.22	1.22	.23	–.58	.29	–.03	.02
	Total factor productivity*	1.10	.31	.76	.32	–.34	.36	–.02	.02
	Population*	1.17	.08	1.1	.06	–.07	.08	0	0
	Price of investment: all*	–1.77	.15	–1.13	.34	.64	.26	.03	.02
	Price of investment: nonresidential	–2.38	.19	–1.75	.29	.63	.25	.04	.02
	Price of investment: equipment	–3.62	.60	–3.27	.53	.34	.72	.02	.04
	Price of investment: intellectual property products	–1.71	.30	–2.15	.36	–.44	.52	0	.02
	Employment-population ratio*	62.34	.58	60.84	0.94	–1.51	1.06	–.07	.06

Sources: See the online appendix, section 1, for all data sources.

a. This table reports, for each variable, the mean in the 1984–2000 sample, in the 2001–16 sample, their difference, and the coefficient on a linear time trend, all with standard errors. * = a moment targeted in our estimation exercise. SE = standard error; CRSP = Center for Research in Security Prices; GRR = Gomme, Ravikumar, and Rupert (2011); GOS = gross operating surplus; NRK = nonresidential capital. Variables' construction is detailed in section 1 of the online appendix (the online appendixes for this and all other papers in this volume may be found at the *Brookings Papers* web page, www.brookings.edu/bpea, under "Past BPEA Editions").

Figure 2. U.S. Investment and Valuation Ratios, 1984–2016[a]



Sources: See the online appendix, section 1, for all data sources.

a. The top left panel displays the price-dividend ratio from the Center for Research in Security Prices (CRSP). The top right panel shows the ratio of price to operating earnings for the S&P 500. The bottom left panel shows the ratio of nominal investment spending to nominal GDP. The bottom right panel shows the ratio of nominal investment to capital (at current cost). The horizontal lines represent the mean in the first and second halves of the samples—1984–2000 and 2001–16, respectively.

the former exhibits a large boom and bust in about 2000, before settling down to a higher value. Another commonly used valuation ratio is the price-smoothed earnings ratio of Shiller (the Cyclically Adjusted Price-Earnings Ratio), which divides the S&P 500 price by a 10-year moving average of real earnings, and is reported in table 1. Though all these ratios are quite volatile, overall, they exhibit only a moderate increase from the first period to the second period. Our analysis emphasizes that this limited increase is puzzling, given the large decline of the risk-free rate (fact 1).

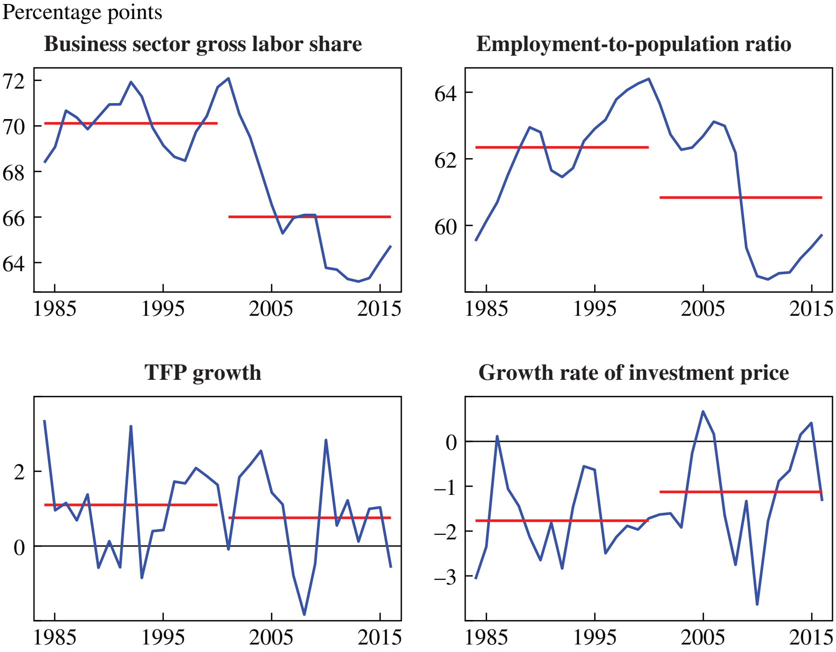
Fact 4: The share of investment in output or in capital has fallen slightly. The bottom two panels of figure 2 depict the behavior of investment. As several researchers have noted recently (Lewis and Eberly 2016; Gutiérrez and Philippon 2017), investment has been relatively lackluster over the past decade or more; but the magnitude of this decline is quite different depending on exactly how one measures it. Because the price of investment goods falls relative to the price of consumption goods, it is simpler to focus on the expenditure share of GDP (the bottom left panel of figure 2) or the ratio of nominal investment to capital (evaluated at current cost; the bottom right panel). Both ratios ought to be stationary in standard models, and they appear nearly trendless over long samples. Investment spending exhibits a strong cyclical pattern, increasing faster than GDP during expansions and falling faster than GDP during recessions; but overall, both ratios appear to exhibit small to moderate declines across our two subsamples. Table 1 also reports the ratios for the nonresidential sector (that is, business fixed investment), which behaves very similarly, indicating that our results are not driven by housing. Note that business fixed investment includes equipment, structures, and intellectual property products. The table also reports two measures of the evolution of the capital-output ratio: first, the ratio of capital at current cost to GDP; and second, the ratio of a real index of capital services (from the Bureau of Labor Statistics, BLS) to real output (which we normalize to 1 in 1984).[5] Both ratios exhibit an increase of about 0.15 and 0.13, respectively.[6]

Fact 5: Total factor productivity and investment-specific growth have slowed down, and the employment-to-population ratio has fallen. There has been much public discussion that overall GDP growth has declined over the past couple of decades. This decline is in part attributable to a decline in the employment-to-population ratio, largely due to demographic factors (Aaronson and others 2015), shown in the top right panel of figure 3. However, the decline between the two samples in output per worker growth is still large, from about 1.8 to 1.2 percent a year, according to table 1. This decline is largely driven by lower total factor productivity (TFP) growth and lower investment-specific technical progress. Table 1 shows that the growth rate of John Fernald's (2015) TFP measure goes from 1.1 percent a year to less than 0.8 percent a year, while the growth rate of the relative

5. This index aggregates underlying capital goods using rental prices, which is the correct measure for an aggregate production function. In contrast, capital at current cost is a nominal value that sums purchase prices.

6. Over the long term, these ratios behave differently. The BLS index has exhibited an upward trend since the mid-1970s due to the decline in the price of investment goods, but this trend has slowed down recently. In contrast, the current cost capital-output ratio is nearly trendless.

Figure 3. U.S. Macroeconomic Trends, 1984–2016[a]



Sources: See the online appendix, section 1, for all data sources.

a. The top left panel shows the gross labor share for the nonfinancial corporate sector, measured as the ratio of nonfinancial business labor compensation to gross nonfinancial business value added. The top right panel is the employment-to-population ratio. The bottom left panel shows the growth rate of total factor productivity (TFP). The bottom right panel is the growth rate of the relative price of investment goods and consumption goods. The horizontal lines represent the mean in the first and second halves of the samples—1984–2000 and 2001–16, respectively.

price of investment goods to nondurable and service consumption goes from about –1.8 percent to –1.1 percent a year. These series are depicted in the bottom panels of figure 3.

Fact 6: The labor share has fallen. Finally, the top left panel of figure 3 presents a measure of the gross labor share for the nonfinancial corporate sector; table 1 also includes a measure that covers the entire U.S. economy. As has been noted by many researchers (Karabarbounis and Neiman 2014; Elsby, Hobijn, and Şahin 2013; Rognlie 2015), the labor share exhibits a decline, especially after 2000 in the United States.

Of course, all these facts are somewhat difficult to ascertain graphically, given the short-term samples and the noise in some series. This leads us to evaluate the statistical significance of these changes.

II.B. Statistical Evaluation

To summarize the trends in these series in a more formal way, table 1 reports several statistics for the series presented in figures 1 through 3 as well as for alternative series that capture the same concepts. The first through fourth columns of table 1 report the means in the first and second subsamples, which are depicted in figures 1 through 3 as horizontal lines, together with standard errors. The fifth column of table 1 reports the difference between the means in the second and first samples, and the sixth column is the associated standard error. The seventh column is the regression coefficient of the variable of interest on a linear time trend, and the eighth column is the associated standard error. (All standard errors are calculated using the Newey-West method with five annual lags.)

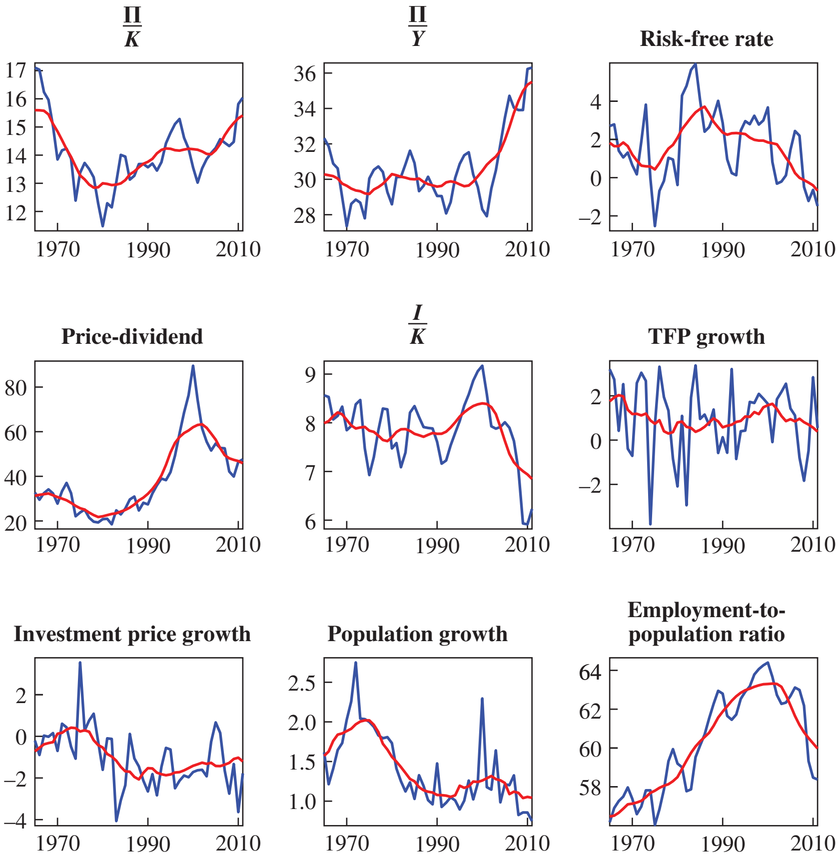
Given the persistence of the series and the relatively short sample, statistical significance should be assessed cautiously. With this caveat, table 1 shows that for some indicators, there is little evidence of a break between the samples, while for others, there is clear evidence of a break. Specifically, interest rates, the labor share, and the investment-capital ratios are markedly lower in the second sample. Conversely, valuation ratios and the return on capital appear fairly stable. Growth measures, such as TFP growth, are substantively smaller in the second sample, but the change is not necessarily statistically significant.

II.C. Longer Historical Trends

Figure 4 presents the evolution of nine of the moments we described above, but over a longer sample, since 1950. (These nine moments will be our estimation targets below.) For clarity, we add an 11-year centered moving average to each series, so we depict the evolution from 1955 to 2011. One motivation for studying a longer sample is that real interest rates were also low in the 1970s and to some extent the 1960s, and hence one question is whether the abnormal period is the early 1980s, when real interest rates were high. The figure shows, however, that the similarities between the 1960s or 1970s and the 2000s are limited to a few variables. It is true that profitability was high in the 1960s, but the price-dividend ratio was lower, and the labor share and the investment-capital ratio were relatively high, in contrast to the more recent period. Overall, neither the 1960s nor the 1970s are similar in all respects to the 2000s. Moreover, a serious consideration of the role of inflation is warranted to study the 1970s and early

Figure 4. Macroeconomic and Financial Trends, 1965–2011[a]

Percentage points



Sources: See the online appendix, section 1, for all data sources.

a. This figure presents the nine series used in our estimation exercise over the 1965–2011 sample, together with an 11-year centered moving average.

1980s, as inflation likely affected many of the macroeconomic aggregates depicted here. This is why, for now, we focus on the post-1984 sample. However, below we present some results starting in 1950 to illustrate what our approach implies for these earlier periods.

III. The Model

This section introduces a simple model to account for the macroeconomic and finance moments. Our framework adds macroeconomic risk and monopolistic competition to the standard neoclassical growth model. Given our focus on medium-run issues, we abstract from nominal rigidities and adjustment costs.

III.A. The Model

We consider a standard dynastic model with inelastic labor supply. To highlight the role of risk, we use Epstein-Zin preferences:

$$V_t = \left((1-\beta)\, L_t c_{pc,t}^{1-\sigma} + \beta E_t \left(V_{t+1}^{1-\theta}\right)^{\frac{1-\sigma}{1-\theta}}\right)^{\frac{1}{1-\sigma}} \tag{1}$$

where V_t is utility, L_t is population size (which is exogenous and deterministic), $c_{pc,t}$ is per capita consumption at time t, σ is the inverse of the intertemporal elasticity of substitution of consumption (IES), and θ is the coefficient of relative risk aversion. We assume that labor supply is exogenous and equal to $N_t = \bar{N} L_t$, where $\bar{N}$ is a parameter that captures the employment-population ratio.

Final output is produced using a constant return to scale from differentiated inputs,

$$Y_t = \left(\int_0^1 y_{i,t}^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}}$$

where $\varepsilon > 1$ is the elasticity of substitution. These intermediate goods are produced using a Cobb-Douglas production function,

$$y_{i,t} = Z_t k_{i,t}^{\alpha} \left(S_t n_{i,t}\right)^{1-\alpha}$$

where $k_{i,t}$ and $n_{i,t}$ are capital and labor in firm i at time t, Z_t is an exogenous deterministic productivity trend, and S_t is a stochastic productivity process, which we assume to be a martingale:

$$S_{t+1} = S_t e^{\chi_{t+1}} \tag{2}$$

where χ_{t+1} is independent and identically distributed (*iid*).

Capital is accumulated using a standard investment technology, but is subject to an aggregate "capital quality" shock ψ_{t+1}, which we also assume to be *iid*:

$$k_{i,t+1} = ((1-\delta)\,k_{i,t} + Q_t x_{i,t})\,e^{\psi_{t+1}}.$$

Here Q_t is an exogenous deterministic trend reflecting investment-specific technical progress, as given by Jeremy Greenwood, Zvi Hercowitz, and Per Krusell (1997). The relative price of investment and consumption goods is $\frac{1}{Q_t}$.

Capital and labor can be reallocated frictionlessly across firms at the beginning of each period after the shocks X and ψ have been realized. Given the constant-return-to-scale technology, firms then face a constant (common) marginal cost. It is easy to see that the economy aggregates to a production function (see the online appendix, section 2, for details):[7]

$$Y_t = Z_t K_t^{\alpha}\,(S_t N_t)^{1-\alpha} \tag{3}$$

and that markups distort the firms' first-order conditions, leading to

$$\frac{(1-\alpha)Y_t}{N_t} = \mu w_t \tag{4}$$

$$\alpha\frac{Y_t}{K_t} = \mu R_t \tag{5}$$

where $\mu = \frac{\varepsilon}{\varepsilon - 1} > 1$ is the gross markup, w_t is the real wage, and R_t is the rental rate of capital.

Moreover, the law of motion for capital accumulation also aggregates,

$$K_{t+1} = ((1-\delta)\,K_t + Q_t X_t)\,e^{\psi_{t+1}}. \tag{6}$$

The choice of investment is determined by the (common) marginal product of capital, leading to the Euler equation:

$$E_t\,[M_{t+1} R^K_{t+1}] = 1 \tag{7}$$

7. The online appendixes for this and all other papers in this volume may be found at the *Brookings Papers* web page, www.brookings.edu/bpea, under "Past BPEA Editions."

where M_{t+1} is the real stochastic discount factor and R^K_{t+1} is the return on capital, which is given by

(8) $$R^K_{t+1} = \left(\frac{\alpha Y_{t+1}}{\mu K_{t+1}} + \frac{1-\delta}{Q_{t+1}}\right) Q_t e^{\psi_{t+1}}.$$

This expression is a standard user cost formula, which incorporates the rental rate of capital of equation 5 but also depreciation, the price of investment goods, and the capital quality shock. Given the preferences assumed in equation 1, the stochastic discount factor is

(9) $$M_{t+1} = \beta \left(\frac{c_{pc,t+1}}{c_{pc,t}}\right)^{-\sigma} \left(\frac{V_{pc,t+1}}{E_t \left(V^{1-\theta}_{pc,t+1}\right)^{\frac{1}{1-\theta}}}\right)^{\sigma-\theta}$$

where $V_{pc,t}$ is the utility normalized by population, $V_{pc,t} = \dfrac{V_t}{1/L_t^{1-\sigma}}$.

The resource constraint reads

(10) $$C_t + X_t = Y_t$$

where $C_t = L_t c_{pc,t}$ is total consumption, and X_t are investment expenses measured in consumption good units.

The equilibrium of this economy is $\{c_{pc,t}, C_t, X_t, K_t, Y_t, R^K_{t+1}, M_{t+1}, V_{pc,t}, V_t\}$, which solves the system of equations 1 through 10, given the exogenous processes $\{L_t, Z_t, Q_t, S_t, \chi_{t+1}, \psi_{t+1}\}$ As is well known, in general such a model admits no closed-form solution. Many researchers build their intuition by studying either the nonstochastic steady state or numerical approximations. This makes it somewhat difficult to explain the role that macroeconomic risk plays. We show, in contrast, that for an interesting special case, our model can be solved easily for a "risky balanced growth path."

III.B. Risky Balanced Growth

We make two simplifying assumptions. First, to obtain a balanced growth path, we make the usual assumption that the exogenous trends (population, L_t; TFP, Z_t; and investment-specific technical progress, Q_t) all grow at possibly different constant rates, so that $\dfrac{L_{t+1}}{L_t} = 1 + g_L$, $\dfrac{Z_{t+1}}{Z_t} = 1 + g_Z$,

$\frac{Q_{t+1}}{Q_t} = 1 + g_Q$ for all $t \geq 0$. Second, we assume that the productivity shock and capital quality shock are equal:

$$\chi_{t+1} = \psi_{t+1}.$$

In this case, it is straightforward to verify that the equilibrium has the following structure:

$$X_t = T_t S_t x^*$$

$$Y_t = T_t S_t y^*$$

and similarly for C_t, while for capital and utility, we have $K_t = T_t S_t Q_t k^*$ and $V_t = L_t^{\frac{\sigma}{1-\sigma}} T_t S_t v^*$. Here, the lowercase, starred values denote constants; S_t is the stochastic trend defined in equation 2 corresponding to the accumulation of past productivity / capital quality shocks X_t; and T_t is a deterministic trend, defined as

$$T_t = L_t Z_t^{\frac{1}{1-\alpha}} Q_t^{\frac{\alpha}{1-\alpha}}$$

whose growth rate is denoted g_T and satisfies the usual condition:

$$1 + g_T = (1 + g_L)(1 + g_Z)^{\frac{1}{1-\alpha}} (1 + g_Q)^{\frac{1}{1-\alpha}} \tag{11}$$

where α is the Cobb-Douglas parameter, g_Q is the rate of growth of investment-specific technical progress, g_L is population growth, and g_z is productivity growth. The trend growth rate of output per capita is

$$1 + g_{PC} = \frac{1 + g_T}{1 + g_L}.$$

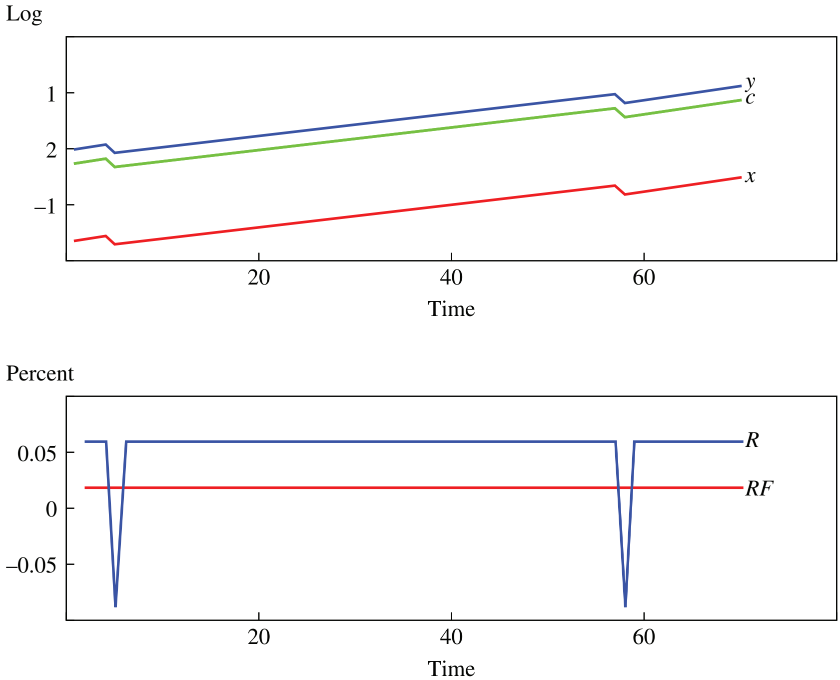
Finally, the stochastic discount factor is

$$M_{t+1} = \beta(1 + g_{PC})^{-\sigma} e^{-\theta\chi_{t+1}} E(e^{(1-\theta)\chi_{t+1}})^{\frac{\theta-\sigma}{1-\theta}} \tag{12}$$

where θ is risk aversion and σ is the inverse of the IES. We can then easily calculate all objects of interest in the model, including x^*, y^*, as we show in the next section and in section 1 of the online appendix.

Figure 5 presents an example of the time series produced by the model. The equilibrium corresponds to a "balanced growth path," but one where

Figure 5. An Example of the Time Series Produced by the Model[a]



Source: Authors' calculations.

a. The figure presents an example of the time series generated by the model—in the top panel, output, consumption, and investment (in log); in the bottom panel, return on capital and the risk-free rate. In this example, the economy is affected by two realizations of χ shocks, at $t = 4$ and $t = 57$.

macroeconomic risk still affects decisions and realizations. Specifically, the realization of the macroeconomic shock χ_{t+1} affects the stochastic trend S_{t+1} and hence X_{t+1}, Y_{t+1}, and so on, while the effect of risk, conversely, is reflected in the constants x^*, y^*. The bottom line is that the "big ratios"—such as $\frac{X_t}{Y_t}, \frac{\Pi_t}{Y_t}, \frac{\Pi_t}{K_t/Q_t}$, and the like—are constant, as in the standard Kaldor calculations, but now incorporate risk; we discuss these ratios in the next section.[8] This result holds regardless of the probability distribution of χ_{t+1}.

8. Of course, the economy can also exhibit transitional dynamics if its initial capital is too low or too high, before it reaches the "risky balanced growth" path.

The treatment of deterministic trends is completely standard. What is less standard is that in our model, a common stochastic trend affects all variables equally, which generates great tractability. In the standard real business cycle model, there are no capital quality shocks—that is, $\psi_{t+1} = 0$, and a (permanent) productivity shock χ_{t+1} leads to a transition as the economy adjusts its capital stock to the newly desired level, before eventually reaching the new steady state. By assuming $\chi_{t+1} = \psi_{t+1}$, this transition period is eliminated because the capital stock "miraculously" adjusts by the correct amount. This simplifies the solution of the model because agents' expectations of future paths are now easy to calculate.[9] The capital quality shock is also important if the economy is to generate a significant equity premium, for it makes the return on capital volatile rather than bounded below by $1 - \delta$.

III.C. Model Implications

This subsection presents model implications for the "big ratios" and other key moments of interest along the risky balanced growth path. We present the Euler equation, which leads to a standard user cost calculation, and then discuss valuation ratios and rates of return.

