

# Rents, Technical Change, and Risk Premia

## Accounting for Secular Trends in Interest Rates, Returns on Capital, Earning Yields, and Factor Shares

By RICARDO J. CABALLERO, EMMANUEL FARHI, AND PIERRE-OLIVIER GOURINCHAS\*

The secular decline in safe interest rates since the early 1980s has been the subject of considerable attention. In this short paper, we argue that it is important to consider the evolution of safe real rates in conjunction with three other first-order macroeconomic stylized facts: the relative constancy of the real return to productive capital, the decline in the labor share, and the decline and subsequent stabilization of the earnings yield. Through the lens of a simple accounting framework, these four facts offer suggestive insights into the economic forces that might be at work.

### I. Four Facts and a Framework

- **Fact 1: Decline in safe real interest rates.**

Figure 1(a) reports the real return on U.S. Treasury securities between 1980 and 2006. Over this period, real safe interest rates declined by about 6%.

- **Fact 2: Stable or slightly increasing real return on productive capital.**

Gomme, Ravikumar and Rupert (2011) constructs estimates of the aftertax real return to productive capital exclusive of capital gains, defined as aftertax capital income (observed in the NIPA) divided by an estimate of the stock of capital. Their updated estimates, reported in

Figure 1(b), show that the real return to business capital has remained quite stable around 7%, except for the large fluctuations in 2008-2010 at the time of the global financial crisis, and has increased slightly since then.

Together, Figures 1(a) and 1(b) illustrate the growing divergence between the return on productive capital and the return on safe assets.

- **Fact 3: Decline in the labor share.**

A substantial body of evidence indicates that the labor share, measured as the ratio of labor compensation to nominal value added, has declined since the early 2000s in the U.S. and other economies. Figure 1(c) reports the estimates of the corporate and total labor shares by Karabarbounis and Neiman (2014). According to their estimates, the U.S. labor share is stable until the early 2000s and then goes through a decline of between 3% (total labor share) and 6% (U.S. corporate labor share).

It is important to also bear in mind the secular decline in the relative price of investment goods since the early 1980s, as documented by Karabarbounis and Neiman (2014): the Penn World Table indicates that the relative price of U.S. investment goods has declined by 42% between 1980 and 2012.

We now introduce a simple accounting framework based on a small number of key economic concepts: the safe real interest rate  $r^s$ , the real rental rate of capital  $r^K$ , the depreciation rate  $\delta$ , the relative price of investment goods  $\zeta$  and its expected growth rate  $g_\zeta^e$ , the average goods markup  $\mu \geq 1$ , the real average product of capital  $APK$  (net of depreciation and excluding capital gains), the real marginal product of capital  $MPK$ , the labor share  $s_N$ , and the expected risk premium in capital  $KRP$ . When necessary, we use the superscript  $e$  to denote expected values.

Investor indifference between physical capital and risk-free bonds requires  $r^{K,e} = \zeta(r^s + \delta + KRP - (1 - \delta)g_\zeta^e)$  where the last term captures

\* Caballero: MIT Department of Economics, 77 Massachusetts Avenue, Building E52-528, Cambridge, MA 02139. Phone: (617) 253-0489. Email: [caball@mit.edu](mailto:caball@mit.edu). Farhi: Department of Economics, Harvard University, Littauer 318, 1805 Cambridge Street, Cambridge, MA 02138, USA. Phone: (617) 496-1835. Email: [efarhi@fas.harvard.edu](mailto:efarhi@fas.harvard.edu). Gourinchas: UC Berkeley Dept. of Economics, 697D Evans Hall, #3880, Berkeley CA 94720. Phone: (510) 643-3783. Email: [pog@berkeley.edu](mailto:pog@berkeley.edu). This paper was prepared for the 2017 AEA meetings. For useful comments, we thank Daron Acemoglu, Markus Brunnermeier, John Campbell, Gabriel Chodorow-Reich, Paul Gomme, Arvind Krishnamurthy, Matteo Maggiori, Thomas Philippon, Jeremy Stein, and our discussant Guido Lorenzoni.

the expected capital loss when the price of investment goods declines over time. Profit maximization requires  $r^K = MPK/\mu$ . The average product