It is useful to define the composite parameter

$$\beta^* = E_t(M_{t+1}e^{\chi_{t+1}})$$

which equals

$$\beta^* = \beta(1 + g_{PC})^{-\sigma} \times E(e^{(1-\theta)\chi_{t+1}})^{\frac{1-\sigma}{1-\theta}} \tag{13}$$

and its rate of return version $r^* = \frac{1}{\beta^*} - 1 \simeq -\log\beta^*$, which satisfies

$$r^* \simeq \rho + \sigma g_{PC} + \sigma\frac{1-\frac{1}{\sigma}}{1-\theta}\log E(e^{(1-\theta)\chi_{t+1}}) \tag{14}$$

9. Because we do not study the actual responses to χ_{t+1} shocks, there is little loss in this simplification; what is key for us is that agents regard the future as uncertain, and that bad realizations of χ_{t+1} will have reasonable consequences (for example, a low return on capital), which lead agents ex ante to adjust their choices, such as for investment. This argument—formulated by Gabaix (2011) and Gourio (2012)—can be applied to larger models; for instance, for New Keynesian models with disaster risk, see Gourio, Kashyap, and Sim (2018); and Isoré and Szczerbowicz (2017).

where $\rho = \frac{1}{\beta} - 1 \simeq -\log\beta$.[10] The parameter r^* will turn out to equal in equilibrium the expected return on capital, and to be a "sufficient statistic" to solve for the "big ratios"—that is, we do not need to know ρ (that is, β) θ, σ, or the distribution of χ, but only r^*.

CAPITAL ACCUMULATION To solve the model, we use the Euler equation 7, which along the risky balanced growth path reads

$$\frac{1}{\beta^*} = \left(\frac{\alpha}{\mu} Q^* \left(\frac{k^*}{\bar{N}}\right)^{\alpha-1} \frac{1}{1+g_Q} + \frac{1-\delta}{1+g_Q}\right) \tag{15}$$

where Q^* is the level of investment technical progress Q_t, that is, $Q_t = Q^*(1+g_Q)^t$; so $\frac{1}{Q^*}$ affects the level of the relative price of investment and consumption. This equation pins down k^* and the capital-labor ratio, and it generalizes the familiar condition of the neoclassical growth model to incorporate risk, through β^*. We can rewrite this as the equality of the user cost of capital and marginal revenue:

$$\frac{1}{Q^*}(r^* + \delta + g_Q) \approx \frac{\alpha}{\mu}\left(\frac{k^*}{N^*}\right)^{\alpha-1}. \tag{16}$$

Equation 16 directly shows how higher market power or a higher required *risky* return lowers the desired capital-labor ratio.

To calculate the other big ratios, first note that K_t/Q_t is the capital stock, evaluated at current cost. The capital-output ratio is obtained from equation 16 as

$$\frac{K_t/Q_t}{Y_t} \approx \frac{\alpha}{\mu}\frac{1}{r^* + \delta + g_Q} \tag{17}$$

10. Here and thereafter, the $\simeq$ sign reflects the first-order approximation $\log(1+x) \simeq x \simeq \frac{1}{1-x}$.

and the investment-capital ratio is

$$\frac{X_t}{K_t/Q_t} \approx g_Q + g_T + \delta \tag{18}$$

which reflects the familiar balanced growth relation. Last, the investment-output ratio is obtained by combining equations 17 and 18:

$$\frac{X_t}{Y_t} \approx \frac{\alpha}{\mu}\frac{g_T + \delta + g_Q}{r^* + \delta + g_Q}. \tag{19}$$

INCOME DISTRIBUTION The labor share in gross value added is, using equation 4,

$$s_L = \frac{w_t N_t}{Y_t} = \frac{1-\alpha}{\mu} \tag{20}$$

and hence the measured capital share is

$$s_K = 1 - s_L = \frac{\mu + \alpha - 1}{\mu}.$$

This capital share can be decomposed into a pure profit share, which rewards capital owners for monopoly rents, and a true capital remuneration share, corresponding to rental payments to capital, that is, $s_K = s_\pi + s_C$, with

$$s_\pi = \frac{\mu - 1}{\mu} \tag{21}$$

and

$$s_C = \frac{\alpha}{\mu}. \tag{22}$$

VALUATION RATIOS The firm value is the present discounted value of the dividends $D_t = \Pi_t - X_t$. In equilibrium, this value equals the value of installed capital plus monopolistic rents. Formally, the ex-dividend firm value P_t satisfies the standard recursion

$$P_t = E_t\left(M_{t+1}\left(P_{t+1} + D_{t+1}\right)\right).$$

Given that the equilibrium is *iid,* the price-dividend ratio is constant, and satisfies the familiar Gordon growth formula:

$$\frac{P^*}{D^*} = \frac{\beta^*(1+g_T)}{1-\beta^*(1+g_T)} \approx \frac{1+g_T}{r^*-g_T}. \tag{23}$$

Tobin's Q is defined as

$$\frac{P_t}{K_t/Q_t} \approx (1+g_T)\left(1+\frac{\mu-1}{\alpha}\frac{r^*+\delta+g_Q}{r^*-g_T}\right). \tag{24}$$

Because we do not incorporate adjustment costs, Tobin's Q equals (approximately) 1 when there is no market power—that is, $\mu = 1$.[11] But if there is some market power, the value of Tobin's Q depends on several parameters, which affect (1) the size of the economy and hence the rents, and (2) the discount rate applied to all future rents.

RATES OF RETURN We now compare three benchmark rates of return in this economy: the risk-free rate, the return on equity, and the profitability of capital, which is often used in macroeconomics as a proxy for the marginal product of capital. The gross risk-free rate (which can be priced, even though it is not traded in equilibrium) is

$$RF = \frac{1}{E(M_{t+1})} = \frac{E(e^{(1-\theta)\chi_{t+1}})}{\beta^* E(e^{-\theta\chi_{t+1}})}.$$

which we can rewrite as the net risk-free rate, that is, $r^f = RF - 1$:

$$r_f \approx r^* + \log E(e^{(1-\theta)\chi_{t+1}}) - \log E(e^{-\theta\chi_{t+1}}) \tag{25}$$

The average profitability of capital can be inferred—as by Gomme, Ravikumar, and Rupert (2011) and Casey Mulligan (2002)—as the ratio of

11. Tobin's Q is usually defined as $\frac{P_t}{K_{t+1}/Q_{t+1}}$, but with capital quality shocks K_{t+1} is unknown at time t, leading us to adopt this definition, which creates the $1 + g_T$ wedge. One could also define Tobin's Q as $\frac{P_t}{E_t K_{t+1}/Q_{t+1}}$, which eliminates the wedge provided that $E_t e^{\chi_{t+1}} = 1$, an assumption that we maintain through most of the paper.

(measured) profits to the stock of capital. We denote it *MPK* because it is often used as a proxy for the marginal product of capital, though this holds only under constant return to scale and perfect competition. This *MPK* can be calculated either gross or net of depreciation. For instance, in gross terms, we have

$$MPK = \frac{\Pi_t}{K_t/Q_t} = \frac{\mu + \alpha - 1}{\alpha}(r^* + \delta + g_Q). \tag{26}$$

Conceptually, this *MPK* exceeds the risk-free rate for three reasons: first, it is gross of both physical and economic depreciation; second, it incorporates profit rents; and third, it is risky. We can decompose the spread between the *MPK* and the risk-free rate to reflect these three components:

$$MPK - r_f = \delta + g_Q + \frac{\mu - 1}{\alpha}(r^* + \delta + g_Q) + r^* - r_f. \tag{27}$$

A main goal of our empirical analysis is to evaluate the importance of these different components.

The expected equity return is defined as

$$E(R_{t+1}) = E\left(\frac{P_{t+1} + D_{t+1}}{P_t}\right)$$

and it is easy to show using equation 23 that

$$E(R_{t+1}) = \frac{1}{\beta^*} E(e^{\chi_{t+1}}). \tag{28}$$

In the case where $E(e^{\chi_{t+1}}) = 1$, which we use in our applications, the gross expected return on equity is exactly $\frac{1}{\beta^*}$, and the net return is r^*. The same expected return also applies the return on physical capital $R^K_{t+1} = \left(\frac{aY_{t+1}}{\mu K_{t+1}} + \frac{1-\delta}{Q_{t+1}}\right) Q_t e^{\chi_{t+1}}$ defined in equation 8. Conceptually, the firm value here stems from capital and rents, but it turns out that both components have equal risk exposure and hence equal expected returns.

Finally, the equity risk premium (*ERP*) is obtained by combining equations 25 and 28:

$$ERP = \frac{E(R_{t+1})}{R_{f,t+1}} = \frac{E(e^{-\theta\chi_{t+1}})E(e^{\chi_{t+1}})}{E(e^{(1-\theta)\chi_{t+1}})}.$$

III.D. Comparative Statistics

We now use the expressions developed in the previous subsection to illustrate key comparative statics of the risky balanced growth path. These statics are useful for understanding the identification of our model. Most of the parameters have the usual effects; we focus on parameters that are typically absent from the neoclassical growth model, or parameters that play an important role in our empirical results.

THE EFFECT OF RISK The effect of higher risk on macroeconomic variables is mediated through β^*. The cleanest thought experiment is to consider a shift in the distribution of the shock χ in the sense of second-order stochastic dominance, so that χ becomes more risky. Such a shift reduces $E(e^{(1-\theta)\chi})^{\frac{1}{1-\theta}}$, and hence leads to a lower β^* if and only if $\sigma < 1$, that is, the IES is greater than unity. A lower β^* in turn leads to a lower capital-output ratio, a lower investment-output ratio, and a higher profit-capital ratio, according to equations 17, 19, and 26, respectively. The logic is that risk deters investment in this case, leading to less capital accumulation. This reduction in the supply of capital increases *MPK*, given a stable demand for capital. Moreover, as is well known in the macroeconomic and finance literature, and as shown by equation 23, higher risk decreases the *PD* ratio if the IES is greater than unity. Conversely, if the IES is lower than unity, higher risk leads to a lower expected return, and hence to higher capital accumulation and a higher price-dividend ratio. In the knife-edge case of a unit IES, corresponding to log preferences, risk does not affect the required return on capital r^* and hence does not affect capital accumulation. In all cases, risk has no effect on the labor share or long-term growth (though higher risk has a level effect on capital and GDP, that is, k^* and y^*). The equity risk premium $r^* - r_f$ is increasing in risk, regardless of the IES. The spread between the *MPK* and the risk-free rate is hence increasing in risk, at least if μ is small enough so that the middle term of equation 7 does not dominate the third term.

We have not specified the distribution of the shock χ; but for some particular distributions, one can obtain exact formulas. For instance, if χ is normal with variance σ_χ^2 and mean $\mu_\chi = -\frac{\sigma_\chi^2}{2}$, so that an increase in σ_χ is a pure increase in risk, we have, denoting $\hat{\beta} = \beta(1 + g_{PC})^{-\sigma}$,

$$\log\beta^* = \log\hat{\beta} - (1-\sigma)\theta\frac{\sigma_\chi^2}{2}$$

$$\log RF = -\log\hat{\beta} - (1+\sigma)\theta\frac{\sigma_\chi^2}{2}$$

$$\log ERP = \theta\sigma_\chi^2$$

These formulas capture the usual effect of risk aversion and the quantity of risk on the *ERP* and the risk-free rate, but are now valid in a production economy, and furthermore β^* links macroeconomic risk to macroeconomic variables such as the capital-output ratio, as discussed above. We provide more discussion in section 2 of the online appendix for different assumptions about the distribution of χ.

THE EFFECT OF SAVINGS SUPPLY In our model, the effects of a change in the discount factor β are the same as a change in risk, because both are mediated through β^*. The one exception is the risk-free rate, which is affected directly by β^* but also directly by risk measures, for example, risk aversion θ or the quantity of risk χ. In the case where the IES is greater than unity, higher β has the same implications as lower risk. Hence, higher savings supply leads to higher capital accumulation, a higher investment-output ratio and a lower marginal product of capital, and a higher price-dividend ratio, while the risk-free rate falls. The spread between the *MPK* and the risk-free rate, shown in equation 27, is little affected by β: β only affects the quantity of rents through r^*, while the equity risk premium $r^* - r_f$ is independent of β.

THE EFFECT OF MARKET POWER One potentially important factor that has been invoked to explain the trends we document is market power. In our model, an increase in μ has no effect on long-term growth, the risk-free rate, or the price-dividend ratio; but it has a significant effect on other variables. Higher markups reduce both the labor share and the "true capital share," s_c, but increase the pure profit share, s_π. According to equations 19 and 17, higher market power also reduces investment-output and capital-output ratios, as firms have less incentive to build capacity. The spread between the *MPK* and the risk-free rate is increasing in market power (equation 27). Finally, higher market power reduces the level of GDP by reducing capital accumulation.

THE EFFECT OF TREND GROWTH Trend growth, g_T—which can be traced back to productivity growth, population growth, or investment-specific technical growth—affects β* but also independently affects the ratios of interest. Higher growth generally increases the investment-capital and investment-output ratios and increases the risk-free rate and valuation ratios, while the effect on profitability ratios depends on the exact source of growth.

IV. The Accounting Framework

This section describes our empirical approach and discusses identification.

IV.A. Methodology

We use a simple method of moment estimation. In the interest of clarity and simplicity, we perform an exactly identified estimation with nine parameters and nine moments. In a first exercise, we estimate the model separately over our two samples: 1984–2000 and 2001–16. We then discuss which parameters drive variation in each moment. In a second exercise, we estimate the model over 11-year rolling windows, starting with 1950–61 and ending with 2006–16. In all cases, we fit the model's risky balanced growth path to the model's moments. In doing so, we abstract from business cycle shocks, in line with our focus on longer frequencies.[12]

The moments we target are motivated by the observations in the introduction and section I:

(M1) the gross profitability, $\frac{\Pi}{K}$;[13]

(M2) the gross capital share, $\frac{\Pi}{Y}$;

(M3) the investment-capital ratio, $\frac{I}{K}$;

(M4) the risk-free rate, RF;

12. This exercise involves some "schizophrenia," because our model assumes that parameters are constant, even though they are estimated to change over time; and when parameters change, the model would exhibit some transitional dynamics, which we abstract from for now; see section VI. Further, the agents inside our model do not understand that parameters might change, let alone anticipate some of these changes.

13. From here on, we denote measured average profitability $\frac{\Pi}{K}$ and the investment rate $\frac{I}{K}$—that is, we omit Q; and we denote investment with X.

(M5) the price-dividend ratio, PD;

(M6–M8) the growth rates of population, TFP, and investment prices; and

(M9) the employment-population ratio.

As we show here, these moments lead to a clear identification of our nine parameters, which are:

(P1) the discount factor, β;

(P2) risk, modeled as the probability of an economic crisis or "disaster," p;

(P3) the markup, μ;

(P4) the depreciation rate of capital, δ;

(P5) the Cobb-Douglas parameter, α;

(P6–P8) the growth rates of TFP, g_z, investment-specific progress, g_Q, and population, g_L; and

(P9) the labor supply parameter, $\bar{N}$.

The choice of moments is motivated, of course, by the questions of interest—explaining the joint evolution of interest rates, profitability, investment, valuation, and trend growth—but also by the clarity with which these moments map into estimated parameters. For instance, because we target $\frac{\Pi}{K}$, $\frac{\Pi}{Y}$, and $\frac{I}{K}$ (and because we have taken care to construct these moments in a consistent manner), the model will mechanically match the evolution of the investment-output ratio $\frac{I}{Y}$ or the capital-output ratio $\frac{K}{Y}$. Hence, we could have taken $\frac{I}{Y}$ as a targeted moment, which would have led to the exact same estimates and implications, but the identification is clearer with $\frac{I}{K}$. Beyond this, some changes in identification strategy are possible, however; for instance, one could target the price-earnings ratio instead, or GDP growth per worker; these yield quite similar results.

We also note that the parameters can be mapped into the narratives often put forth when discussing the trends, at least at a high level; in particular, changes in longevity map into a change in the discount factor β; more generally, changes in savings supply can be captured as changes in β; changes in the competitive environment are captured by a change in μ; changes in technology should be reflected in α, δ, or the growth rates of the technological factors g_z and g_Q; and so on. However, it is also possible that some economic factors affect all our parameters at the same time.

There are three parameters that we do not estimate; we discuss why, and how this affects our results in the next section on identification. The three parameters are the IES $\frac{1}{\sigma}$, the coefficient of risk aversion θ, and the size of macroeconomic shocks b. Specifically, we assume that χ_{t+1} follows a "disaster risk" three-point distribution, that is,

$$\chi_{t+1} = 0 \text{ with probability } 1 - 2p$$

$$\chi_{t+1} = \log(1 - b) \text{ with probability } p$$

$$\chi_{t+1} = \log(1 + b_H) \text{ with probability } p$$

where b_H is chosen so that $E(e^{\chi_{t+1}}) = 1$. We estimate p but fix b (and hence b_H).

IV.B. Identification

In this subsection, we provide a heuristic discussion of identification, and make two main points. First, the identification is nearly recursive, so that it is easy to see which moments affect which parameters. Second, and consequently, the identification of some parameters does not depend on all the data moments.[14]

The identification is easily seen to be nearly recursive. First, some parameters are obtained directly as their counterparts are assumed to be observed: population growth, investment price growth (the opposite of g_Q), and the employment-population ratio. The growth rate g_z is next chosen to match measured TFP.[15] One hence obtains g_T, the trend growth rate of GDP,

14. Section 3 of the online appendix includes the matrix of sensitivity of parameters to moments, as suggested by Andrews, Gentzknow, and Shapiro (2017).

15. This step is, however, not completely straightforward, which is why we only say that the identification is nearly recursive. TFP in the data is measured using the revenue-based labor share, which in the model is $s_L = \frac{1-\alpha}{\mu}$ rather than the cost-based labor share, which in the model is $1 - \alpha$. As a result, the TFP that an economist would measure in our model is

$$g_T - s_L g_N - (1 - s_L) g_K = \left(\frac{s_L}{1-\alpha} g_z + \left(\frac{s_L \alpha}{1-\alpha} - (1 - s_L)\right) g_Q\right)$$

and hence is not equal to g_z because $s_L \neq 1 - \alpha$. In particular, matching TFP requires knowing the value of α, which is why it is not fully recursive. This turns out to have relatively small effects in our empirical work.

given by equation 11. The depreciation rate δ is then chosen to match $\frac{I}{K}$ according to the familiar balanced growth relation (equation 18):

$$\frac{I}{K} \simeq \delta + g_Q + g_T.$$

The model then uses the Gordon growth formula (equation 23) to infer the expected return on risky assets, r^*, given the observed price-dividend ratio:

$$\frac{P^*}{D^*} \simeq \frac{1+g_T}{r^* - g_T}.$$

Importantly, to infer r^*, we do not need data on the risk-free rate, or assumptions about the value of β, risk aversion θ, or the distribution of χ.

The next step is to identify the parameters α and μ to match the profit share of output and the ratio of profits to capital, using equations 20 and 27, that is:

$$s_L = \frac{1-\alpha}{\mu}$$

and

$$MPK = \frac{\mu + \alpha - 1}{\alpha}(r^* + \delta + g_Q)$$

where s_L and $MPK = \frac{\Pi}{K}$ are the observables and α and μ the unknowns.

The solution is, denoting by $uc = r^* + \delta + g_Q$ the frictionless user cost of capital, to set

$$\mu = \frac{MPK}{s_L MPK + (1 - s_L)uc}$$

and

$$\alpha = \frac{uc(1 - s_L)}{s_L MPK + (1 - s_L)uc}.$$

Intuitively, the first equation infers market power (here, the Lerner index) from the discrepancy between *MPK* and the frictionless user cost of capital *uc*. The parameter α is then obtained to fit the observed labor share. A key remark is that our identification of α and μ does not require data on the risk-free rate or making any assumption about risk aversion θ or the distribution of χ—we simply use the sufficient statistic r^*, which has been previously identified.

Economically, our approach boils down to using the traditional Gordon growth formula—which holds in our standard neoclassical framework—to deduce the required return on capital from the price-dividend ratio and the growth rate, and hence to construct a user cost of capital $r^* + \delta + g_Q$ that incorporates risk.[16]

At this point, we can also bring in data on the risk-free rate to infer the equity premium $r^* - r_f$. Here again, note that the behavior of the equity premium is therefore inferred without making assumptions about risk aversion θ or the distribution of χ. However, to understand what drives the risk-free rate, one needs to separately infer β, risk aversion θ, and the quantity of risk χ. Doing so requires extra assumptions about these variables and about the IES (which is not identified in our model, given that growth rates are *iid*), as can be seen from equation 14:

$$r^* \simeq \rho + \sigma g_{PC} + \sigma \frac{1 - \frac{1}{\sigma}}{1 - \theta} \log E\left(e^{(1-\theta)\chi_{t+1}}\right).$$

We present our baseline result with an IES of 2, a rare disaster distribution[17] for χ with a shock of 15 percent ($e^b = 0.85$), a probability p that we estimate, and a risk aversion coefficient of 12. As should be clear by now, none of these choices affects our inferences about α, μ, or the equity premium. Concretely, given these additional assumptions, we can solve for the quantity of risk p that satisfies

$$r^* - r_f = \log E\left(e^{-\theta\chi_{t+1}}\right) - \log E\left(e^{(1-\theta)\chi_{t+1}}\right)$$

16. Our procedure is closely related to the approach of Barkai (2016), the main difference being the way we incorporate risk. Barkai (2016) simply uses a Treasury rate or corporate bond yield to construct the user cost.

17. The asset pricing disaster literature—Barro (2006), Gabaix (2012), Gourio (2012), and Wachter (2013)—often models disasters as much larger shocks; here, the 15 percent decline we assume is roughly in line with the U.S. experience after 2008 (for example, the level of GDP as of 2016 is about 15 percent below what would have been predicted based on a log-linear trend in 2007).

Table 2. Estimated Parameters: Baseline Model[a]

Parameter name	*Symbol*	*Estimate* 1984–2000	2001–16	*Difference*
Discount factor	β	0.961	0.972	0.012
Markup	μ	1.079	1.146	0.067
Disaster probability	p	0.034	0.065	0.031
Depreciation	δ	2.778	3.243	0.465
Cobb-Douglas	α	0.244	0.243	–0.000
Population growth	g_N	1.171	1.101	–0.069
Total factor productivity growth	g_Z	1.298	1.012	–0.286
Investment in technical growth	g_Q	1.769	1.127	–0.643
Labor supply	$\bar{N}$	0.623	0.608	–0.015

Source: Authors' calculations.

a. This table reports the estimated parameters in our baseline model for each of the two subsamples, 1984–2000 and 2001–16, and the change between subsamples.

and we can then use the equation above for r^* to deduce ρ—that is, β. In section VI, we present the results when the IES is instead assumed to be 0.5, and we also discuss results when we choose other distributions for χ, or if we instead fix the amount of risk and estimate the risk aversion coefficient θ.

V. Empirical Results

We first compare the two subsamples, and then we contrast the results with more standard macroeconomic approaches that do not entertain a role for risk. Finally, we present results over rolling windows in a long sample.

V.A. A Comparison of Two Subsamples

Table 2 shows the estimated parameters for each subsample and the change of parameters between subsamples. Overall, our results substantiate many of the narratives that have been advanced and that we mention in the introduction. The discount factor β rises by about 1.2 points, reflecting higher savings supply. Market power increases significantly, by about 6.7 points. Technical progress slows down, and the labor supply falls (relative to population). The model also estimates a significant increase in macroeconomic risk (the probability of a crisis), which goes from about 3.4 percent to 6.5 percent a year. We will return to the interpretation of this result below. Conversely, there is only moderate technological change: Depreciation increases, reflecting the growing importance of high-depreciation capital such as computers, but the Cobb-Douglas parameter remains fairly stable. This stability of the production function is an interesting result. Overall, the model gives some weight to four of the most popular explanations (β, μ, p, gs). But exactly how much does each story explain?

Table 3 provides one answer. By construction, the model fits perfectly all nine moments in each subsample using the nine parameters. We can decompose how much of the change in each moment between the two subsamples is accounted for by each parameter. Because our model is nonlinear, this is not a completely straightforward task; in particular, when changing a parameter from a first subsample value to a second subsample value, the question is at which value to evaluate the other parameters (for example, the first or second subsample value). If the model were linear, or the changes in parameters were small, this would not matter; but such is not the case here, in particular for the price-dividend ratio. In this table, we simply report the average over all possible orders of changing parameters, as we move from the first to the second subsamples.[18]

Overall, we see that the decline in the risk-free rate of about 3.1 percent (314 basis points) is explained mostly by two factors: higher perceived risk p, and higher savings supply β, with lower growth playing only a moderate role.[19] Why does the model not attribute all the change in the risk-free

18. Formally, let $\theta^a = (\theta^a_1, \ldots \theta^a_K)$ and $\theta^b = (\theta^b_1, \ldots \theta^b_K)$ denote the parameter vectors in subsamples a and b respectively, and consider a model moment that is a function of the parameters: $m = f(\theta)$. Consider a permutation σ: $[1, K] \rightarrow [1, K]$ that describes an order in which we change parameters from their initial to final value; we first change $\theta_{\sigma(1)}$, then $\theta_{\sigma(2)}$, and so on. Then calculate the change implied when we change parameter $[l \in 1, K]$ along this order, that is,

$$\Delta_l(\sigma) = f\left(\theta^b_{z_2}; \theta^a_{-z_2}\right) - f\left(\theta^b_{z_1}; \theta^a_{-z_1}\right)$$

where $z_2 = \sigma(1{:}\sigma^{-1}(l))$ are the parameters that have been switched already from initial to final values, and $z_1 = \sigma(1{:}\sigma^{-1}(l) - 1)$ the ones which are not switched yet. The change in m due to parameter $[l \in 1, K]$ is defined as

$$\Delta_l = \frac{1}{N_\sigma}\sum_\sigma \Delta_l(\sigma)$$

where the sum ranges over all possible permutations. By construction, $\sum_{l=1}^{K} \Delta_l = f(\theta^b) - f(\theta^a)$ accounts exactly for the model implied change in the moment, which, because the model fits the targeted moments perfectly, and also accounts exactly for the change in the data: $f(\theta^b) - f(\theta^a) = m^b - m^a$. In the online appendix, we also report the upper and lower bounds when we consider all possible combinations of other parameters. This provides a way to bound the importance of each factor.

19. This conclusion does depend somewhat on our assumed IES, as we discuss in detail below.

Table 3. Contributions of Parameters to Changes in Targeted Moments[a]

	Targeted moment			Contribution of each parameter to change in moment								
Parameter	*1984–2000*	*2001–16*	*Difference*	β	μ	p	δ	α	g_N	g_Z	g_Q	$\bar{N}$
Gross profitability	14.01	14.89	0.88	–1.88	2.76	0.76	0.68	0.00	–0.00	–0.29	–1.15	–0.00
Capital share	29.89	33.99	4.10	0.00	4.13	0.00	0.00	–0.03	0.00	0.00	0.00	0.00
Risk-free rate	2.79	–0.35	–3.14	–1.22	0.00	–1.62	0.00	–0.00	–0.00	–0.19	–0.10	0.00
Price-dividend ratio	42.34	50.11	7.78	30.67	0.00	–13.19	0.00	–0.02	–1.86	–5.07	–2.76	0.00
Investment-capital ratio	8.10	7.23	–0.88	0.00	0.00	0.00	0.47	–0.00	–0.07	–0.39	–0.88	0.00
Growth of TFP	1.10	0.76	–0.34	0.00	–0.14	0.00	0.00	–0.00	–0.00	–0.26	0.06	0.00
Growth of investment price	–1.77	–1.13	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.00
Growth in population	1.17	1.10	–0.07	0.00	0.00	0.00	0.00	0.00	–0.07	0.00	0.00	0.00
Employment-population ratio	62.34	60.84	–1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	–1.51

Source: Authors' calculations.

a. TFP = total factor productivity. This table reports the targeted moments in each of the two subsamples, 1984–2000 and 2001–16, as well as the change between samples, and the contribution of each parameter to each change in moment, so that the 3rd column equals the sum of the 4th through 12th columns. See the text for details.

rate to savings supply? Simply because it would make it impossible to match other moments, in particular the *PD* ratio. Even as it is, if only the change in savings supply β were at work, the *PD* ratio would increase by over 30 points. The model attributes offsetting changes to risk and growth, explaining in this way that the *PD* ratio increased only moderately over this period, despite the lower interest rates.

Similarly, profitability would decrease by almost 2 percentage points if the change in β was the only one at work—all rates of return ought to fall if the supply of savings increases. The model reconciles the stable profitability with the data by inferring higher markups and higher risk. Overall, we see how the model needs multiple forces to account for the lack of changes observed in some ratios. The higher capital share is attributed entirely to higher markups, as capital-biased technical change appears to play little role.

We can now use these model estimates to explain the evolution of some other moments; these are reported in table 4. First, as we discussed in section III (equation 27), the spread between the measured *MPK* and the risk-free rate can be decomposed in three components:

$$MPK - r_f = \delta + g_Q + \frac{\mu - 1}{\alpha}(r^* + g_Q + \delta) + r^* - r_f$$

where the three components are depreciation ($\delta + g_Q$), rents, and risk ($r^* - r_f$). We can calculate this decomposition in the model using the estimated parameters. The table reveals that depreciation changed little overall—faster physical depreciation is offset by slower economic depreciation—but the rents and risk components both rise by about 2 percentage points. (An alternative way to decompose the change in spread is to read, in the first row, the decomposition of the change in spread due to each parameter change; this yields a similar answer, as the increases in μ and in p account for the bulk of the increase in the spread.)

We also report the model implied equity return and equity premium. Though not a direct target, we estimate a sizable equity premium, of nearly 5 percent a year in the recent sample. (This premium assumes no leverage; see section VI for a discussion of leverage.) More interestingly, the premium has increased by about 2 percentage points since 2000. In total, expected equity returns have fallen by almost 1 percentage point because the decline in the risk-free rate is larger than this increase in the equity premium.

Regarding valuation ratios, we have already emphasized the moderate increase of the price-dividend ratio due to offsetting factors. Table 4 also

Table 4. Contributions of Parameters to Other Moments[a]

	Model-implied moments			Contribution of each parameter								
Parameter	*1984–2000*	*2001–16*	*Difference*	β	μ	p	δ	α	g_N	g_Z	g_Q	$\bar{N}$
A. MPK–RF spread												
Total spread	11.22	15.24	4.02	–0.66	2.76	2.39	0.68	0.00	–0.00	–0.10	–1.05	–0.00
Depreciation	4.55	4.37	–0.18	0.00	0.00	0.00	0.47	0.00	0.00	0.00	–0.64	0.00
Market power	3.39	5.55	2.17	–0.59	2.73	0.24	0.21	0.00	–0.00	–0.09	–0.35	0.00
Risk premium	3.15	5.23	2.08	–0.05	0.00	2.14	0.00	–0.00	0.00	–0.01	–0.00	0.00
B. Rate of return												
Equity return	5.85	4.90	–0.96	–1.22	0.00	0.56	0.00	–0.00	–0.00	–0.19	–0.10	0.00
Equity premium	3.07	5.25	2.18	0.00	0.00	2.18	0.00	0.00	0.00	0.00	0.00	0.00
Risk-free rate	2.79	–0.35	–3.14	–1.22	0.00	–1.62	0.00	–0.00	–0.00	–0.19	–0.10	0.00
C. Valuation ratios												
Price-dividend	42.34	50.11	7.78	30.67	0.00	–13.19	0.00	–0.02	–1.86	–5.07	–2.76	0.00
Price-earnings	17.85	25.79	7.94	10.16	5.08	–4.57	–0.35	0.00	–0.59	–1.47	–0.34	–0.00
Tobin's Q	2.50	3.84	1.34	1.05	1.34	–0.48	0.11	0.00	–0.08	–0.28	–0.31	–0.00
D. Income shares												
Share of labor	70.11	66.01	–4.10	0.00	–4.13	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Share of capital	22.59	21.24	–1.35	0.00	–1.33	0.00	0.00	–0.03	0.00	0.00	0.00	0.00
Share of profit	7.30	12.76	5.46	0.00	5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Macroeconomy												
K/Y	2.13	2.28	0.15	0.29	–0.13	–0.12	–0.11	–0.00	0.00	0.04	0.18	–0.00
I/Y	17.28	16.50	–0.78	2.20	–1.03	–0.90	0.23	–0.02	–0.16	–0.52	–0.59	0.00
Detrend Y (% change)	—	—	–0.30	4.18	–1.95	–1.70	–1.52	–0.07	0.00	0.65	2.56	–2.45
Detrend I (% change)	—	—	–4.95	17.18	–8.02	–6.98	–0.12	–0.20	–0.94	–2.45	–0.96	–2.45

Source: Authors' calculations.

a. *MPK* = marginal product of capital; *RF* = risk-free rate. This table reports some moments of interest calculated in the model using the estimated parameter values for each of the two subsamples, 1984–2000 and 2001–16, as well as the change between samples, and the contribution of each parameter to each moment change.

shows the analysis of the price-earnings ratio and Tobin's Q. The latter increases significantly, from about 2.5 to 3.8 between the two samples, reflecting both the increase in market power and the effect of the change in discount rates at which these rents are discounted.

The model also speaks to the income distribution between labor, capital, and rents. The approach taken here is that we accurately observe the payments to labor in the data, and cannot easily split the remainder between capital and profits. In the model, we can study the decomposition and how it changes between the two subsamples. The decline of about 4 points in the labor share is accompanied by an even larger increase in the profit share, of about 5 points, so that the capital share actually declines slightly.

Finally, we can use the model to see the effect of these changes on macroeconomic variables—for instance, the capital-output and investment-output ratios. On one hand, a higher savings supply pushes investment up, leading to more capital accumulation. For instance, the change in β would push the investment-output ratio up by over 2 percentage points, while in the data it fell. On the other hand, rising market power and rising risk push investment down. Our model hence accounts for the coexistence of low investment and low interest rates. Note also that higher depreciation also requires more investment along the balanced growth path, while lower growth implies less investment. The model hence produces a fairly nuanced decomposition for the evolution of this ratio.

We can also ask what is the effect of each parameter on the level of GDP or investment.[20] For instance, higher market power discourages capital accumulation and reduces output. It is easy to show that the elasticity of GDP to markups in this model is $-\frac{\alpha}{1-\alpha}$, or about –0.32 for our estimate of α. Given the fact that estimated markups rise by 6.2 percent (= 6.7/1.079), the effect on GDP is about –0.32 × 6.2, or about –2 percentage points (–1.95 percent in table 4). Here, too, there are several counteracting factors, however, which imply that the overall level effect on GDP is small (about –0.30 percent). In particular, a higher savings supply and lower economic depreciation lead to higher capital accumulation, while higher risk leads to lower capital accumulation. Investment is more negatively affected by the changes, with a level effect of about –5 percentage points, owing largely

20. By level of GDP we mean y^*, that is, the level of GDP once the proper deterministic and stochastic trends have been removed. We abstract from the growth effects—for example, a higher g_z or g_Q has the mechanical effect of steepening the overall path of GDP.

to markups and risk, but also to lower growth and a lower employment-population ratio.

V.B. A Comparison with Macroeconomic Approaches

It is interesting to compare our results with alternative procedures followed by macroeconomists. Indeed, our empirical exercise is essentially the calibration of the "steady state" of a very-bare-bones dynamic stochastic general equilibrium (DSGE) model. Any DSGE model writer faces the same issues as we do to fit these key moments.

Indeed, real business cycle modelers are aware of a trade-off between fitting the capital-output ratio and the risk-free interest rate. Because these models also target the labor share, the discrepancy precisely reflects the gap between the *MPK* (the profit-capital ratio) and the risk-free interest rate. Often, modelers reject short-term Treasury interest rates as measures of the rate of return on capital, noting that these securities have special safety and liquidity attributes, which are not explicitly modeled.[21] Mechanically, these models consider that the observed risk-free rate equals the model risk-free rate times an unobserved convenience yield e^{ξ}. This yields an additional parameter ξ to estimate. At the same time, these models have traditionally abstracted from aggregate market power, setting $\mu = 1$,[22] and from risk, so that $p = 0$, and have not explicitly targeted the price-dividend ratio. The assumptions lead to a well-defined exactly identified exercise with eight moments (our baseline, minus the price-dividend ratio) and eight parameters (our baseline, plus the liquidity wedge ξ, less market power μ and risk p), which is an alternative to our approach. The last three columns of table 5 present the results from this exercise, which we call the "macro-without-markups" approach.

This approach leads to a much higher value of α and "explains" the decline of the labor share by an increase of α. The decline of the Treasury rate, and the growing gap between the *MPK* and this rate, are fully accounted for by a very large, and growing, liquidity premium, which equals about $-\xi = 6.1$ percent in the first sample and about 10.2 percent in the second sample. We find both the level and change in this wedge to be implausible.

21. See, for instance, Campbell and others (2017) for a presentation of the Federal Reserve Bank of Chicago's DSGE model, which, based on Fisher (2015), introduces a liquidity wedge that accounts for the discrepancy between the rate of return of capital and the risk-free rate.

22. New Keynesian models are an important exception, but market power is often set on an a priori basis in these studies (for example, a markup of 15 percent), and profits are offset in a steady state by fixed costs.

Table 5. Parameter Estimates: Baseline versus Macroeconomic Approaches[a]

	Baseline approach			*Macro-with-markups*			*Macro-without-markups*		
Variable	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*
β	0.961	0.972	0.012	0.984	1.012	0.028	0.925	0.913	–0.012
μ	1.079	1.146	0.067	1.165	1.330	0.166	1	1	0
p	0.034	0.065	0.031	0	0	0	0	0	0
δ	2.778	3.243	0.465	2.778	3.243	0.465	2.778	3.243	0.465
α	0.244	0.243	–0.000	0.183	0.122	–0.061	0.299	0.340	0.041
g_P	1.171	1.101	–0.069	1.171	1.101	–0.069	1.171	1.101	–0.069
g_Z	1.298	1.012	–0.286	1.544	1.358	–0.187	1.074	0.738	–0.335
g_Q	1.769	1.127	–0.643	1.769	1.127	–0.643	1.769	1.127	–0.643
$\bar{N}$	62.344	60.838	–1.507	62.344	60.838	–1.507	62.344	60.838	–1.507
ξ	0	0	0	0	0	0	–0.061	–0.102	–0.041

Source: Authors' calculations.

a. This table reports the estimated parameters in each of the two subsamples, 1984–2000 and 2001–16, in our baseline model; in the macro model with markups; and in the macro model without markups.

An alternative approach is to abstract from this liquidity but to allow for markup, while still omitting the *PD* ratio from the list of targets and risk from the potential parameters. This is also a well-posed exercise with eight moments and eight parameters, which we call the "macro-with-markups" approach. In this case, the spread between the *MPK* and the risk-free rate must reflect depreciation or rents. Intuitively, this approach assumes that the risk-free rate can be used to infer the cost of capital, and hence rents are deduced as a residual. The approach is conceptually quite similar to that taken by Simcha Barkai (2016), though we present it in a slightly more structural framework. The results are shown in the middle two columns of table 5. There are a number of differences between these results and our baseline results. First, the level of markups is much higher, and the increase in markups is much stronger (about 16.6 points instead of 6.7 points). Second, the increase in markups is so large that the model requires a sharp decline in α (from about 0.18 to 0.12) to keep the labor share from falling too much. This estimate suggests that technical progress has been biased toward labor over the past 30 years—a somewhat implausible conclusion. Conversely, this model also implies that β rose significantly. Below, we discuss further differences for a longer sample.

Table 6 presents the implications of these different "calibrations." Notably, our approach offers a balanced view where increases in markups and risk premia jointly explain the rising spread, while the macroeconomic model without markups accounts for all of it with an unmodeled liquidity premium and the macro model with markups accounts for all of it with rising market power. As a result, the macro model with markups implies a sharp decline in the level of GDP, by about 8 percentage points. Moreover, the share of income going to capital falls, while the share of profits surges. Conversely, the macro model without markups predicts an increase in the level of GDP relative to trend—the liquidity premium does not discourage capital accumulation in that model as much as markups or risk premia do in the other versions of the model.

Another interesting implication is that Tobin's *Q*, which increase significantly in our baseline, in a way that is broadly consistent with the data, is actually undefined in the macro-with-markups approach, because the low discount rates make the firm value infinite. In this sense, that model cannot match the evolution of valuation ratios, given its target of interest rates. Furthermore, the macro-without-markups approach implies decreasing valuation ratios, which are at odds with the data, owing to the very large, and rising, liquidity premium. These results provide indirect support for our baseline model.

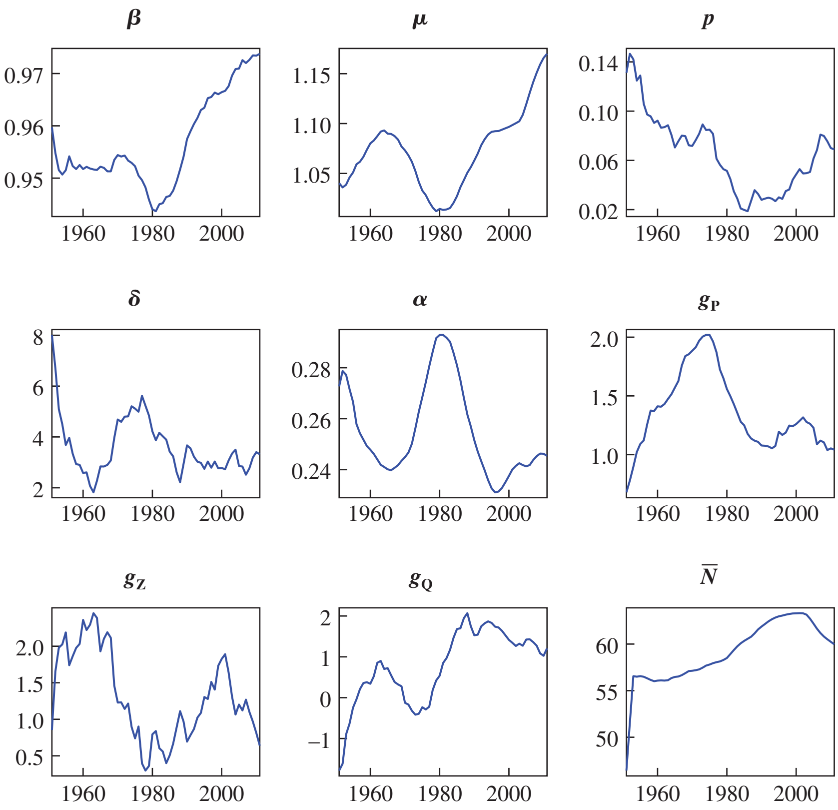
Table 6. The Model's Implications: Baseline versus Macroeconomic Approaches[a]

	Baseline approach			*Macro-with-markups*			*Macro-without-markups*		
Parameter	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*
A. MPK–RF spread									
Total spread	11.22	15.24	4.02	11.22	15.24	4.02	11.22	15.24	4.02
Depreciation	4.55	4.37	–0.18	4.55	4.37	–0.18	4.55	4.37	–0.18
Market power	3.39	5.55	2.17	6.58	10.89	4.30	0.00	0.00	0.00
Risk premium	3.15	5.23	2.08	0.00	0.00	0.00	0.00	0.00	0.00
Liquidity premium	0.00	0.00	0.00	0.00	0.00	0.00	6.51	10.75	4.24
B. Rates of return									
Equity return	5.85	4.90	–0.96	2.79	–0.35	–3.14	9.30	10.40	1.10
Equity premium	3.07	5.25	2.18	0.00	0.00	0.00	0.00	0.00	0.00
Risk-free rate	2.79	–0.35	–3.14	2.79	–0.35	–3.14	2.79	–0.35	–3.14
C. Valuation ratios									
Price-dividend	42.34	50.11	7.78	NA	NA	NA	17.82	13.57	–4.25
Price-earnings	17.85	25.79	7.94	NA	NA	NA	7.52	6.98	–0.53
Tobin's Q	2.50	3.84	1.34	NA	NA	NA	1.05	1.04	–0.01
D. Income shares									
Share of labor	70.11	66.01	–4.10	70.11	66.01	–4.10	70.11	66.01	–4.10
Share of capital	22.59	21.24	–1.35	15.75	9.17	–6.58	29.89	33.99	4.10
Share of profit	7.30	12.76	5.46	14.14	24.82	10.69	0.00	0.00	0.00
E. Macroeconomy									
K/Y	2.13	2.28	0.15	2.13	2.28	0.15	2.13	2.28	0.15
I/Y	17.28	16.50	–0.78	17.28	16.50	–0.78	17.28	16.50	–0.78
Detrend Y (% change)	—	—	–0.30	—	—	–8.00	—	—	7.77
Detrend I (% change)	—	—	–4.95	—	—	–12.65	—	—	3.12

Source: Authors' calculations.

a. This table reports some moments of interest calculated in the baseline model, in the macro model with markups, and in the macro model without markups, using the estimated parameter values for each of the two subsamples 1984–2000 and 2001–16, as well as the change between samples.

Figure 6. Estimated Parameters over Rolling windows, 1955–2011[a]



Source: Authors' calculations.

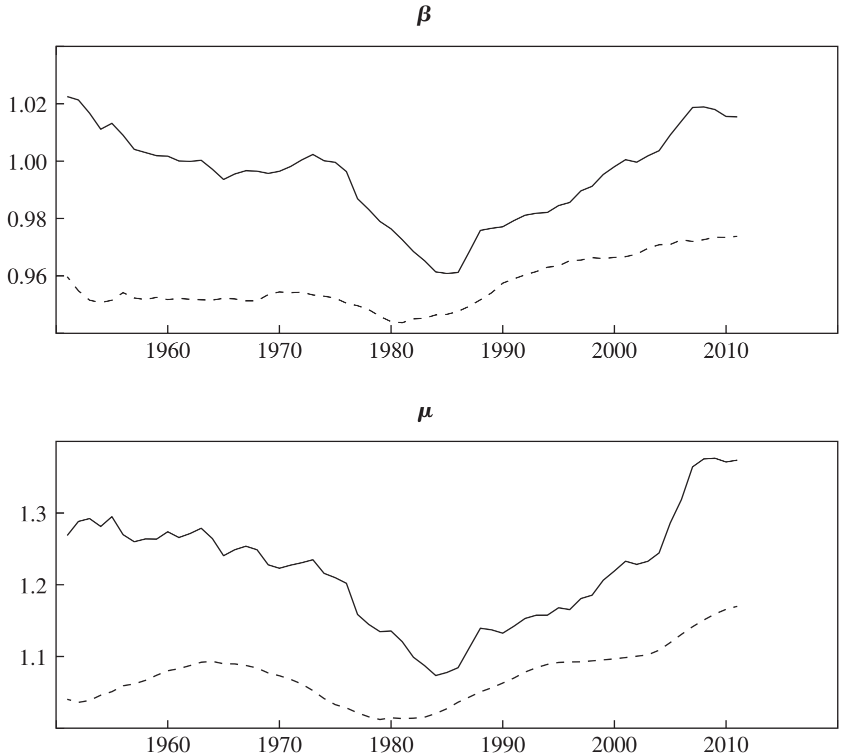
a. This figure plots the estimated parameters for each year. The target moments are the local moving averages over the 11 surrounding years.

V.C. Rolling Estimation

An alternative approach to fitting the model is to estimate it using rolling windows rather than two subsamples. In this spirit, figure 6 presents the estimated parameters when we estimate the model each year using an 11-year centered moving average to calculate the targeted moments. (That is, we target the smooth lines shown in section II, in figure 4.) We start our analysis in 1950 to avoid World War II.[23] As noted above, this calculation assumes that agents are myopic, in the sense that they believe that

23. We thank Matthew Rognlie for proposing (and executing) this exercise in his discussion at the National Bureau of Economic Research's Summer Institute.

Figure 7. Estimated Parameters β, μ: Baseline versus "Macro-with-Markups" Approach, 1951–2011[a]



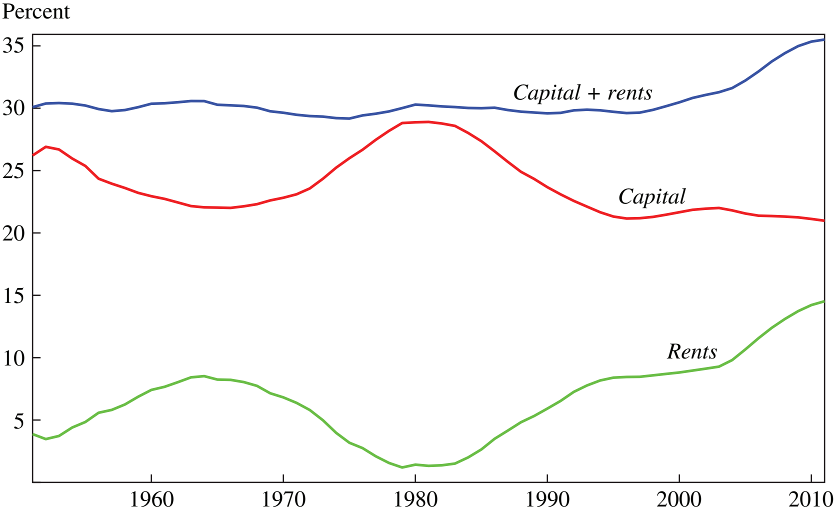
Source: Authors' calculations.

a. The figure plots the estimated β and μ over rolling windows for the baseline model (dashed line) and for the macro approach with markups (solid line).

the currently observed targeted moments will be constant forever, and it abstracts from transitional dynamics.

We find a U shape in the parameter β (savings supply) and in macroeconomic risk p. Hence, our results suggest that risk premia declined in the 1970s and in the early to middle 1980s, before rising. Markups also have a U shape but also an initial increase in the 1950s and 1960s. The capital parameter α has an increase in the late 1970s, which is later reversed. Figure 7 compares the evolution of our parameters β, μ with the parameters estimated using the macro-with-markups approach. Our estimated parameters are significantly more stable over time—the U shape is much weaker. We find this interesting because accounting for stock market valuation

Figure 8. Decomposition of Income, 1951–2011[a]



Source: Authors' calculations.

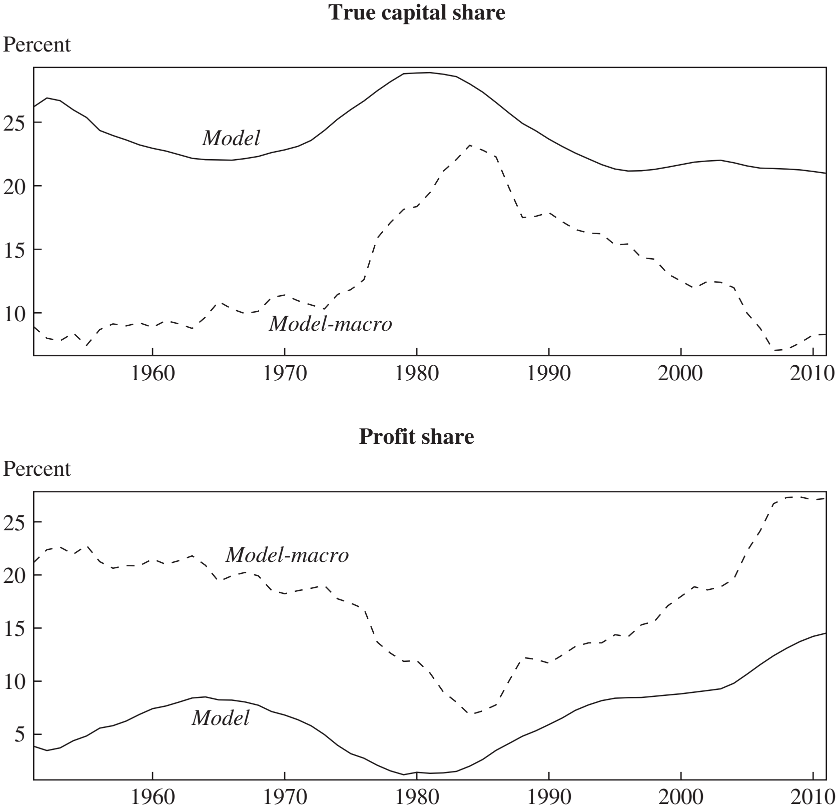
a. This figure presents the model-implied distribution of income, using the parameters estimated in each year using the rolling window estimation. The labor share is 1 minus the sum of capital and rents.

ratios might be expected to lead to more unstable parameters—but we find the opposite.

We can then use these rolling estimates to study the income distribution, the return spread *MPK* – *RF*, and their drivers. Figure 8 presents the share of pure profits, the true capital share, and the sum of the two for each year. By construction, the total equals 1 minus the labor share, and matches the data exactly.

The figure shows that the share of pure profits is estimated to have risen in the 1960s, then fallen in the 1970s and risen since 1980. Inversely, the capital share fell, then rose and fell. This picture reflects the puzzling pattern of a U shape in profits and an inverse U shape in α emphasized by Karabarbounis and Neiman (2019). However, we find it interesting that the U shape is significantly less strong with our estimation strategy than if one follows the macro-with-markups strategy. Karabarbounis and Neiman (2019) note that the strong negative correlation between the interest rate and the capital share, and the strong positive correlation between the interest rate and the profit share, are suggestive of measurement problems in the cost of capital. Figure 9 shows the capital share and

Figure 9. The Capital Share and the Pure Profit Share: Baseline versus "Macro-with-Markups" Approach, 1951–2011[a]



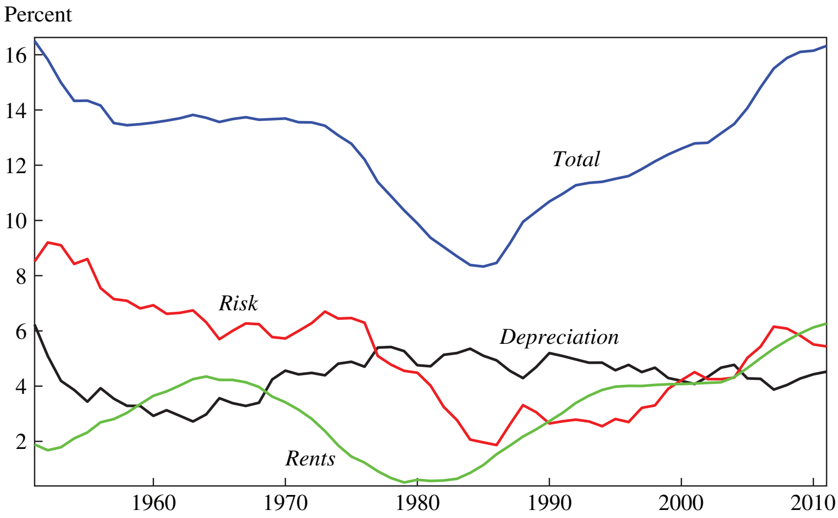
Source: Authors' calculations.

a. This figure presents the distribution of income, using the parameters estimated at each point in time, for both the "macro-with-markups" and macrofinance (baseline) estimations. The top panel shows the true capital share, and the bottom panel shows the profit share; the dashed lines correspond to the macro estimation, and the solid lines to the macrofinance (baseline) estimation.

the pure profit share implied by the two estimations. There is clearly less volatility for the macroeconomic and finance estimates.

Figure 10 presents the *MPK–RF* spread and its three subcomponents: economic and physical depreciation, rents, and risk. The spread falls in the 1970s before rising in the 1980s. The depreciation component moves, if anything, in the opposite direction from the spread, and hence does not help explain its movements. Rents are estimated to fall and then rise, and so is risk. The empirical success here is that the risk premium—which is

Figure 10. Decomposition of the Spread *MPK–RF*, 1951–2011[a]



Source: Authors' calculations.

a. This figure presents the model-implied spread between the average product of capital and the risk-free rate, and the three components that explain this wedge—depreciation, rents, and risk—using the parameters estimated for each year using the rolling windows moments.

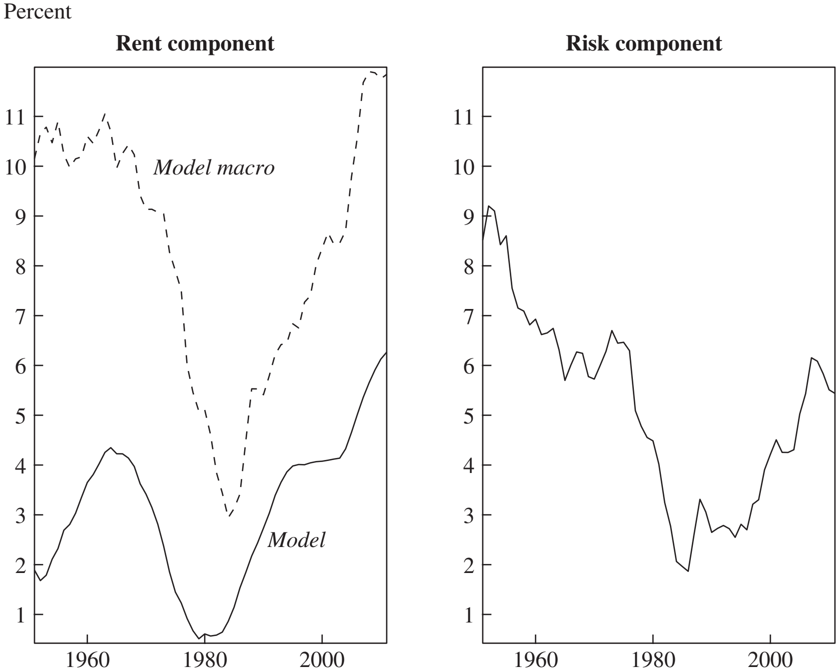
estimated without looking at the *MPK*, but rather by single-mindedly observing the *PD* ratio and growth rates—helps explain some of this variation.

Figure 11 again compares these results with those obtained with the more standard macroeconomic estimation. Both estimation approaches infer the same depreciation component. The macro approach attributes none of the spread to risk by construction, and hence infers a large and highly volatile rent (or profit) component. Finally, figure 12 depicts the implied risk-free rate, expected equity return, and equity risk premium. The risk-free rate exactly matches our data target, by construction. The equity premium mimics the evolution of p depicted in figure 6.

VI. Extensions and Robustness

This section presents some extensions of our baseline framework. We first discuss the interpretation of rising risk premia and alternative approaches to modeling them. We next analyze how financial leverage, the IES, alternative interest rates that adjust for liquidity or term premia, and capital

Figure 11. Rents and Risk Premium Components of the Spread Between the Marginal Product of Capital and the Risk-Free Rate, 1951–2021[a]



Source: Authors' calculations.

a. This figure presents the three components of the model-implied spread between the marginal product of capital and the risk-free rate, for both the baseline (macrofinance) calibration and the macroeconomic calibration. The left panel shows the rent (profit) component and the right panel shows the risk component.

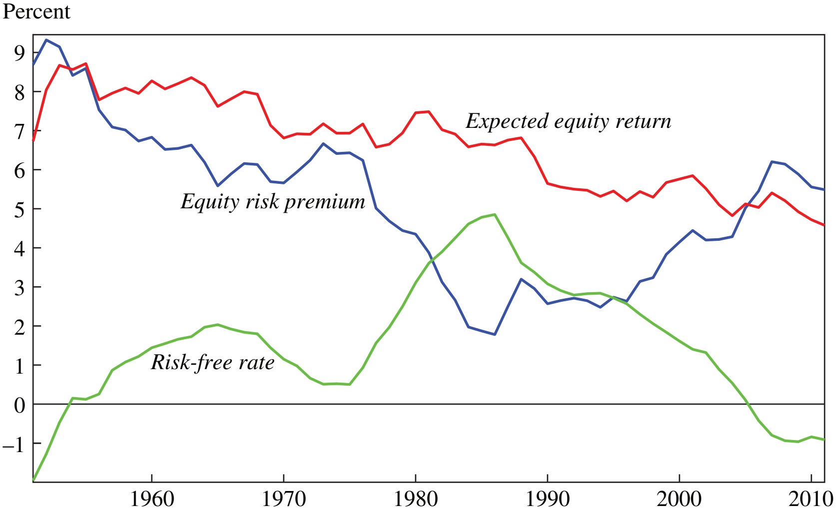
mismeasurement affect our results. Finally, we present an example to evaluate the importance of transitional dynamics.

VI.A. Interpretation of Rising Risk Premia

Our baseline results are obtained using a parameterization of χ as a rare "disaster" corresponding to a permanent decline of 15 percent in the level of GDP. Our estimates suggest that the risk of such a large shock was low in the 1990s but rose gradually in the 2000s and 2010s. Part of this increase may be attributed to a recognition after 2008 that financial crises are recurrent events that affect even developed economies.[24] But part of this increase occurs before the financial crisis. One interpretation is that this increase

24. Kozlowski, Veldkamp, and Venkateswaran (2018) offer a quantitative theory along these lines.

Figure 12. Risk-Free Rate, Expected Equity Return, and Equity Risk Premium, 1951–2011[a]



Source: Authors' calculations.
a. By construction, the risk-free rate matches the data.

corresponds to a higher perception of risk starting in the late 1990s and early 2000s, owing to the combination of the Asian financial crisis, the Long-Term Capital Management crisis, and the 2001 crash in the United States. We must acknowledge, however, that it is not straightforward to relate our estimate of the probability of a "disaster" to data on beliefs or other asset prices.[25] This leads us to study alternative risk modeling in this section. For instance, the aging of developed economies, or the desire of emerging markets to accumulate safe reserves, might be interpreted in a reduced form as higher effective risk aversion. Alternatively, one may interpret the time-varying risk premium as reflecting time-varying pessimism—that is, a "behavorial" interpretation.

As explained in subsection IV.B, the precise specification of the risk model is theoretically irrelevant for some conclusions, such as the value of markups μ or the Cobb-Douglas parameter α, or the estimated equity premium, *ERP*. We now illustrate that even for the objects where this specification is potentially relevant, it may not be quantitatively first-order.

25. The issues also arise when studying the 1960s and 1970s, where our model says the risk of disaster was larger. The 1970s were a volatile decade, so it is perhaps not surprising that the perceived tail risk was high.

Table 7. Parameter Estimates for Different Risk Assumptions[a]

Assumption		β	*Risk*	*b*	θ	σ
Baseline	1984–2000	0.961	0.034	0.163	12	0.5
	2001–16	0.972	0.065	0.163	12	0.5
Baseline with drift	1984–2000	0.960	0.038	0.163	12	0.5
	2001–16	0.971	0.071	0.163	12	0.5
Baseline with no offset	1984–2000	0.962	0.034	0.163	12	0.5
	2001–16	0.974	0.066	0.163	12	0.5
Lognormal	1984–2000	0.962	0.050	0.163	12	0.5
	2001–16	0.974	0.065	0.163	12	0.5
Time-varying disaster size	1984–2000	0.960	0.020	0.192	12	0.5
	2001–16	0.970	0.020	0.229	12	0.5
Time-varying risk aversion	1984–2000	0.960	0.020	0.163	15.316	0.5
	2001–16	0.970	0.020	0.163	19.560	0.5
IES = 1	1984–2000	0.966	0.034	0.163	12	1
	2001–16	0.970	0.065	0.163	12	1
IES = 0.5	1984–2000	0.976	0.034	0.163	12	2
	2001–16	0.965	0.065	0.163	12	2

Source: Authors' calculations.

a. IES = intertemporal elasticity of substitution. This table reports the estimated parameters in each of the two subsamples 1984–2000 and 2001–16 in the baseline model and in some variants: disaster risk with certain small offsets rather than rare windfalls; disaster risk without offset; lognormal risk; time-varying risk aversion; time-varying disaster size; IES = 1; and IES = 0.5.

Table 7 presents estimates of parameters in the first and second samples under different assumptions. The table's first row presents the baseline model. The second and third rows present alternative disaster models where, rather than a "bonanza" to offset the disaster risk, we introduce a small positive drift (the second row) or simply do not offset the disaster (the third row). The results are nearly identical. The fourth row considers a log-normal process for χ rather than a rare disaster. That model requires a large, and rising, standard deviation σ_χ of the lognormal shock to account for the data; but as we will see, it behaves quite similarly overall. The fifth and sixth rows display estimates when the disaster size b (respectively, risk aversion θ), rather than the disaster probability, is allowed to vary. Unsurprisingly, these models require rising disaster size or risk aversion to account for the data.[26] But all these models generate the same perfect fit of the data moments. Finally, the seventh and eighth rows present estimates of the baseline model when the IES is set to unity or 0.5 rather than 2; we discuss these below.

Table 8 presents the "causal" decomposition along the lines of tables 3 and 4; that is, they show the effect of the changes in β, the risk parameter

26. The estimated rising risk aversion could reflect wealth reallocation between agents of different risk aversion as studied, for instance, by Barro and others (2016) and Hall (2017).

Table 8. Contribution of the Parameters to Changes in Financial Variables for Different Risk Assumptions[a]

	Risk-free rate			*Price-dividend*			*Tobin's Q*		
Assumption	β	*Risk*	*Others*	β	*Risk*	*Others*	β	*Risk*	*Others*
Baseline	–1.22	–1.62	–0.29	30.67	–13.19	–9.70	1.05	–0.48	0.77
Baseline with drift	–1.17	–1.67	–0.29	28.86	–11.62	–9.47	0.99	–0.42	0.77
Baseline with no offset	–1.32	–1.53	–0.29	34.55	–16.52	–10.25	1.17	–0.60	0.77
Lognormal	–1.26	–1.59	–0.29	32.07	–14.40	–9.89	1.09	–0.52	0.77
Time-varying disaster size	–1.05	–1.80	–0.29	24.82	–8.03	–9.01	0.85	–0.29	0.78
Time-varying risk aversion	–1.04	–1.81	–0.29	24.45	–7.70	–8.97	0.84	–0.28	0.78
IES = 1	–0.43	–2.12	–0.59	9.30	0.00	–1.52	0.33	0.00	1.01
IES = 0.5	1.14	–3.11	–1.17	–35.66	27.75	15.68	–1.32	0.95	1.71

Source: Authors' calculations.

a. IES = intertemporal elasticity of substitution. This table reports for each variant of the baseline model, the decomposition of the risk-free rate, the price-dividend ratio, and Tobin's Q, into the changes driven by (1) the discount factor, (2) the risk parameter, and (3) all the other parameters.

used in the variant (p, θ, b, or σ_χ), or the other parameters (all grouped together for simplicity) on some model moments. We know already that the implications for α, μ, and so on are unchanged; so we focus here on three key financial variables: the risk-free rate, the price-dividend ratio, and Tobin's Q. The table shows that across a range of specifications, the decline of the risk-free rate is driven in significant parts by β and by the risk parameter—the probability of disaster, or the risk aversion or disaster size, regardless of the exact specification. Similarly, the increase in the price-dividend ratio and in Tobin's Q is the result of offsetting effects of the decline of β, the increase of the risk factor, and the decline of growth factors ("others"). Hence, our results are insensitive to the exact way risk is modeled.

VI.B. Leverage

Our model calculations assume an all-equity-financed firm. In reality, corporations are leveraged, which in particular may affect the price-dividend ratio, which we use as an input in our estimation strategy. In this subsection, we propose a simple approach to bound the effect of leverage. To take this into account, we assume a Modigliani-Miller world where corporate leverage has no effect on real quantities, and only affects prices and dividends. We assume that corporate debt is fully risk-free. We then adjust the price-dividend ratio of the model given an exogenous leverage decision, which we take directly from the data.[27] We then reestimate the model and obtain the results shown in the third set of columns in tables 9 and 10.[28]

Qualitatively, the findings are quite similar to those of the model without leverage: β, μ, and p all go up, and are important contributors to the observed changes in the risk-free rate, profitability, and the price-dividend ratio. However, the role of risk is somewhat smaller than in our baseline version. The logic is clear from the Gordon formula: With leverage, the change in r^* required to account for the change in valuation ratio is smaller. (Going in the other direction, however, is that in

27. Specifically, we use S&P 500 data and define *leverage* as short-term debt plus long-term debt less cash, divided by market value of equity; see the online appendix.

28. As an alternative approach, one can adjust the r^* from the model directly to account for leverage, noting that the r^* identified by the model from the *PD* ratio is actually $(1 + \omega)r^* - \omega r^f$ where ω is the observed debt-equity ratio. This approach yields nearly identical results to the one where we adjust the *PD* ratio directly.

Table 9. Parameter Estimates for the Two Subsamples: Robustness[a]

	IES = 0.5			*Leverage*			*AA rate as risk-free rate*			*10-year Treasury adjusted for term premium as risk-free rate*		
Parameter	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*
β	0.976	0.965	–0.011	0.968	0.982	0.014	0.957	0.969	0.012	0.963	0.972	0.008
μ	1.079	1.146	0.067	1.106	1.191	0.084	1.079	1.146	0.067	1.079	1.146	0.067
p	0.034	0.065	0.031	0.021	0.044	0.023	0.012	0.043	0.031	0.052	0.061	0.009
δ	2.778	3.243	0.465	2.778	3.243	0.465	2.778	3.243	0.465	2.778	3.243	0.465
α	0.244	0.243	–0.000	0.224	0.214	–0.010	0.244	0.243	–0.000	0.244	0.243	–0.000
g_P	1.171	1.101	–0.069	1.171	1.101	–0.069	1.171	1.101	–0.069	1.171	1.101	–0.069
g_Z	1.298	1.012	–0.286	1.378	1.096	–0.282	1.298	1.012	–0.286	1.298	1.012	–0.286
g_Q	1.769	1.127	–0.643	1.769	1.127	–0.643	1.769	1.127	–0.643	1.769	1.127	–0.643
$\bar{N}$	62.344	60.838	–1.507	62.344	60.838	–1.507	62.344	60.838	–1.507	62.344	60.838	–1.507

Source: Authors' calculations.

a. IES = intertemporal elasticity of substitution. This table reports the estimated variable values of each of the two subsamples, 1984–2000 and 2001–16, in the baseline model; in the model with IES = 0.5; in the model with financial leverage; and in the model estimated with a different interest rate target (AA).

Table 10. Model Implications: Robustness[a]

	IES = 0.5			*Leverage*		
Moment	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*
A. MPK–RF spread						
Total spread	11.22	15.24	4.02	11.22	15.24	4.02
Depreciation	4.55	4.37	–0.18	4.55	4.37	–0.18
Market power	3.39	5.55	2.17	4.47	6.99	2.52
Risk premium	3.15	5.23	2.08	2.08	3.81	1.73
B. Rates of return						
Equity return	5.85	4.90	–0.96	5.77	4.84	–0.93
Equity premium	3.07	5.25	2.18	2.99	5.19	2.20
Risk-free rate	2.79	–0.35	–3.14	2.79	–0.35	–3.14
C. Valuation ratios						
Price-dividend	42.34	50.11	7.78	NA	NA	NA
Price-earnings	17.85	25.79	7.94	NA	NA	NA
Tobin's Q	2.50	3.84	1.34	NA	NA	NA
D. Income shares						
Share of labor	70.11	66.01	–4.10	70.11	66.01	–4.10
Share of capital	22.59	21.24	–1.35	20.26	17.96	–2.30
Share of profit	7.30	12.76	5.46	9.62	16.03	6.40
E. Macroeconomy						
K/Y	2.13	2.28	0.15	2.13	2.28	0.15
I/Y	17.28	16.50	–0.78	17.28	16.50	–0.78
Detrend Y (% change)	—	—	–0.30	—	—	–1.88
Detrend I (% change)	—	—	–4.95	—	—	–6.52

Source: Authors' calculations.

a. IES = intertemporal elasticity of substitution; *MPK* = marginal product of capital; *RF* = risk-free rate; TP = term premium. This table reports some moments of interest calculated in the baseline model, in the model with IES = 0.5, in the model with financial leverage, and in the model estimated with a different interest rate target (AA), using the estimated parameter values for each of the two subsamples, 1984–2000 and 2001–2016, as well as the change between samples.

our data, aggregate leverage declines from the first sample to the second one.) In particular for the spread decomposition *MPK–RF* in table 10, the share of the spread due to risk is smaller (about 2.1 and 3.8 percentage points in the first and second samples, respectively). However, the share of the increase in the spread due to risk remains substantial. Moreover, in terms of the implied equity premium, the increase is actually similar, because leverage now amplifies the variation in r^*. These results are conservative, because we have assumed that corporate debt pays the same return as the risk-free asset; in reality, corporate debt yields

AA rate as risk-free rate			*10-year Treasury adjusted for term premium as risk-free rate*		
1984–2000	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*
9.32	13.80	4.48	12.49	14.98	2.49
4.55	4.37	–0.18	4.55	4.37	–0.18
3.39	5.55	2.17	3.39	5.55	2.17
1.25	3.79	2.54	4.42	4.97	0.55
5.88	4.84	–1.05	5.87	4.88	–0.99
1.19	3.75	2.56	4.35	4.97	0.62
4.69	1.09	–3.60	1.52	–0.09	–1.61
42.34	50.11	7.78	42.34	50.11	7.78
17.85	25.79	7.94	17.85	25.79	7.94
2.50	3.84	1.34	2.50	3.84	1.34
70.11	66.01	–4.10	70.11	66.01	–4.10
22.59	21.24	–1.35	22.59	21.24	–1.35
7.30	12.76	5.46	7.30	12.76	5.46
2.13	2.28	0.15	2.13	2.28	0.15
17.28	16.50	–0.78	17.28	16.50	–0.78
—	—	–0.30	—	—	–0.30
—	—	–4.95	—	—	–4.95

are higher than Treasury securities yields, which would reduce the adjustment to the *PD* ratio.

VI.C. The Intertemporal Elasticity of Substitution

We have assumed an IES equal to 2 in our baseline estimation. The IES cannot be identified, given that the model generates *iid* growth rates for all macroeconomic variables. As noted above, the assumed value for the IES does not affect estimates of α, μ, r^*, or the equity premium. This can be verified in tables 9 and 10, where we present parameter estimates for an elasticity equal to 0.5. Our conclusions that risk and market power increased are hence completely unaffected by this assumption. However, changing the IES does affect the counterfactual decompositions studied above; for instance, the effect of an increase in risk on capital accumulation depends on the assumed IES.

Table 8 presents decompositions for three financial variables, and section 3 of the online appendix provides the decompositions of all variables. With a low IES, the effect of the decline of growth in accounting for the decline of the risk-free rate is larger. The model hence does not require an increase in β—rather, β falls. The change of the risk-free rate due to uncertainty is now larger. In this sense, a lower IES gives a larger role for risk. The low IES implies very different decompositions of the changes in the *PD* ratio. As emphasized by Ravi Bansal and Amir Yaron (2004), with a low IES, higher risk and lower growth both raise the *PD* ratio because of their strong effect on the risk-free rate.

VI.D. Liquidity and Term Premia

As a risk-free rate proxy in the data, we use the 1-year Treasury rate (minus lagged core inflation). One concern is that our model abstracts from the liquidity premium, which makes this rate especially low. To gauge the role of the liquidity premium, we instead use as a risk-free rate proxy the rate on AA corporate bonds, minus the SPF median Consumer Price Index inflation over the next 10 years. This is a rate for securities that do not possess the same unique liquidity attributes as a U.S. Treasury security. We then repeat our estimation. Tables 9 and 10 show the results. Given the identification provided by the model, changing the risk-free rate does not affect α, μ, or r^*. However, the different risk-free rate target will affect the value of β and the amount of risk identified by the model, and their respective changes. Indeed, we see that both the estimated β and the estimated p are lower than in our baseline model; but crucially, our model still estimates that β and p increased significantly between the two samples. Our conclusion about the relative importance of risk and markups is also not affected by this change in target, suggesting that liquidity considerations do not play a very large role in these trends.

A related concern is that long-term rates reflect term premia that may be driven by an inflation or real rate premium which is not present in the model. We hence consider as a target for the risk-free rate the 10-year Treasury constant maturity rate, less SPF-expected inflation, less the term premium estimate made by Tobias Adrian, Richard Crump, and Emanuel Moench (2013), which they obtained from a statistical term structure model. Because the term premia estimate declines strongly during this period, the decline in this measure of the risk-free rate is only about 1.5 points rather than over 3 points. The resulting estimates imply a smaller increase in macroeconomic risk. Moreover, the spread *MPK–RF* is also increasing by a smaller amount, and the contribution of risk premia is smaller there as well. We view these results as somewhat less plausible because the decline of the term premium implied by this model is very large—we are unaware of macroeconomic models that can rationalize this. Also, to the extent that the decline of the term premium is related to macroeconomic risk, it may not be sound to adjust for it.

VI.E. Capital Mismeasurement

One natural explanation for the rising spread *MPK–RF* is that *K* is mismeasured, and in particular is underestimated by the U.S. Bureau of Economic Analysis (BEA) analysts, who traditionally focus on tangible assets. To get a sense of how much mismeasurement of capital matters, we present a simple approach in this subsection. In section 4 of the online appendix, we then estimate a more detailed model of intangible accumulation. We are interested in two questions: First, can a plausible amount of mismeasurement explain the rising spread? Second, is this mismeasurement also consistent with the other observed features of the data?

In this section, we simply assume that the BEA measures only a fraction, λ, of total investment. When $\lambda = 1$, there is no mismeasurement, corresponding to our baseline model. When $\lambda < 1$, however, this mismeasurement of investment affects our targeted moments, and hence possibly our parameter estimates. We denote with a superscript m the measured values of the model variables.[29] Measured investment is $x^m = \lambda x$, and hence along the balanced growth path $k^m = \lambda k$. Moreover, GDP and the profit share are now underestimated, because the unmeasured investment $(1 - \lambda)x$ is treated as an intermediate input by BEA accountants. As a

29. We do the algebra for detrended variables, but one can obviously also apply the same adjustments to the level variables.

result, measured GDP is $y^m = y - (1 - \lambda)x$. Measured profits equal measured GDP, less labor compensation, or $\pi^m = \pi - (1 - \lambda)x$. The profit share is hence underestimated as

$$\frac{\pi^m}{y^m} = \frac{\pi - (1-\lambda)x}{y - (1-\lambda)x} < \frac{\pi}{y}.$$

However, dividends are correctly measured because the unmeasured investment reduces both profits and investment: $d = \pi - x = \pi^m - x^m$. Hence, the asset price is unaffected by measurement error (even if investors do not observe intangible investment).

It is easy to extend our formula 27 for the spread:

$$(29) \qquad MPK - r_f = \delta + g_Q + \frac{\mu - 1}{\alpha}(r^* + \delta + g_Q) + r^* - r_f + \frac{1-\lambda}{\lambda}\frac{d}{k}$$

and we see that mismeasurement ($\lambda < 1$) now adds an additional component to the measured spread, which is consistent with basic intuition.

How important is this mismeasurement wedge? First, note that the measured ratio $\frac{d}{\lambda k} = \frac{d}{k^m}$ can be calculated as the difference between profitability and the investment rate, and hence equals about 6 percent in the first sample and 7.5 percent in the second sample. Hence, with $\lambda = 0.8$, or a 20 percent undermeasurement, the wedge is about 1.2–1.5 points, which is significant. Our focus, however, is on the *increase* in the spread. To explain this increase requires a rising mismeasurement. Though there is wide agreement that intangibles play a critical role in modern economies, it is not as clear if mismeasurement has increased over the past few decades. Suppose however, that one wanted to generate an increase in the spread by 2 percentage points (or about half the increase in the spread observed during our sample, and about the same as what is explained by risk premia or markups according to our baseline results), the model requires λ to go, for instance, from 1 (perfect measurement) to $\lambda = 0.73$, a 27 percent underestimation of investment. This rising mismeasurement would reduce measured GDP by about 4.4 percent, and the profit share by about 4 percentage points.[30] One

30. This calculation is based on the formulas of the previous page, $y^m = y - (1 - \lambda)x$ and $\pi^m = \pi - (1 - \lambda)x$, assuming a measured investment-output ratio equal to 0.17, as in our data.

tension, hence, is that rising intangibles lead to a measured labor share going up rather than down, as in the data.

To evaluate more precisely how this mismeasurement affects our results, we estimate three versions of our baseline model corresponding to different assumptions about mismeasurement. In the first version, mismeasurement is constant at 10 percent in both samples ($\lambda = 0.9$). In the second version, mismeasurement starts at 10 percent in the first subsample and then rises to 20 percent in the second subsample. In the third version, mismeasurement starts at 10 percent and then rises to 30 percent. These numbers are largely illustrative; note, however, that the share in capital of measured "intangibles"—that is, intellectual property products—is about 6 percent recently.[31] We are hence assuming that the unmeasured stock of intangible capital is significantly larger than the current measured stock, and has been rising significantly over the past 15 years.

Table 11 reports the parameter estimates, and table 12 reports the implied moments corresponding to different scenarios. There are a few interesting results. First, all parameters are completely unaffected, except for μ and α. In particular, the increase in β and in risk are not affected by these assumptions. Second, when mismeasurement is constant at 10 percent, the model has similar implications to our baseline model (the level of α is higher and the level of μ lower, but the changes between two subsamples are nearly identical). Third, the estimated increase in markup is smaller when there is an increase in mismeasurement. For instance, with a mismeasurement rising to 30 percent of capital, the markup rises by only about 4.1 points instead of 6.6 points when mismeasurement is constant and 6.7 points in the baseline model. This is intuitively consistent with the simple formula 29: With more mismeasurement, there is less of a gap between the *MPK* and the risk-free rate to explain. The other implication is that the estimated α rises. This is because the labor share rises with mismeasurement; to offset this, the model needs an increase in capital-biased technical change—that is, α.

Overall, in our most generous calibration, the rising mismeasurement explains about a 1.65-point increase in the wedge, the markup now only 0.47 point, and the risk premium 2.08 points. Of course, the magnitude of the mismeasurement is difficult to ascertain. But it is interesting that

31. This number is obtained by dividing line 7 by line 3 in table 1.1 of the Fixed Asset Accounts of the United States.

Table 11. Parameter Estimates for the Two Subsamples: Capital Mismeasurement[a]

	Baseline			*Constant bias: 10 percent*			*Rising bias: 10–20 percent*			*Rising bias: 10–30 percent*		
Variable	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*
β	0.961	0.972	0.012	0.961	0.972	0.012	0.961	0.972	0.012	0.961	0.972	0.012
μ	1.079	1.146	0.067	1.070	1.136	0.066	1.070	1.125	0.055	1.070	1.111	0.041
p	0.034	0.065	0.031	0.034	0.065	0.031	0.034	0.065	0.031	0.034	0.065	0.031
δ	2.778	3.243	0.465	2.778	3.243	0.465	2.778	3.243	0.465	2.778	3.243	0.465
α	0.244	0.243	–0.000	0.264	0.263	–0.000	0.264	0.287	0.023	0.264	0.315	0.051
g_P	1.171	1.101	–0.069	1.171	1.101	–0.069	1.171	1.101	–0.069	1.171	1.101	–0.069
g_Z	1.298	1.012	–0.286	1.217	0.956	–0.262	1.217	0.889	–0.328	1.217	0.809	–0.408
g_Q	1.769	1.127	–0.643	1.769	1.127	–0.643	1.769	1.127	–0.643	1.769	1.127	–0.643
$\bar{N}$	62.344	60.838	–1.507	62.344	60.838	–1.507	62.344	60.838	–1.507	62.344	60.838	–1.507

Source: Authors' calculations.

a. This table reports the estimated parameters in each of the two subsamples, 1984–2000 and 2001–16, in the baseline model and in the model with mismeasured capital, for different values of the mismeasurement parameters, using the estimated parameter values for each of the two subsamples, as well as the change between samples.

incorporating realistic mismeasurement would reduce further the implied markup, while leaving the role of risk unaffected.

VI.F. Transitional Dynamics

Our calculations so far assume that the economy remains along its "risky balanced growth path." However, if the model parameters such as the discount factor or markup change, the economy will experience a transition before it reaches its new balanced growth path. This transition may affect our estimation results.

To evaluate the importance of this bias, we estimated the model, taking into account the transitional dynamics. Specifically, we make the following assumptions. We use the baseline version of the model and assume that the economy starts in 1992 in balanced growth with the parameters that we estimate over the first sample.[32] We then assume that the nine parameters change linearly over 24 years (to end in 2016), from the value we estimated in the first sample to a final value that we will estimate (and that may not be our estimate for the second sample).

We then calculate the transitional dynamics for this economy using a standard shooting method. A key issue is agents' expectations. With perfect foresight, the model cannot fit the data, because agents see the lower interest rates coming, which leads to a boom in the price-dividend ratio. (Furthermore, the long-term interest rate would fall significantly more than the short-term rate, unlike what we see in the data.) We hence assume myopic expectations: In each period, agents observe the new values of the parameters, and they assume (incorrectly, at least for the first 24 years) that these parameters will remain constant forever.[33]

We then numerically find the final parameters such that, when calculating the transition, this procedure yields an average time series for our targets (over the period 2001–16) that matches what we measured in

32. We use 1992 to take into account that these parameters are estimated over the period 1984–2000.

33. Agents consequently make investment choices that would, eventually, lead to converge to a new steady state corresponding to today's parameter values. However, the next period, new parameter values (unexpectedly) arrive, leading to new choices and a revised transition path. This process continues until the parameters are indeed constant, and the economy then converges to its final steady state.

Table 12. Implications: Baseline versus Capital Mismeasurement[a]

	Baseline			*Constant bias: 10 percent*		
Moment	*1984–2000*	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*
A. MPK–RF spread						
Total spread	11.22	15.24	4.02	11.22	15.24	4.02
Depreciation	4.55	4.37	–0.18	4.55	4.37	–0.18
Market power	3.39	5.55	2.17	2.80	4.79	1.99
Risk premium	3.15	5.23	2.08	3.15	5.23	2.08
Mismeasurement	0.13	0.09	–0.05	0.72	0.85	0.13
B. Rates of return						
Equity return	5.85	4.90	–0.96	5.85	4.90	–0.96
Equity premium	3.07	5.25	2.18	3.07	5.25	2.18
Risk-free rate	2.79	–0.35	–3.14	2.79	–0.35	–3.14
C. Valuation ratios						
Price-dividend	42.34	50.11	7.78	42.34	50.11	7.78
Price-earnings	17.85	25.79	7.94	17.85	25.79	7.94
Tobin's *Q*	2.50	3.84	1.34	2.50	3.84	1.34
D. Income shares						
Share of labor	70.11	66.01	–4.10	68.79	64.82	–3.97
Share of capital	22.59	21.24	–1.35	24.63	23.17	–1.46
Share of profit	7.30	12.76	5.46	6.58	12.01	5.43
E. Macroeconomy						
K/Y	2.13	2.28	0.15	2.13	2.28	0.15
I/Y	17.28	16.50	–0.78	17.28	16.50	–0.78
Detrend *Y* (% change)	—	—	–0.30	—	—	0.05
Detrend *I* (% change)	—	—	–4.95	—	—	–4.60

Source: Authors' calculations.

a. *MPK* = marginal product of capital; *RF* = risk-free rate. This table reports some moments of interest calculated in the baseline model and in the model with mismeasured capital, for different values of the mismeasurement parameters, using the estimated parameter values for each of the two subsamples, 1984–2000 and 2001–16, as well as the change between samples.

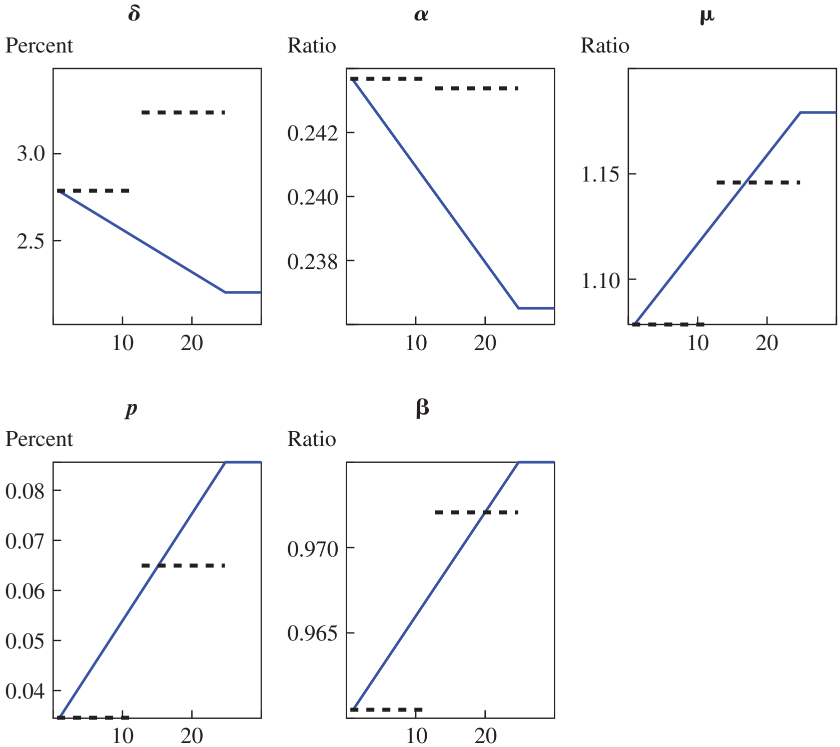
the data. Figure 13 presents the path obtained for parameter values, and figure 14 shows the path for the moments targeted (we abstract here from parameters that map directly into moments). The dashed lines in these tables represent the parameters and moments from the baseline estimation for the two samples. Table 13 presents the numerical counterpart to these graphs.

As can be eyeballed in figure 14, the model moments, averaged over periods 13–25 (corresponding to the second sample), match reasonably well the targeted moments for the second sample (the darker line). The more

Rising bias: 10–20 percent			*Rising bias: 10–30 percent*		
1984–2000	*2001–16*	*Difference*	*1984–2000*	*2001–16*	*Difference*
11.22	15.24	4.02	11.22	15.24	4.02
4.55	4.37	–0.18	4.55	4.37	–0.18
2.80	4.03	1.23	2.80	3.27	0.47
3.15	5.23	2.08	3.15	5.23	2.08
0.72	1.61	0.89	0.72	2.37	1.65
5.85	4.90	–0.96	5.85	4.90	–0.96
3.07	5.25	2.18	3.07	5.25	2.18
2.79	–0.35	–3.14	2.79	–0.35	–3.14
42.34	50.11	7.78	42.34	50.11	7.78
17.85	25.79	7.94	17.85	25.79	7.94
2.50	3.84	1.34	2.50	3.84	1.34
68.79	63.39	–5.40	68.79	61.65	–7.14
24.63	25.49	0.87	24.63	28.33	3.71
6.58	11.11	4.53	6.58	10.02	3.44
2.13	2.28	0.15	2.13	2.28	0.15
17.28	16.50	–0.78	17.28	16.50	–0.78
—	—	5.74	—	—	13.60
—	—	1.10	—	—	8.95

surprising result is in figure 13, where we see that the parameter values estimated in this way are quite similar to these obtained in the simple baseline model, which assumes balanced growth. To see this, note that the full line, averaged over periods 13–25, is economically quite similar to the darker line (results from the baseline model). The one exception is δ, which now falls slightly instead of rising. Table 13 shows the same result: Comparing the third and fourth columns, the estimated parameters are quite similar, except for δ. We view these results as suggesting that, at least in the myopic case, perhaps not much is lost by focusing on the risky

Figure 13. Estimated Path for the Parameters[a]



Source: Authors' calculations.

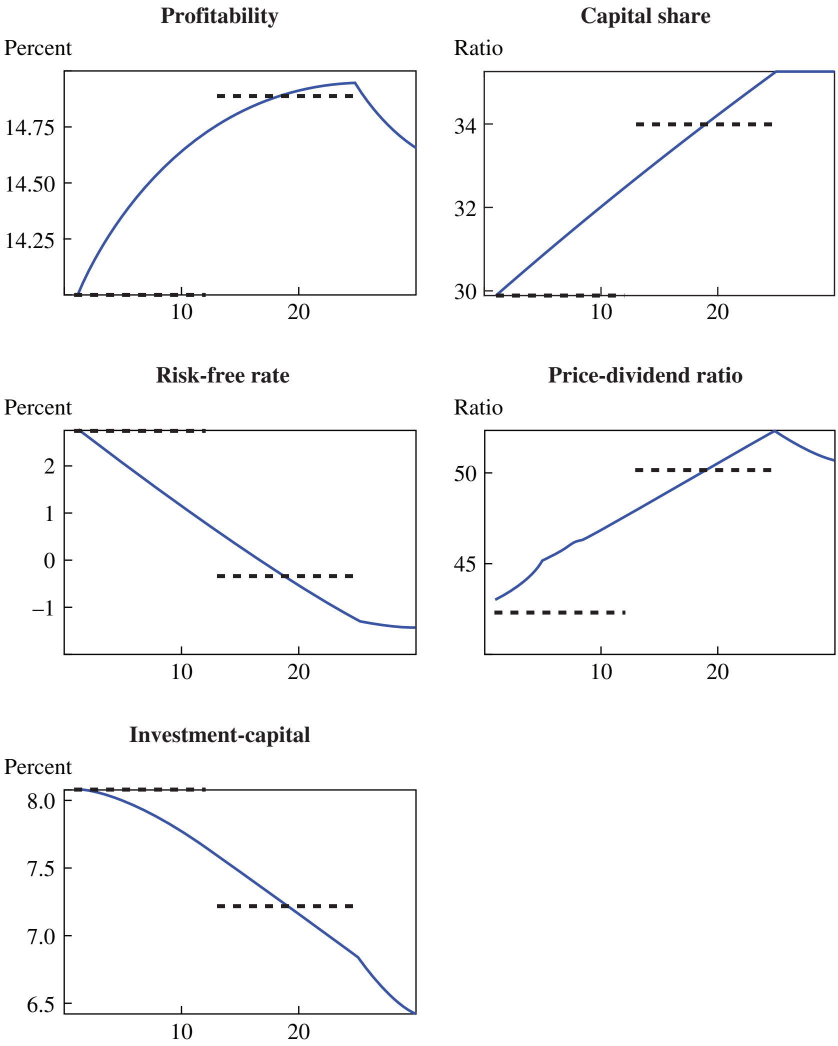
a. This figure plots the estimated path for the parameters using the transitional dynamics method. The dashed lines denote the values estimated in the baseline approach in the first and second samples.

balanced growth path. This conclusion might not hold true for all models, however—in particular, with intangibles, if there is significant accumulation during the transition.

VII. Other Evidence on Market Power, Risk Premia, and Intangibles

Our empirical results show that rising risk premia and rising market power appear to be two of the significant drivers of some of the macroeconomic and finance trends on which we focus, and intangibles have a

Figure 14. Fitted Path for the Targeted Moments[a]



Source: Authors' calculations.

a. This figure plots the estimated path for the target moments using the transitional dynamics method. The dashed lines denote the values targeted in the baseline approach.

Table 13. Average Parameter Estimates and Moments: Transitional Dynamics[a]

	1984–2000		*2001–16*	
Variable	*Baseline*	*Transition*	*Baseline*	*Transition*
Moments				
$\frac{\Pi}{K}$	14.012	14.426	14.890	14.890
$\frac{\Pi}{Y}$	29.887	31.194	33.992	33.991
RF	2.787	1.785	–0.350	–0.350
PD	42.336	45.451	50.115	50.115
$\frac{I}{K}$	8.103	7.932	7.227	7.227
Estimated parameters				
α	0.244	0.242	0.243	0.238
μ	1.079	1.102	1.146	1.154
β	0.961	0.964	0.972	0.971
p	0.034	0.046	0.065	0.073
δ	2.778	2.642	3.243	2.334

Source: Authors' calculations.
a. This table reports the average value of the targeted moments and the average values of the estimated parameters over the first and second samples using the transitional dynamics method. The final parameter values are chosen such that the average values of the moments match the targeted moments in the second sample. See the text for details.

potential contribution as well. In this section, we step outside the model and present independent evidence for these two phenomena. We also discuss related estimates presented by other researchers, which tend to support our conclusions.

VII.A. Empirical Estimates of the Equity Risk Premium

We first present reduced-form estimates of the equity premium. Estimating the equity premium is notoriously difficult, even retrospectively. Using realized excess equity returns is essentially pointless over short-term samples, because returns are noisy, and because an increase in the risk premium may lead, by itself, to lower realized returns.[34] But methods that use standard forecasting return regressions have also been found to be very

34. For instance, suppose a researcher has a sample of 16 years (as we do) and that the excess equity return has a mean of 8 percent with a volatility of 16 percent. The 95 percent confidence interval for the mean excess equity return is [0%, 16%]. It is clearly impossible to detect a change of the equity premium of even several percentage points based solely on realized returns.

unstable; Ivo Welch and Amit Goyal (2008) argue that none of them outperforms the simple mean out of sample. Here, we follow a few approaches that have been shown to be somewhat more successful empirically.

Our first approach is simply to use the static Gordon growth formula, which states that the price-dividend ratio is the inverse of the difference between the return on the asset and the dividend growth rate:

$$\frac{P}{D} = \frac{1}{R - G}$$

where R is the expected equity return, which can be decomposed into $R = RF + EP$, with RF risk-free and EP the equity premium, and G the growth rate of dividends. This approach can be used at any point in time, given the observed PD and RF and given an assumption about G. The main difference with our structural estimation above is that here we use data on dividends.

Our second approach builds on the research of Eugene Fama and Kenneth French (2002), who argue that, if the dividend yield or earnings yield is stationary, as each one ought to be, one can advantageously estimate the mean of $\frac{P_{t+1}}{P_t}$ by $\frac{D_{t+1}}{D_t}$ by $\frac{E_{t+1}}{E_t}$ (which are less volatile). As a result, they suggest estimating

$$ERP = E\left(\frac{D_{t+1}}{P_t}\right) + E\left(\frac{D_{t+1}}{D_t}\right) - E(RF),$$

which amounts to the Gordon growth formula, or replacing dividend growth with earnings growth,

$$ERP = E\left(\frac{D_{t+1}}{P_t}\right) + E\left(\frac{E_{t+1}}{E_t}\right) - E(RF).$$

This approach is best thought of as applying to a long-sample average.

Our third approach follows that of John Campbell (2008) and Campbell and Samuel Thompson (2008), who show how combining the current dividend yield and the return on book equity can be used to create a real-time estimate of the equity premium:

$$ERP = \frac{D}{E}\frac{E}{P} + \left(1 - \frac{D}{E}\right)ROE$$

and where they suggest smoothing the payout ratio $\frac{D}{E}$, earnings-price ratio $\frac{E}{P}$, and the return on book equity ROE to reduce the effect of influential but transitory observations.

These formulas can be applied either using arithmetic averages or using geometric averages. We report both in table 14, though we like Campbell and Thompson's recommendation to use the geometric averages. We then incorporate an adjustment of half the variance of stock returns to produce an estimate of the arithmetic equity premium.

The key observation from table 14 is that, though the estimates of the equity premium are clearly different across models and methods, most calculations suggest that the ERP increased from the first sample to the second sample. Specifically, all nine estimates are positive, ranging from about 1.8 percent to 7.2 percent. This reflects the fact that valuation ratios increased moderately, while earnings or dividend growth increased more significantly, and the risk-free rate fell. (For this exercise, we take the risk-free rate to be the 10-year Treasury yield minus SPF inflation expectations over the next 10 years.)

Figure 15 graphically presents estimates of the equity risk premium for each of the three approaches, obtained over centered 11-year rolling windows. We smooth the estimates using a 3-year moving average. Here, too, the exact numbers vary quite a bit across models, but all models suggest some increase over the past 15 years or so. (A particular difficulty is how one deals with the very low corporate earnings in 2008 or 2009, which affect the Fama-French Earnings Model significantly, leading to the extreme arithmetic implication in the middle panel.)

VII.B. Other Measures of Changes in Risk Premia

We now discuss other evidence on the changes in the risk premium. Fernando Duarte and Carlo Rosa (2015) provide an exhaustive survey of the different methods that can be used to estimate the equity premium in real time. They distinguish between different methods based on variants of the Gordon Growth Model, on predictive regressions, and on cross-sectional regressions. Overall, the conclusion is that the equity premium has risen, in line with our findings.[35] Campbell and Thompson (2008)

35. An earlier body of literature documented a decline of the equity premium during the 1980s and 1990s (Blanchard 1993; Jagannathan and McGrattan 2000; Heaton and Lucas 1999; Lettau and Ludvigson 2007), which is not inconsistent with our results.

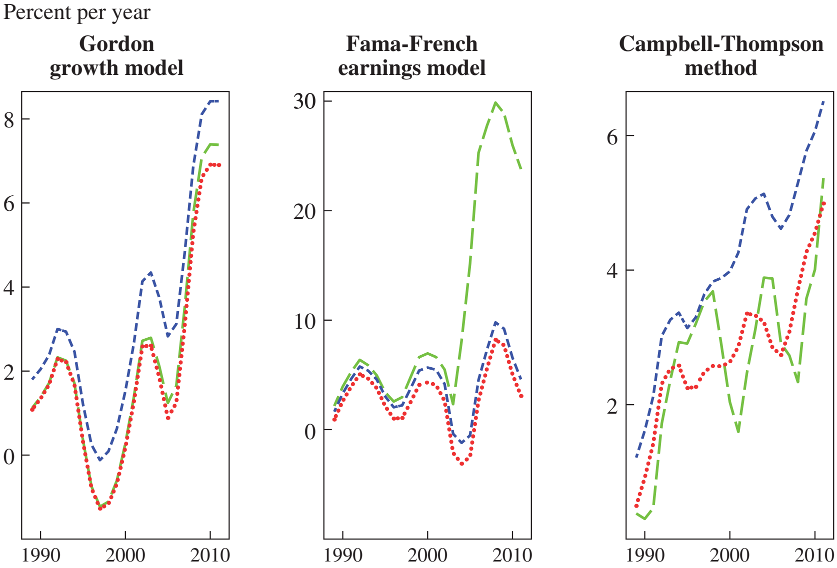
Table 14. Reduced-Form Estimates of the Equity Risk Premium[a]

	Arithmetic average			Geometric average		
Variable	*1984–2000*	*2001–16*	*Change*	*1984–2000*	*2001–16*	*Change*
Real dividend growth	2.03	4.7	2.67	2.04	8.21	6.17
Real earnings growth	6.22	16.97	10.75	10.25	12.06	1.81
Return on book equity	10.94	10.0	–0.94	10.7	9.4	–1.3
Dividend yield D/P	2.78	1.92	–0.86	—	—	—
Payout ratio, D/E	0.49	0.47	–0.02	—	—	—
Earnings-price ratio, E/P	5.74	4.69	–1.05	—	—	—
ERP, Gordon Growth Model	0.87	5.56	4.69	1.91	9.16	7.25
ERP, Fama-French Earnings Model	2.43	4.78	2.35	4.61	8.66	4.05
ERP, Campbell-Thompson	1.47	4.11	2.64	1.84	3.65	1.81
ERP, Gordon, with variance adjustment	—	—	—	2.43	8.26	5.83
ERP, Fama-French, with variance adjustment	—	—	—	4.81	10.3	5.49
ERP, Campbell-Thompson, with variance adjustment	—	—	—	2.31	5.56	3.25

Source: Authors' calculations.

a. ERP = equity risk premium. This table reports the estimated equity premium as well as the mean of some variables used to construct our estimates, for the samples 1984–2000 and 2001–16. See the text for details.

Figure 15. Reduced-Form Estimates of the Equity Risk Premium, 1989–2011[a]



Source: Authors' calculations.

a. This figure depicts some reduced-form estimates of the equity risk premium. The left panel shows the Gordon growth model; the middle panel shows the Fama-French earnings model; and the right panel shows estimates from the Campbell-Thompson method. The dotted line = arithmetic average; the long-dashed line = geometric; and the short-dashed line = geometric + variance adjustment.

propose a method to estimate the equity premium in real time. Their estimate also shows a small increase after 2000. Using a very different methodology, based on a maximum-likelihood estimation of a structural model, Efstathios Avdis and Jessica Wachter (2017) reach a fairly similar conclusion. Another important contribution is Ian Martin (2017), who uses an ingenious argument to provide, under a relatively weak condition, a lower bound on the equity premium based on option data. His lower bound has a very high correlation with the Chicago Board Options Exchange's Volatility Index (VIX). The estimate is very elevated during the global financial crisis, and remains at a higher level after the crisis. However, his lower bound is quite low in the mid-2000s. If the lower bound has a constant bias with the mean, then this series does not behave like the other estimates we discussed above. However, it is possible that the bias between the lower bound he finds and the true expected equity premium is time-varying.

Table 15 presents evidence on the evolution of some other measures of risk: the Gilchrist–Zakrajšek (2012) spread, the standard BAA and AAA

Table 15. Other Measures of Risk Premia[a]

	Mean			Difference			
Measure	*1984–2000 (1)*	*2001–16 (2)*	*2001–16, excluding global financial crisis (3)*	*(2) – (1)*	*SE*	*(3) – (1)*	*SE*
Spread, Gilchrist–Zakrajšek	1.5	2.54	2.31	1.04	0.24	0.81	0.16
Spread, BAA–10 year	1.94	2.74	2.61	0.80	0.19	0.67	0.15
Spread, AAA–10 year	1.01	1.64	1.61	0.63	0.13	0.60	0.12
VIX	18.92	20.22	18.62	1.3	2.27	–0.3	1.98
Realized volatility	13.36	17.43	15.34	4.07	2.21	1.98	1.62

Sources: See the online appendix, section 1, for all data sources.

a. SE = standard error; VIX = Chicago Board Options Exchange Volatility Index. This table reports the mean of various credit spreads and volatility measures for the samples 1984–2000; 2001–16; and 2001–16, excluding the June 2007–June 2009 period of the global financial crisis. The table also reports the difference between these means and an SE (calculated using the Newey-West method, with 12 monthly lags).

spreads, the VIX, and stock-market-realized volatility (calculated using daily data). The table reports the mean in the two samples, as well as the mean in the second sample excluding the period of the global financial crisis. We see that all these credit spreads have increased between the two samples, and this conclusion is true even excluding this period. Realized volatility is also somewhat higher. The VIX exhibits little trend (but is only available starting in 1996). These results are consistent with Del Negro and others (2017), who show that the premia for safe and liquid assets increased over time.[36]

VII.C. Independent Evidence on Rising Markups

A number of recent contributions, using different methods, have found that average markups have been increasing. For example, Barkai (2016) uses aggregate data and implements a user cost approach à la Robert Hall and Dale Jorgenson (1967) to decompose the nonlabor share into a true capital share and a profit share. The true capital share is computed by multiplying the capital-output ratio by the user cost of capital. The profit share is a residual. The aggregate markup can be directly inferred from the profit share. Because his measure of user cost does not incorporate a meaningful risk premium, Barkai finds that the evolutions of the user cost track those of the interest rate, so the user cost declined substantially over the period 1984–2014. This implies a large decrease in the capital share, a large increase in the profit share, and a large increase in the aggregate markup of about 20 percent, roughly in line with our macroeconomic estimation.

Jan De Loecker and Jan Eeckhout (2016) use firm-level data and estimate firm-level markups using a production function approach that recovers markups as the ratio of the elasticity of production to a flexible input share of that input in revenues, where the former is computed by estimating the production function. The aggregate markup, computed as a harmonic sales-weighted average of firm-level markups, increases by about 25 percent. James Traina (2018) criticizes the measure of costs used by De Loecker and Eeckhout. Using a broader measure, he finds that the increase in average markups is much smaller. Germán Gutiérrez and Thomas Philippon (2017) also use firm-level data, but they estimate firm-level markups using a user cost approach allowing for sizable and variable risk premia. They also find a sizable increase in aggregate markups

36. One caveat is that the underlying riskiness of the firms issuing corporate bonds may have changed over time, even within credit ratings.

of about 10 percent over the period 1984–2014, somewhat above our baseline results.

VII.D. Rising Intangible Capital

There is a growing body of literature that recognizes the importance of intangible capital in the U.S. economy. Carol Corrado, Charles Hulten, and Daniel Sichel (2005, 2009) and Leonard Nakamura (2010) present estimates of the size of intangible capital. Anmol Bhandari and Ellen McGrattan (2017) also contribute to this measurement. Dongya Koh, Raül Santaeulàlia-Llopis, and Yu Zheng (2015) argue that rising intangibles help explain the evolution of the labor share. Nicolas Crouzet and Janice Eberly (2018) argue that growing intangibles help explain both the rising market power and lower capital investment. Andrea Caggese and Ander Perez (2018) show how growing intangibles may help account for some of the same macroeconomic trends on which we focus in this paper.

VIII. Conclusion

We provide a simple accounting framework that allows decomposing the changes observed over the past 30 years in some key macroeconomic and finance trends into "semistructural" parameters using a fairly clear identification. We say "semistructural" because, allowing these parameters to vary over time flexibly suggests they are not microfounded and invariant to policy. Yet we find the results useful because deeper explanations need to be consistent with the changes of parameters implied by our approach.

We find that about half the increase in the spread between the return on private capital and the risk-free rate is due to rising market power, and half is due to rising risk premia. Technical change plays little role. Higher savings supply and higher risk premia are the prime proximate contributors to the decline in the risk-free rate. Rising market power helps explain the evolution of the capital share, profitability, and capital accumulation, but its contribution is substantially overstated if the model is estimated using a macroeconomic approach that abstracts from risk. Finally, taking into account intangibles reduces further the estimated increase in market power.

One limitation of our approach is that we treat the parameter changes as independent causal factors, but they might actually be driven by common causes; for instance, higher market power might reduce innovation and hence productivity growth, but we treat these as independent. Our analysis also does not incorporate some factors that could help explain the evolution of some of the big ratios that we study. In particular, we abstract from taxes and from agency issues (for example, external finance or corporate governance frictions) or market incompleteness, that could also give rise to wedges that might vary over time. Our study of transitional dynamics is only scratching at the vast possibilities. Finally, it would be interesting to study these issues taking into account the specific open economy considerations or at least to study these same facts for a variety of countries.

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Comments and Discussion

COMMENT BY

MARK GERTLER This very nice paper by Emmanuel Farhi and François Gourio certainly clarified many key issues in the literature for me. The most useful way I can use my space here is to describe what I think are the paper's key arguments. Then I offer a few suggestions.

The paper's goal is to account for a variety of macroeconomic trends over the past several decades. Farhi and Gourio describe nine trends. But I think these three facts are central to their analysis:

1. Declining real interest rates,
2. A rising capital income share, and
3. A slightly increasing average return to capital.

The first two facts are widely known, and each is the subject of a large independent body of literature. The third fact is well known by insiders in the area. Consistent with a very recent wave of literature, the authors note that the macroeconomic trends are interdependent phenomena and thus need to be studied within a unified framework. The distinctive methodological aspect of their approach is to integrate finance explicitly within their macroeconomic model. By including finance, they mean allowing for a role for risk and risk premia.

How Farhi and Gourio account for various phenomena ranges from less to more controversial. Chief among the less controversial results is the way they account for fact 1: the declining real interest rate. Here, they find that a combination of an increased propensity to save (a rising discounted factor) and increased demand for safe assets (due to increasing risk) does the job. These findings are consistent with the range of explanations in the literature (Bernanke 2005; Caballero, Farhi, and Gourinchas 2008; Del Negro and others 2017).

On the more controversial side is the way the authors account for facts 2 and 3: the rising capital income share, and the stable average return to capital. Within their baseline model, they allow for a tug of war between technology, market power, and risk. (In extensions of the baseline model, they consider other factors, such as intangible capital.) What makes the analysis somewhat controversial is the gold rush of recent literature that emphasizes rising market power and how this phenomenon can account for a variety of important phenomena, including the increasing capital share. The authors push back a bit on this euphoria by emphasizing the role of increasing risk premia. Their key message is that allowing for increasing risk premia dampens significantly (though does not eliminate) the measured increase in market power.

ACCOUNTING FOR TRENDS: THE IDENTIFICATION PROBLEM To understand the problem of disentangling the relative importance of technology, market power, and risk, it is first useful to examine the expression for the capital income share. Let W be the average wage, N total employment, R the rental rate to capital, K the capital stock, and Π monopoly profits. Then we can express the capital income share S^K as

$$S^K = 1 - \frac{WL}{Y} = \frac{RK + \Pi}{Y}. \tag{1}$$

The key point to note is that capital income is the sum of the rental income to capital RK and monopoly profits Π. Accordingly, one can categorize theories of the rising capital income share into whether they yield increasing rental income or increasing monopoly power. For example, the early literature emphasized capital-biased technological change, which involved a reallocation of rents from labor to capital. Intangible capital provides another way to account for rising rental income. Stories based on rising market power appeal to increasing markups to explain increasing profits.

The challenge in sorting out these different theories is that the division of total capital income between rents and profits is not directly observed, as Loukas Karabarbounis and Brent Neiman (2018) emphasize. A very nice paper by Simcha Barkai (2016) attempts to solve this problem directly by measuring capital rental income and then using this measure along with the total measure of capital income to impute profits. One of the problems is that the capital rental rate is not directly observed. Barkai effectively assumes that the rental rate equals the risk-free rate plus a fixed equity premium. As a result, the measured rental rate declines with the risk-free rate. The net effect is that the measured composition of capital income shifts in favor of monopoly profits. For this reason, he finds that a large increase in the markup is required to explain the increasing capital share.

Where the authors step in is to argue that the equity premium may have increased, implying that the rental income to capital may have not fallen nearly as much as Barkai suggests, and, conversely, that monopoly profits may not have increased as much. It is largely for this reason that the authors find a much smaller increase in markups.

THE FARHI–GOURIO FRAMEWORK The model the authors develop to analyze trends is elegantly simple. It is a variant of a standard neoclassical growth model, modified to include monopoly power and risk. The way they include market power is to allow for monopolistically competitive final goods producers. These producers use intermediate goods as an input to make a differentiated final product. Intermediate goods producers, in turn, make output Y using capital K and labor N, according to this Cobb-Douglas production function:

$$Y_t = Z_t K_t^{\alpha} (S_t N_t)^{1-\alpha} \tag{2}$$

and where Z_t and S_t reflect productivity disturbances. To include risk, the authors add a time-varying disaster probability. Finally, they restrict the shocks to the economy to ensure that the economy is always on a balanced growth path, absent any changes in parameters. Doing so makes the model appropriate for analyzing trends.

There are three key parameters of interest:

1. $\alpha \equiv$ output elasticity of capital
2. $\mu \equiv$ gross markup
3. $\chi \equiv$ equity premium

Each parameter reflects one of the factors driving the macroeconomic trends. The output elasticity of capital α, which comes from the production function, reflects technology. We refer to a rise in α as capital-biased technical change, given that the marginal product of capital rises, everything else being equal. The gross markup μ measures market power (and is a function of the elasticity of substitution between the differentiated final output goods). Finally, the equity premium χ captures risk. Note that the primitive model parameter is the disaster probability p. However, given χ, one can use the model equations to back out p.

Over a given sample, three moment conditions pin down the parameter vector (μ, α, χ). Let r^f denote the riskless rate, g trend growth, P the price of stocks, and D dividends. Then the three moments conditions are given by

1. Capital income share

$$S^K = \frac{\alpha}{\mu} + \frac{\mu - 1}{\mu} \tag{3}$$

2. Average return to capital

$$\frac{RK + \Pi}{K} = \left(1 + \frac{\mu - 1}{\alpha}\right)(\chi + r^f) \tag{4}$$

3. Gordon growth formula

$$\frac{P}{D} = \frac{1}{\chi + r^f - g}$$

$\rightarrow$

$$\frac{D}{P} + g = \chi + r^f \tag{5}$$

where r^f and g are given by data, as are the three target variables S^K, $\frac{RK + \Pi}{K}$, and $\frac{P}{D}$.[1]

It is useful to give the intuition underlying each of the moment conditions. The capital income share depends on two terms: The first is the rental income share, which is increasing in α. The second is monopoly profits, which is increasing in μ. The average return to capital is a multiple of the expected return to capital, which is the sum of the risk premium and the risk-free rate, $\chi + r^f$. In the absence of market power ($\mu = 1$), the average return simply equals the expected equity return. With market power, there is an extra term that reflects monopoly profits.

Observe that conditional on the trend equity premium χ, conditions 3 and 4 determine the technology and market power parameters, α and μ. To solve for χ, the authors use the familiar Gordon growth formula, which relates the price-dividend ratio along a balanced growth path to the inverse of the expected equity return net of the steady state growth rate of output.

1. For simplicity, I am abstracting from the effects of depreciation and investment-specific technical change, which do not appear to affect the results significantly.

From rearranging the Gordon formula, one can express the trend expected return to equity as the sum of the price-dividend ratio and the steady state growth rate.

IMPLEMENTATION AND RESULTS The authors first compute averages of the three target variables over each of the two subsamples: 1984–2000 versus 2001–16. They find that across subsamples:

1. S^K increases
2. $\frac{RK + \Pi}{K}$ increases slightly
3. $\frac{D}{P} + g$ decreases slightly

They next compute model parameters over each subsample. The key findings are that across subsamples:

1. The gross markup μ increases 700 basis points
2. Technology as measured by α is unchanged
3. The equity premium χ increases 200 basis points (from 300 to 500)

I have several observations about the findings: First, the estimate of the markup increase is well below that of similar studies using aggregate data. It is about half the number estimated by Gauti Eggertsson, Jacob Robbins, and Ella Getz Wold (2018), and a third of what Barkai (2016) finds. Second, it is interesting that technology is not a factor in the declining labor share, given the widespread view that there has been significant capital-biased technological change. (Perhaps this kind of technological change mainly affects the distribution of income between skilled and unskilled labor.) Finally, the estimate of the increase in the risk premium is not without controversy, given the absence of clear indicators of increased risk since the Great Recession. I return to this issue shortly.

What is the intuition for the authors' findings? First, because the Gordon measure of the expected return to equity, $\frac{D}{P} + g$, falls by much less than the risk-free rate, r^f, the equity premium χ increases as required by equation 5. Second, the increase in χ offsets much of the effect of decline in r^f on the expected return to equity. As a result, the increase in the markup μ required to account for the uptick in the average return to capital is smaller than would be the case otherwise, as equation 4 suggests. Finally, the resulting rise in μ is sufficient to account for the rise in the labor share without any change in α, as plugging the number into equation 3 will confirm.

We now get to perhaps the central message of the paper. If we were to ignore the increase in the risk premium, the model would predict a much larger increase in the markup. Intuitively, a much larger rise in μ would be required to account for the slight increase in the average return to capital (given the sharp decline in r^f). There is a significant corollary implication of failing to account for the rising risk premium: The overestimate of the markup leads to an underestimate of the technology parameter α. What this implies is that failing to account for the increasing risk premium leads to estimating a decline in α, suggesting that recent technical change has been labor biased, which clearly goes against conventional wisdom.

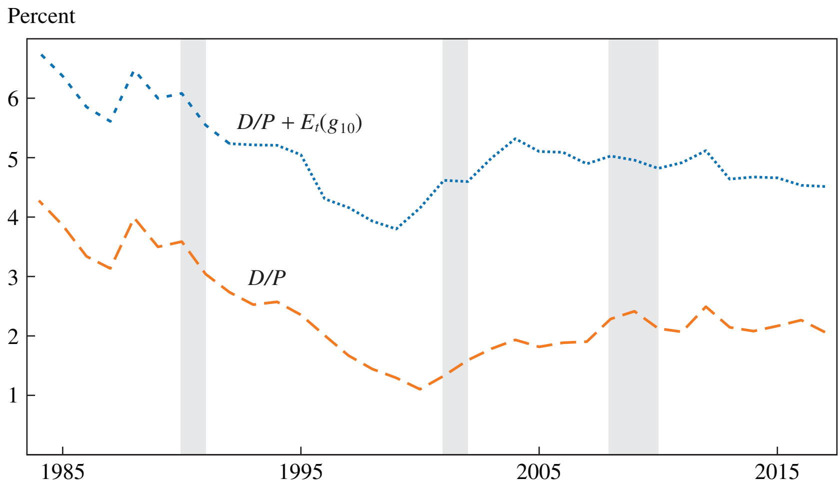
A FEW ISSUES WORTH FURTHER INVESTIGATION The paper's overall message is sensible and reasonably persuasive. It is likely that the cost of capital has not fallen nearly as much as the risk-free rate. Not taking this into account is likely to substantially overstate the increase in markup. Along these lines, it is important to take account of the role of risk in measuring the cost of capital.

Several issues, however, merit further investigation. The first involves the measure of the required expected return to capital. Over each subsample, the authors use the Gordon formula to compute the expected return to capital as the sum of the average dividend-price ratio and the average growth rate. By using subsample averages, the calculation masks a high degree of variability of the dividend-price ratio. In addition, the average growth rate may be a poor indicator of future growth expectations, especially toward the end of each subsample.

Accordingly, in my figure 1, I use annual data to compute a "real-time" Gordon measure of expected return to equity. For each year, I calculate the expected return to equity as the sum of the dividend-price ratio and the expected long-run average growth rate of output. To measure the latter I use the median 10-year average growth rate from the Survey of Professional Forecasters. As with the standard Gordon formula, two assumptions underlie the calculations: (1) the required return to equity at any time t is expected to be constant (think of it as evolving as a random walk); and (2), dividends are cointegrated with output, so expected output growth is also a measure of expected dividend growth. Think of this real-time Gordon measure as providing a benchmark estimate of the expected return to equity. To the extent that the two assumptions are violated, the expected return will differ from this benchmark.

The dashed line in my figure 1 is the dividend-price ratio, while the dotted line is the measure of the expected return given by the sum of the dividend-price ratio and the expected long-run growth rate. Because the survey data only go back to 1992, we use the 1992 forecast to measure expected output growth in the earlier years. Throughout the early

Figure 1. Real-Time "Gordon" Expected Return on Equity, 1985–2015[a]



Sources: Center for Research in Security Prices; Survey of Professional Forecasters; author's calculations.

a. The expected return on equity (the upper, dashed-and-dotted line) is defined as the dividend yield (the lower, long-dashed line) plus the expected long-term growth rate: $\frac{D}{P} + \frac{E_t(g_{10})D}{P} + E_t(g_{10})$. The dividend yield is computed by the Center for Research in Security Prices. The expected 10-year growth rate is from the Survey of Professional Forecasters, and is extrapolated backward from 1992 (the dashed section of the upper, dashed-and-dotted line).

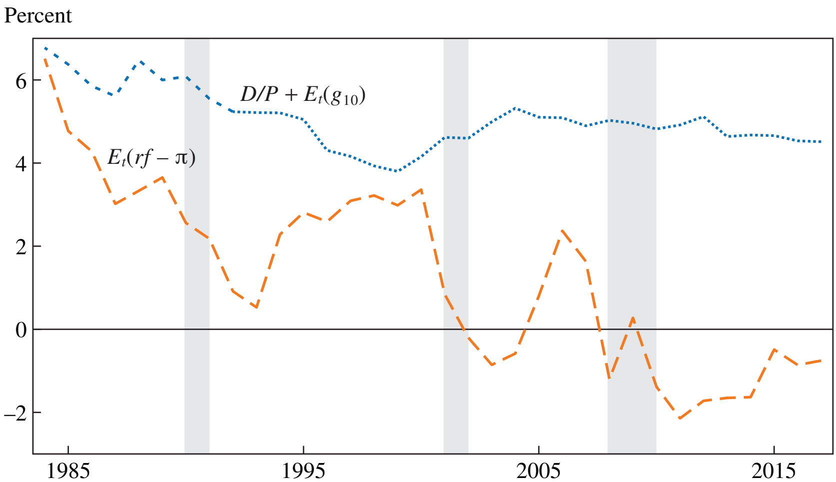
subsample, there is a downward trend in the required return to equity, which accelerates due to the stock market boom in the later 1990s (which reduces the dividend-price ratio). The stock market correction in the early 2000s reverses this downward trend. The net effect is that though the measured expected return in the second subsample is lower than in the first one, the difference is not dramatic, consistent with the authors' argument.

In particular, the decline in the measured expected return to equity is much less over the sample than is the drop in the expected 1-year Treasury yield, as my figure 2 shows. To the extent that we can take as an estimate of the equity premium the gap between the Gordon measure of the expected return to equity and the expected 1-year Treasury yield, then it is clear from the figure that the equity premium has widened nontrivially over the sample, as the authors suggest.

But two concerns arise. First, to calculate the equity premium using the Gordon approach, investors must expect the current 1-year yield to persist.[2]

2. Otherwise, for example, a high dividend-price ratio could reflect an expected increase in future interest rates as opposed to a high equity premium.

Figure 2. Real-Time "Gordon" Equity Premium, 1985–2015[a]



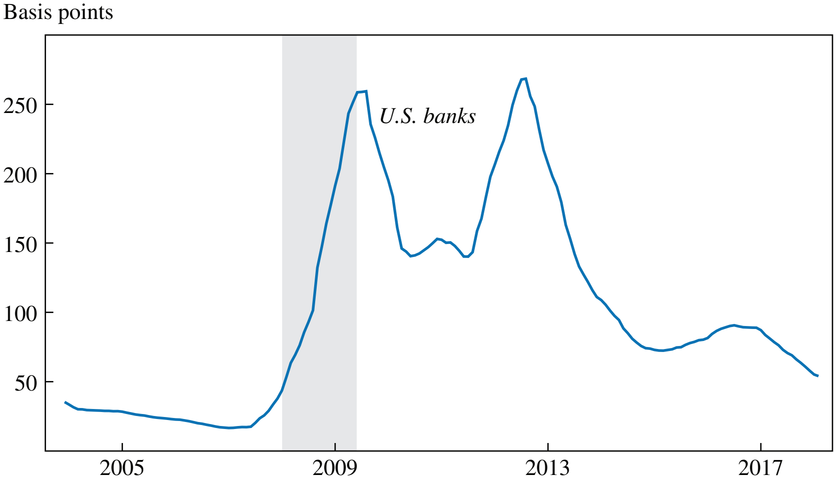
Sources: Adrian, Crump, and Moench (2013); Survey of Professional Forecasters; author's calculations.

a. The equity premium is the expected return on equity $\frac{D}{P} + E_t(g_{10})$ (dotted line) minus the expected real 1-year Treasury yield $E_t(rf - \pi)$ (dashed line). The expected equity return is computed by the Center for Research in Security Prices and the Survey of Professional Forecasters. The 1-year nominal Treasury yield is from Adrian, Crump, and Moench (2013). The expected 1-year Consumer Price Index inflation rate is from the Survey of Professional Forecasters.

Not only is there a downward trend in the real rate over the sample; there are also clear cyclical patterns: Relative to trend, the short-term real rate increases in expansions and decreases in recessions. An open question is how much investors perceive the low real rates after the Great Recession as reflecting a trend versus a cycle. As I discuss below, this matters for the calculation of the benchmark equity premium using the Gordon formula. The second issue involves identifying where the increase in risk in the system may be that could account for the increasing risk premium.

I address the two issues in reverse. First, where is the risk? The puzzle is that some traditional indicators of risk, such as the Chicago Board Options Exchange's Volatility Index market indicator, are down. I think the most natural source of greater risk is the perceived increase in risk to the banking system. Within the authors' model, the relevant risk is that of a disaster, which would lead to an exogenous decline in real activity. In practice, at the core of most economic disasters are banking crises. My figure 3, which is adapted from a paper by Darrell Duffie (2019), plots the average credit default swap (CDS) rate for banks from 2004 to 2018. The CDS rate

Figure 3. Where Is the Risk? Bank Credit Default Swaps, 2005–17[a]



Sources: Bloomberg; Duffie (2019).

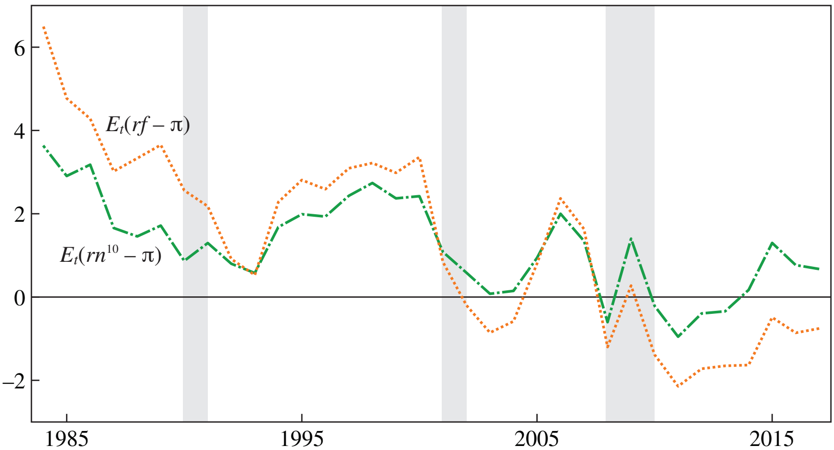
a. Average 5-year credit default swap rates (in basis points) of the five major U.S. dealer banks: Bank of America Merrill Lynch, Citigroup, Goldman Sachs, JPMorgan Chase, and Morgan Stanley.

increases from below 50 basis points before the Great Recession to a peak of 250 basis points at the recession's height. Importantly, the rate fluctuates between 150 and 250 basis points through 2013. It eventually declines a bit, but remains elevated relative to its pre–Great Recession value by a factor of roughly three (about 100 basis points, versus roughly 30 pre–Great Recession). Accordingly, the CDS data suggest that market perceptions of the probability of a banking crisis are elevated relative to the pre–Great Recession period. As Duffie notes, the experience of the recent crisis has led market participants to attach a higher probability to a future crisis than might otherwise have been the case. Also relevant are new restrictions on the extent to which the government can protect banks and bank creditors. The elevated perception of bank risk could account for the authors' observation that credit spreads are high after relative to before the Great Recession. It similarly could be a factor accounting for an increase in the equity risk premium.

Finally, given the real-time Gordon measure of the return to equity, I address the issue of which real rate to use to calculate the equity premium. Because the Gordon measure is effectively a trend measure of the return to equity at each point in time, the real rate with which to compare this return should similarly be a trend measure. A natural candidate for the latter is the

Figure 4. Short-Term Rates versus Risk-Neutral Long-Term Rates, 1985–2015[a]

Percent



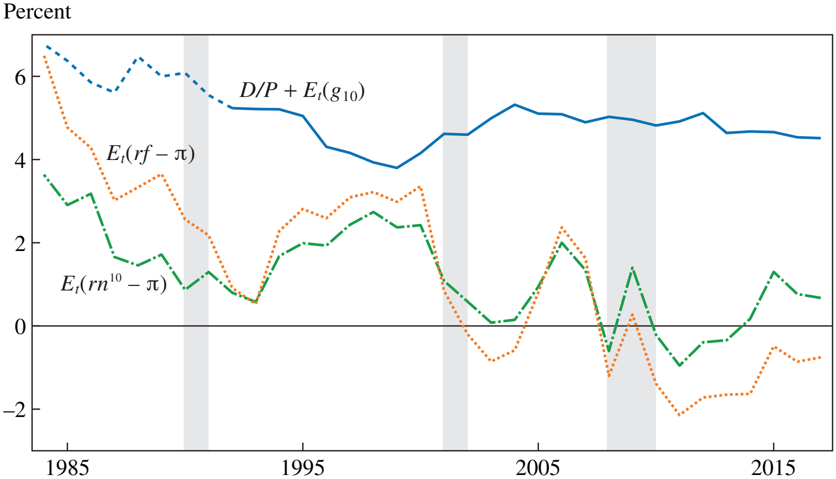
Sources: Adrian, Crump, and Moench (2013); Survey of Professional Forecasters; author's calculations.

a. The expected real 1-year Treasury yield $E_t(rf - \pi)$ (dotted line) is the nominal 1-year yield minus the expected 1-year Consumer Price Index inflation rate. The expected real risk-neutral longer-term Treasury yield $E_t(rn^{10} - \pi)$ (dashed-and-dotted line) is the nominal 10-year yield minus the term premium (per Adrian, Crump, and Moench) and the expected Consumer Price Index inflation rate. Yields are from Adrian, Crump, and Moench (2013). Inflation expectations are from the Survey of Professional Forecasters.

10-year government bond rate adjusted to eliminate the term premium. After eliminating the term premium, the 10-year bond rate reveals the market expectation of the average long-term real rate. Accordingly, the dashed-and-dotted line in my figure 4 plots the long-term real rate, measured as the nominal 10-year government bond rate adjusted to eliminate the term premium as measured by Michael Abrahams and others (2016), minus the 10-year forecast of inflation from the Survey of Professional Forecasters. Though the 10-year rate exhibits a secular decline similar to the 1-year rate (the dotted line), it is not as steep. In addition, not surprisingly, the cyclical deviations from trend are smaller than for the 1-year rate. An important consequence is that the long-run rate is below the short-run rate at the beginning of the sample, a period when monetary policy was still tight. Conversely, it is significantly above the short term rate at the end of the sample, a period of easy monetary policy.

As my figure 5 shows, if we use the 10-year real interest rate to compute the trend equity premium, we get a different perspective on the behavior of relative returns. The trend equity premium looks reasonably stable over

Figure 5. Equity Return versus Real Short- and Long-Term Yields, 1985–2015[a]



Sources: Adrian, Crump, and Moench (2013); Center for Research in Security Prices; Survey of Professional Forecasters; author's calculations.

a. The expected return on equity $\frac{D}{P} + E_t(g_{10})$ (solid line) is the dividend yield plus the expected long-term growth rate. The expected real 1-year Treasury yield $E_t(rf - \pi)$ (dotted line) is the nominal 1-year yield minus the expected 1-year Consumer Price Index inflation rate. The expected real risk-neutral longer-term Treasury yield $E_t(rn^{10} - \pi)$ (dashed-and-dotted line) is the nominal 10-year yield minus the ACM term premium and the expected Consumer Price Index inflation rate. The dividend yield is computed by the Center for Research in Security Prices. Treasury yields are from Adrian, Crump, and Moench (2013). Expectations are from the Survey of Professional Forecasters.

the sample, except for a decrease over the period of the stock market boom in the late 1990s that is reversed over the next few years. It is important to emphasize, however, that the authors' estimates of the markup and technology parameters remain valid, as does their argument that previous studies have likely overestimated the increase in markups. What matters for the estimation of these parameters is the estimate of the return on equity and not how this return is divided between the risk premium and the risk-free rate. My only point here is that if one is going to use the Gordon formula to back out an equity premium, it matters which real rate is used, and it may make more sense to use the 10-year rate adjusted for the term premium.

CONCLUDING REMARKS This paper makes a compelling case that in analyzing macroeconomic trends, it is important to think carefully about measuring the cost of capital. By doing so, further, one is likely to obtain much lower estimates of the rise in markups than the previous literature has suggested.

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COMMENT BY

DIMITRIS PAPANIKOLAOU This paper by Emmanuel Farhi and François Gourio illustrates how taking into account financial market data helps explain some recent stylized features of the data: the decline in the labor share of output; the decline in interest rates; the increase in the average product of capital in excess of the riskless rate; and the relatively low levels of corporate investment as a share of output. Previous explanations have relied on a combination of a rise in the importance of intangibles and/or an increase in firms' market power (Barkai 2017; De Loecker and Eeckhout 2017; Gutierrez and Philippon 2017). But in this paper, Farhi and Gourio show that stable equity valuation ratios and declining risk-free rates strongly suggest that the equity premium has increased in recent decades. A structural macroeconomic model attributes a considerable role to an increase in risk in accounting for these recent trends—and a much more modest role for an increase in market power. Interestingly, allowing for the presence of intangibles—here, mismeasured capital—weakens the case for rising markups, but not for rising risk premia. Given that the main contribution of the paper is to provide new evidence on the rising equity premium, my comment mostly focuses on this aspect of the paper.

Farhi and Gourio have written an important paper that illustrates how asset markets can be a useful source of information on macroeconomic models. Overall, I am highly sympathetic to the authors' goal, and I find their main argument broadly convincing. That said, there needs to be some scope for clarifying the limitations of their approach: the equity premium is essentially unobservable, and can only be inferred from the data based on additional assumptions. Hence, the authors' argument would be greatly strengthened if they were to empirically link the imputed equity premium with observable measures of risk. Absent this link, the imputed increase in the equity premium can only be rationalized as an increase in risk aversion—and because shifts in preference parameters are unobservable, they are ultimately unsatisfying as explanations of economic phenomena.[1]

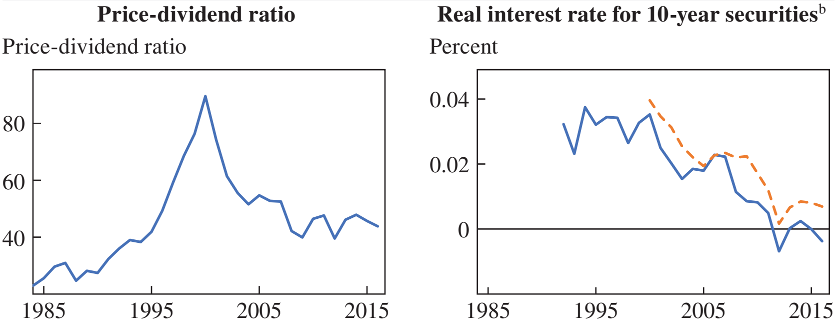
The novel part of the paper infers the equity premium from equity valuations. To understand the authors' identification strategy, consider the familiar Gordon growth formula. It can be rewritten as

$$\frac{D}{P} - r_f = E[R_m^e] - E[g]. \tag{1}$$

The Gordon growth formula links two observable quantities on the left side (the dividend-price ratio and the real risk-free rate) to two unobservable quantities on the right side: the expected excess return on equity $E[R_m^e]$ and the expected growth rate of dividends $E[g]$. The two panels of my figure 1 plot the dividend-price ratio and two measures of the real risk-free rate: the yield on a 10-year Treasury Inflation-Protected Security, and the difference between the 10-year yield of the Constant Maturity Rate series of the Federal Reserve Bank of Saint Louis and 10-year inflation expectations from the Survey of Professional Forecasters (SPF). Examining these two panels brings the main point of the paper into sharp focus: We see that, in terms of levels, stock valuation ratios are at the same level as in 2003,

1. That said, risk aversion in these models is often a metaphor that can be a stand-in for other types of frictions. Specifically, models with financial constraints often imply that economic agents exhibit risk-averse behavior, even if their underlying utility is linear (He and Krishnamurthy 2013). Thus, an alternative route would be to link the imputed equity premium with measures of the health of financial intermediaries.

Figure 1. Interest Rates and Valuation Ratios, 1985–2015[a]



Sources: Center for Research in Security Prices; Federal Reserve Bank of Saint Louis, Constant Maturity Rate series; Survey of Professional Forecasters.

a. The left panel plots the price-dividend ratio from the Center for Research in Security Prices. The right panel plots estimates of the real interest rate: the solid line plots the difference between the 10-year nominal rate (yield on Constant Maturity Rate series bonds) and the expected inflation over the next 10 years from the Survey of Professional Forecasters; the dashed line plots the yield of 10-year Treasury Inflation-Protected Securities.

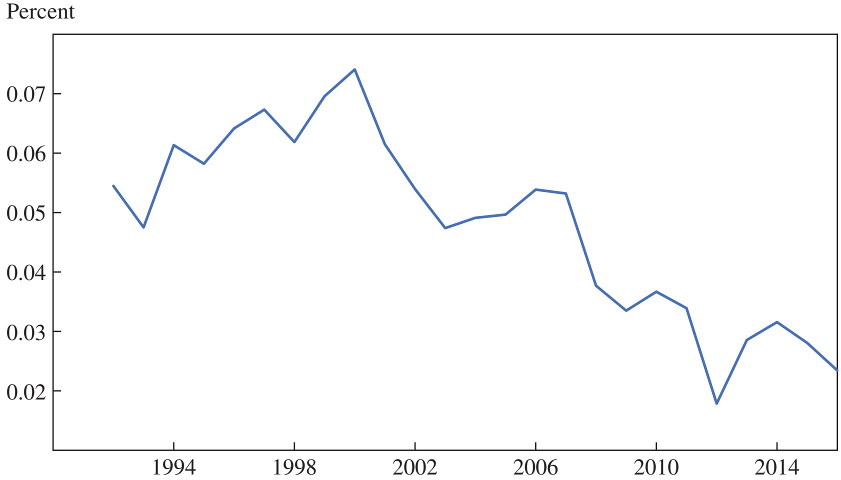
b. Constant Maturity Rate series, expected inflation on Treasury Inflation-Indexed Securities.

even though the real rate of interest declined from about 4 percent in 2003 to less than 1 percent in 2016.

These patterns are consistent with equation 1, as long as either expected dividend growth rates have declined or the equity risk premium has risen. The authors equate dividend to output growth, and assume that expected growth is equal to average realized growth in each period. Because average realized growth was about 30 basis points lower in 2001–16 than in 1984–2000, they conclude that the difference needs to be accounted for by an increase in the equity premium. But is it always reasonable to equate expectations with average realizations? If we were to estimate the expected return on equity based on the average realized return of stocks in excess of bonds in each period, we would have arrived at the opposite conclusion: During the 1984–2000 period, stocks outperformed bonds by 10.5 percent compared with 7.3 percent in 2001–17.[2] Now, there are some very good reasons why estimating the equity premium based on average realizations is fraught with pitfalls; not only are realized stock returns quite noisy, but they are also inversely related to changes in expectations for future returns. Nevertheless, perhaps we should not completely discard this information.

2. Estimates based on data from Kenneth French's website, http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/.

Figure 2. Imputed Dividend Growth Rate, Assuming Constant Equity Premium, 1990–2016[a]



Sources: Center for Research in Security Prices; Federal Reserve Bank of Saint Louis, Constant Maturity Rate series; Survey of Professional Forecasters; author's calculations.

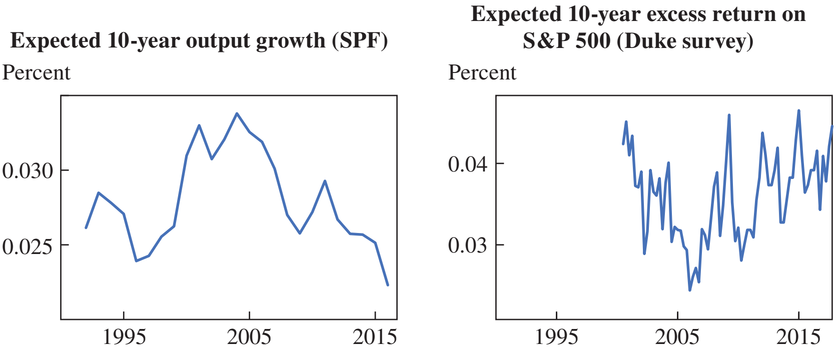
a. This figure plots the imputed expected growth rate of dividends E[g], given equation 1, the Center for Research in Security Prices' price-dividend ratio, and the real risk-free rate—measured as the difference between the 10-year nominal rate (the yield on Constant Maturity Rate bonds) and expected inflation over the next 10 years from the Survey of Professional Forecasters.

For the sake of argument, suppose that we were to assume a constant equity premium and back out the expected growth rate $E[g]$ from equation 1, together with the realizations of D/P and r_f.[3] I plot the resulting series in my figure 2. We see that the data would imply a secular decline in expected growth rates after 2000. Is the resulting expectations series reasonable? Without additional work, it is rather difficult to ascertain whether that is the case. One possibility would be to extend the estimation exercise to allow households' prior beliefs about future productivity to vary from average realizations. One could then infer the extent to which these differences in beliefs could account for additional features of the data—for instance, the decline in corporate investment.

Data on expectations of future economic growth and asset returns could shed some light on these issues. I use expectations of future output growth

3. One could object to this exercise on the grounds that the price-dividend ratio does not appear to forecast future dividend growth very well (Campbell and Shiller 1988). However, recent work by Van Binsbergen and Koijen (2010) shows that, using a different empirical methodology, dividend growth may be predictable.

Figure 3. Expectations of Future Growth and Excess Return on Equity, 1990–2015

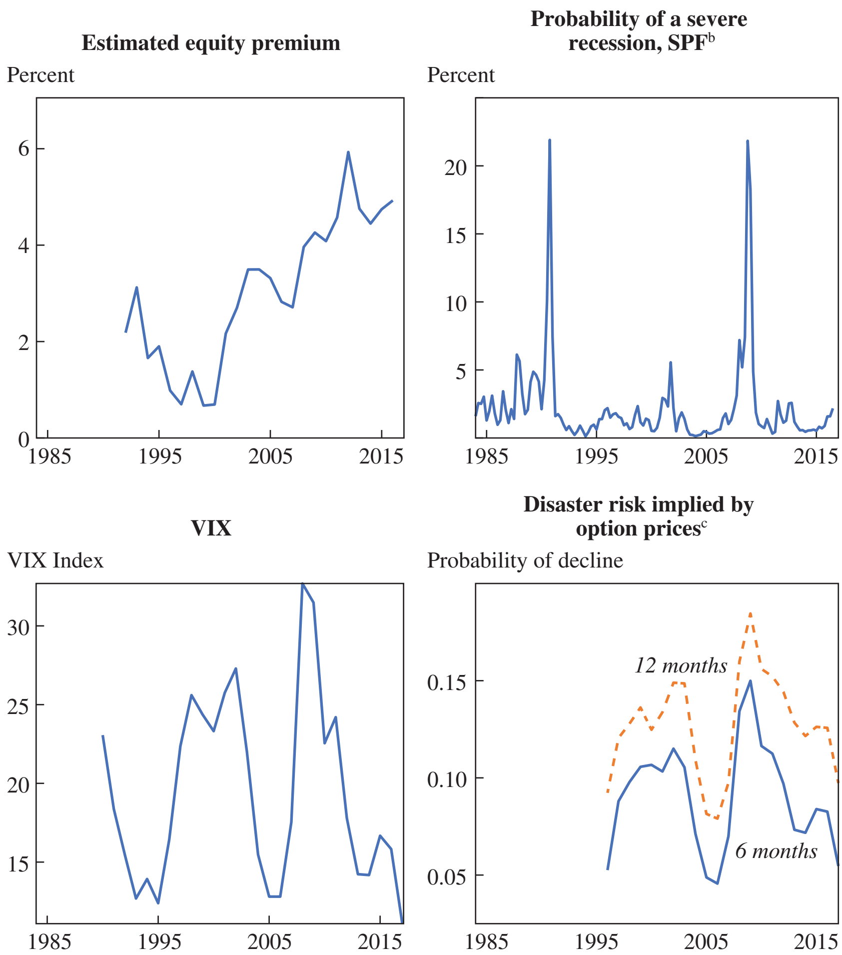


Sources: Survey of Professional Forecasters (SPF); Duke University Quarterly Survey of Chief Financial Officers; author's calculations.

over the next 10 years from the SPF. To measure expectations of future excess returns on equity, I use data from Duke University's quarterly survey of chief financial officers (CFOs) (Duke 2019). In the survey, CFOs are asked what they think the average excess return of the Standard & Poor's 500 will be over the next 10 years. Given that these CFOs are responsible for the capital budgeting decision of the largest firms in the economy, their beliefs about risk premia are likely consequential.

I plot these two series of expected growth and stock market returns, respectively, in the two panels of my figure 3. Examining the left panel, we see that survey expectations of future growth display a qualitatively similar pattern as the imputed growth rate in my figure 2, but the magnitudes are off by a considerable amount. Of course, we should keep in mind that the resulting series are not directly comparable—we are ignoring leverage, taxes, and all other distinctions between cash dividends and output. In the right panel, I plot the equity premium implied by the CFO survey data. The series starts in 2000, hence it is not possible to make comparisons with the pre-2000 period. But we can compare the resulting series with the rolling estimate of the equity premium in Farhi and Gourio's figure 6—or the top left panel of my figure 4. We see that the survey-based measure of the equity premium declines between 2000 and 2006, but then exhibits a secular increase in the 2007–16 period. Naturally, we can quibble on what exactly these surveys measure—hopes about future market performance versus required rates of return. But the point remains that inferring required rates of return from equity valuations is not straightforward.

Figure 4. Estimates of Disaster Risk, 1985–2015[a]



Sources: Survey of Professional Forecasters (SPF); Federal Reserve Bank of Saint Louis, Constant Maturity Rate series; Chicago Board Options Exchange's Volatility Index (VIX); Martin (2017); author's calculations.

a. This figure presents estimates of macroeconomic risk from several sources. The top left panel plots a point-in-time version of the equity premium based on SPF forecasts on inflation and growth over the next 10 years, and the nominal yield on 10-year Treasury bonds (using the Constant Maturity Rate series). The top right panel plots the forecasted probability (from the SPF) of a decline in output in at least three out of the next four quarters. The bottom left panel plots the VIX. And the bottom right panel plots the perceived likelihood of a 15 percent decline in the stock market, from the perspective of a log investor who is fully invested in the market portfolio, from Martin (2017); the solid line uses options of 6-month maturity, and the dashed line uses options of 12-month maturity.

b. GDP decline in three out of the next four quarters.

c. For maturities of 6 months and 12 months; see note a.

To strengthen the main point of Farhi and Gourio's paper, it would be useful to connect the imputed increase in the equity risk premium to observed measures of risk and uncertainty. In the paper, risk is modeled as a (small) possibility of a (large) disaster—that is, destruction of 15 percent of the capital stock. Hence, examining empirical measures of disaster risk is a useful place to start. Naturally, this is easier said than done. Part of the difficulty lies with the fact that rare disasters are, by definition, rare. In the postwar sample, there has been not a single event when the capital stock declined by 15 percent, but given the low estimated probabilities of disaster (3–6 percent), such lucky stretches are not implausible. It is therefore extremely difficult for an econometrician to estimate a time-varying likelihood of a rare disaster from data on real outcomes. However, we have access to additional sources of data: macroeconomic surveys and—consistent with the spirit of the paper—data from financial markets.

I consider three empirical measures of disaster risk. First, I use data from the SPF; I construct the average probability, across survey participants, of a severe recession, which I define as a decline in real output in at least 3 quarters over the next year. Second, I use the Chicago Board Options Exchange's Volatility Index (VIX); this variable, often referred to as "the fear index" in the popular press, is the implied volatility of the Standard & Poor's 500 stock market index that is consistent with traded options on the index. The VIX is an amalgam of the perceived risk in investing in the stock market and the degree of risk aversion of a representative investor. If one is willing to make additional assumptions, one can recover investors' beliefs about the risk of rare disasters from option prices. Ian Martin (2017) derives the perceived probability of a 15 percent drop in the underlying index over the next year, from the perspective of an investor who is 100 percent invested in the stock market and has log utility preferences. I use these implied probabilities, based on 6-month and 12-month equity options, as my third measure of disaster risk.

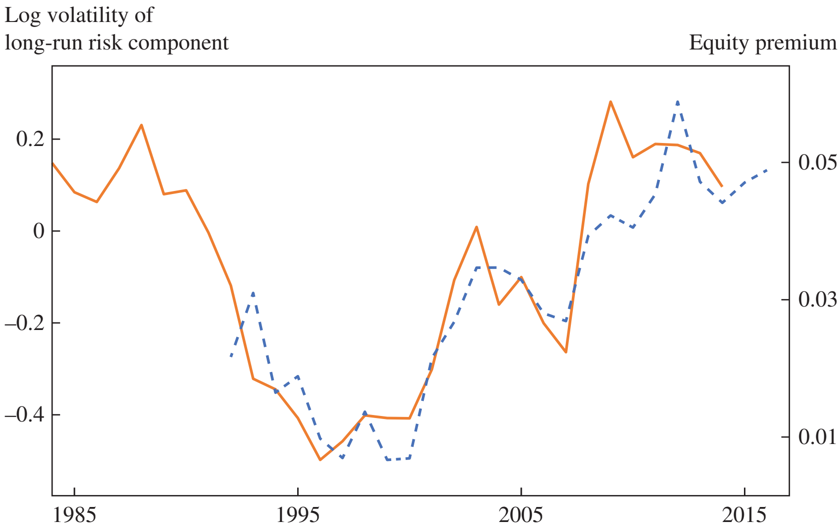
My figure 4 compares these three estimates of disaster risk to the estimates implied by the paper. Specifically, the top left panel of figure 4 plots a point-in-time version of the equity premium in the paper that uses equation 1 above, along with point-in-time estimates of the real risk-free rate and expected (output) growth using the yield on 10-year Treasury securities and forecasts of inflation and output from the SPF. We see a significant upward trend in the equity premium after 2000. In contrast, as we see in the top right panel of figure 4, survey estimates of disaster risk provide rather weak support for a low-frequency increase in perceived macroeconomic risk. Survey estimates of risk spike during recessions, but there are no differences in the average probability between the 1984–2000 and 2000–2015 subsamples. Using different definitions of a "severe recession" yields similar results.

Prices of financial options are reliably available only after the mid-1990s, so we cannot reliably compare the pre-2000 to the post-2000 period. However, we can examine whether they imply a secular increase in disaster risk relative to 2000. The bottom left panel of my figure 4 plots the time series of the VIX. The VIX spiked considerably in the late 1990s and during the Great Recession. Though the average level is somewhat higher during the 2001–15 period relative to 1990–2000, the difference is not statistically significant—probably because the VIX itself is quite volatile. The bottom right panel plots the option-implied estimates of disaster risk, using the methodology of Martin (2017). We see that the resulting series resembles the VIX, and again reveals no evidence of a secular increase in disaster risk after 2000.

In sum, we see that data from macroeconomic surveys and financial markets indicate a transitory increase in the likelihood of a rare disaster during the financial crisis. However, there is no evidence for a secular increase in disaster probabilities after 2000. Here, however, it is helpful to step a bit outside the exact structure of the model; rare disasters are a convenient device to model risk that delivers a realistic equity premium, but they are not the only possibility. A credible alternative is that macroeconomic risk takes the form of uncertainty about long-term economic growth—that is, "long-run risk," as described by Ravi Bansal and Amir Yaron (2004).

Is it possible that perceived uncertainty about long-run growth rates has increased over the last few decades? Perhaps it has; but unfortunately, obtaining direct evidence for small but persistent sources of fluctuations in output is as challenging as obtaining evidence for the changing likelihood of rare disasters. One possibility is to estimate such risk using a structural model—in a way that is similar to what is done by Farhi and Gourio in this paper. Along these lines, Frank Schorfheide, Dongho Song, and Amir Yaron (2018) estimate a structural model in which consumption and dividends are modeled in reduced form. Importantly, there is uncertainty about the long-run mean of consumption growth, and the level of uncertainty varies over time in a persistent fashion. Schorfheide, Song, and Yaron (2018) estimate this time-varying volatility using a particle filter (a nonlinear version of the Kalman filter) that uses asset returns, and the growth rates of consumption and dividends. In sum, Schorfheide, Song, and Yaron (2018) and Farhi and Gourio both rely on asset return data, but their methodologies are quite different.

Figure 5. Estimates of Long-Run Risk versus the Equity Premium, 1985–2015[a]



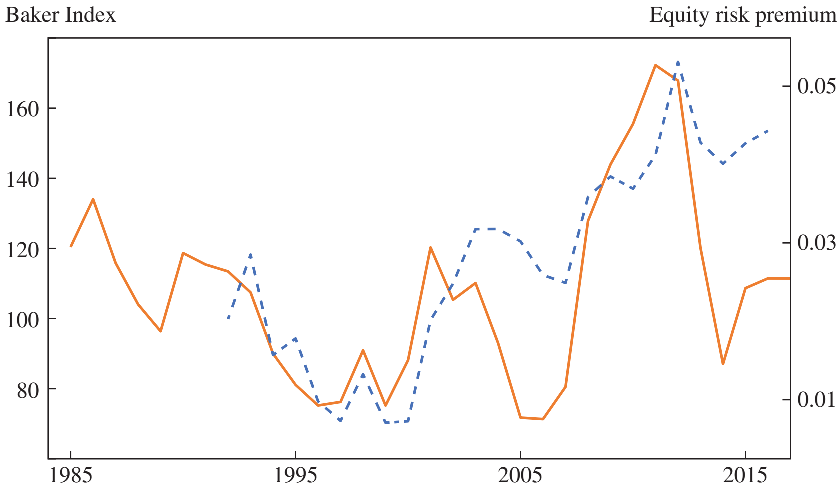
Sources: Schorfheide, Song, and Yaron (2018); Federal Reserve Bank of Saint Louis, Constant Maturity Rate series; Survey of Professional Forecasters (SPF); author's calculations.

a. The solid line in this figure plots the filtered volatility of the long-run risk component from Schorfheide, Song, and Yaron (2018). The dashed line plots a point-in-time estimate of the equity risk premium constructed using SPF forecasts on inflation and growth over the next 10 years, and the nominal yield on 10-year Treasury bonds (using the Constant Maturity Rate series).

In my figure 5, I compare Schorfheide, Song, and Yaron's (2018) estimate of long-run uncertainty (the solid line) with the imputed point-in-time estimate of the equity premium implied by the Gordon growth formula. Interestingly, even though the two papers use different data and methodologies, they display similar behavior. That is, both methodologies imply a secular increase in macroeconomic risk after 2000. Though this correlation is comforting, it still does not fully settle the matter—what aspects of the data identify an increase in uncertainty here is not fully transparent.

However, once we move beyond the notion that disaster risk is the primary determinant of risk premia, we can expand the sources of data that can be used to directly measure risk. Fiscal and monetary policy likely have a measurable impact on economic quantities. Yet another possibility is that perceptions of political risk have shifted since 2000. To explore this idea further, I use the political uncertainty index of Scott Baker, Nicholas Bloom, and Steven Davis (2016). Specifically, Baker and colleagues construct an estimate of the degree of uncertainty about economic policy,

Figure 6. Economic Policy Uncertainty, 1985–2015[a]



Sources: Baker, Bloom, and Davis (2016); Federal Reserve Bank of Saint Louis, Constant Maturity Rate series; Survey of Professional Forecasters (SPF); author's calculations.

a. The solid line in this figure plots the Economic Policy Uncertainty Index of Baker, Bloom, and Davis (2016). The dashed line plots a point-in-time estimate of the equity risk premium constructed using SPF forecasts for inflation and growth over the next 10 years, and the nominal yield on 10-year Treasury bonds (using the Constant Maturity Rate series).

based on an analysis of news articles. Their index captures uncertainty not only about which policies will be implemented but also on their economic impact—about half the articles discuss uncertainty about the economic effect of past, current, or future policy actions.

I plot Baker and colleagues' index in my figure 6. We see an increase in the average level of economic policy uncertainty in the 2001–15 period relative to 1984–2000. Some of this increase can be attributed to the financial crisis and uncertainty about the short- and long-run outcomes of the economic policies that were undertaken to remedy its effects. But their index is also high in the few years after 2000, partly due to the September, 11, 2001, terrorist attacks; the collapse of the tech "bubble"; and the second Gulf War—all of which could have plausibly increased the level of uncertainty about future economic growth. Interestingly, the policy uncertainty series exhibits behavior that is similar to the implied equity risk premium.

In brief, I think the main point of Farhi and Gourio's paper is most likely correct. Financial market data seem to indicate an increase in risk premia after 2000. In any reasonable macroeconomic model, an increase in risk will lead to lower investment in risky projects; a higher capital share; lower interest rates; and a higher average return on capital. I find these forces equally plausible explanations as an increase in market power. My only reservation is that it is not immediately obvious how exactly the economy became riskier after 2000. Perhaps increased political uncertainty—and polarization—played a role. To lend further credibility to the argument that risk premia played an important role for recent trends, I think more work on measurement is needed.

More broadly, I believe that the economic interpretation of these accounting decompositions has been underexplored. In the context of a model, these decompositions quantify the extent to which certain shifts in the data can be accounted for by changes in parameters. But the interpretations of these parameter shifts are not obvious, and the same economic forces may account for all these changes. For instance, brand value is a form of intangible capital that gives firms some measure of market power. Thus, a rise in market power could be driven by an increased importance of intangibles (Crouzet and Eberly 2018a, 2018b). Similarly, one could argue that intangible capital is more fragile than physical capital; it is perhaps easier to argue that 15 percent of the value of a brand is lost than, say, a 15 percent destruction of machines. As the composition of the economy shifts between tangibles and intangibles, so will risk in the economy change endogenously. Understanding the fundamental causes driving these changes is worthwhile.

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GENERAL DISCUSSION James Stock began by noting that it would be useful to get a better sense of what the authors' macroeconomic risk variable reflects, because its historical time series behavior does not necessarily square with what are conventionally thought of as risky periods.

Robert Hall commented that he has found evidence for growth in average market power in some of his own recent research. But there is a low correlation between growth in market power and growth in concentration. He explained that the two phenomena can coexist in terms of oligopoly theory.[1] His research finds there has been a considerable rise in both rents and Tobin's *Q*—a finding that can be reconciled with little growth in market power if intangible assets have become more important to firms. He recommended a Jackson Hole paper by Janice Eberly and Nicolas Crouzet that corroborates the importance of intangibles, and cited research by James

1. Robert Hall, "New Evidence on the Markup of Prices over Marginal Costs and the Role of Mega-Firms in the U.S. Economy," NBER Working Paper 24574 (Cambridge, Mass.: National Bureau of Economic Research, 2018).

Traina that provides a strong critique of the evidence that market power has grown significantly since the 1980s.[2]

Hall said he was surprised that none of the presenters discussed the Campbell-Shiller method of measuring the equity premium, and that the hypothesis that there has been a persistent increase in the equity premium would not be supported by what he regards as the mainstream finance literature.[3]

Steven Davis remarked that the paper's dividend-price ratio, a key input into its analysis, mirrors the time series history of influxes of newly listed firms in the 1980s and 1990s, and that this may present a challenge for their calculation of the ratio. Research by Eugene Fama and Kenneth French shows that the flow of newly listed firms in the United States represented a large share of public firms in the 1980s and 1990s.[4] Later research by Davis and his colleagues calculated that firms first listed in the 1980s and 1990s accounted for more than 40 percent of all employment at publicly listed firms as of 2000.[5] Thus, Davis concluded, there may be a significant role for selection in the evolution of the paper's measured dividend-price ratio, because firms that were first listed in the 1980s and 1990s were likely to have high prices and low dividends. Moreover, this trend reversed after the dot-com bubble burst in the early 2000s. He suggested that the authors recalculate the dividend-price ratio using microeconomic data to construct an index of changes in the ratio based on firms that are listed in consecutive years.

Olivier Blanchard noted that the authors ought to be careful in distinguishing between markups and rents, given that monopolistic competition

2. James Traina, "Is Aggregate Market Power Increasing? Production Trends Using Financial Statements," Stigler Center New Working Paper 17, 2018; Nicolas Crouzet and Janice Eberly, "Understanding Weak Capital Investment: The Role of Market Concentration and Intangibles," technical report for Jackson Hole Symposium, Federal Reserve Bank of Kansas City (https://www.kansascityfed.org/~/media/files/publicat/sympos/2018/papersandhandouts/824180816crouzeteberlyhandout.pdf?la=en).

3. John Campbell and Robert Shiller, "The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors," *Review of Financial Studies* 1, no. 3 (1988): 195–228.

4. Eugene Fama and Kenneth French, "New Lists: Fundamentals and Survival Rates," *Journal of Financial Economics* 73, no. 2 (2004): 229–69.

5. Steven Davis, John Haltiwanger, Ron Jarmin, and Javier Miranda, "Volatility and Dispersion in Business Growth Rates: Publicly Traded versus Privately Held Firms," in *NBER Macroeconomics Annual 2006*, edited by Kenneth Rogoff and Daron Acemoglu (Cambridge, Mass.: National Bureau of Economic Research, 2016).

with free entry leads to markups, which cover fixed costs of entry, but not to rents. As a result, some markets could have seen large increases in markups but small increases in rents.

Blanchard observed that Tobin's *Q* has increased substantially for nonfinancial firms in the United States, and that this could either be the result of measurement methods or increasing rents. In contrast to Robert Hall's view, he argued that mismeasurement of capital due to an increase in intangibles investment would need to be implausibly large to explain the increase in Tobin's *Q*, and thus that increasing rents must make up a large portion of the increase.

Eric Swanson noted that an increase in the savings supply is a key explanatory factor in the authors' analysis, but that this increase in savings is modeled as coming from a change in the domestic discount factor rather than as a capital inflow from abroad. Thus, the authors are studying a "domestic savings glut" rather than a "global savings glut," and the effects of the latter in an open economy can be different in important ways (such as the effect on domestic consumption growth). Swanson also observed that many of the trends the authors describe were present in Europe over the same period, and he suggested that the authors fit their model using European data as a second set of observations to check the robustness of their findings.

Jason Furman remarked that much of the literature on changes in the capital share assume it is a description of technology and nothing more. He noted the importance, thus, of the authors finding a significant role for markups in explaining changes in the capital share. He suggested that the authors consider exploiting variation in concentration across industries to test whether their findings about markups hold across industries.

Janice Eberly responded to the comments by Hall, Blanchard, and Furman, noting that her research with Nicolas Crouzet found not only a role for intangibles and investment but also that they appear to be co-related to both markups and productivity growth. She explained that intangibles should be treated as having different properties from physical capital, and that their properties may vary across industries. In the health industry, for example, intangibles appear to be closely related to markups but not to productivity; in contrast they appear to be correlated with productivity growth in the retail sector.

John Haltiwanger observed that measures of risk in fixed-income markets were declining both before and after the financial crisis, and he asked the authors to comment on why returns in debt markets could have been so low while they were rising in equity markets.

Mark Gertler responded that Baa- and A-rated bond yields have remained elevated since the financial crisis relative to their levels before the crisis. Haltiwanger responded again, noting that high-yield bonds in particular have low yields relative to precrisis levels, and that these provide a closer measure of fixed-income risk.

François Gourio began by thanking the commenters and participants for their observations. He noted that many commented on what has driven macroeconomic risk perception to increase alongside the equity premium. He pointed out that the paper tries to provide some evidence on this question by looking at other measures of risk, such as realized volatility and credit spreads. Another possible set of explanations focuses on changes in risk preferences. For example, he described how aging populations may have higher risk aversion and a larger demand for safe assets. Also, some countries appear to have larger preferences for safe assets, and these may be driving estimates of risk premia.

Responding to comments about estimating the equity premium, Gourio noted that Campbell proposes a method that differs from the Campbell-Shiller approximation. In section VII of their paper, Farhi and Gourio provide an alternative estimate of risk premia according to this method, and they find that it appears to increase after 2000, consistent with their own estimates.[6] He acknowledged that estimating the premium involves some uncertainty, and he suggested that further research could explore the differences between estimation methods.

Gourio acknowledged that modeling one closed economy (that of the United States) is a potential limitation of the paper. However, he argued that one could conceivably treat the model as applying to the global economy, given that many trends observed in the United States are consistent with those observed globally.

Gourio agreed with comments that many of the parameters in the model are reduced-form, to some extent, and that they may be driven by another factor not included in the model, or they may be jointly driven by one common underlying factor. However, the contribution of the paper is to recover these reduced-form parameters, and to decompose their relative importance within the model. Deeper analyses that try to explain what drives these changes in parameters are of course warranted, but they will need to be consistent with the authors' reduced-form findings.

6. John Campbell, "Estimating the Equity Premium," *Canadian Journal of Economics* 41, no. 1 (2008): 1–21.

Regarding Tobin's *Q*, Gourio said that it is important to note that, though it is equal to 1 regardless of the risk premium if there are no rents, it is actually quite sensitive to the risk premium (and to other parameters) if there are rents, because the risk premium affects the discounting of future rents. As a result, he said, the model is consistent with an increase in Tobin's *Q*.

Gourio concluded by agreeing with comments about distinguishing markups from rents, considering cross-industry evidence, and taking into account firm selection when estimating the dividend-price ratio.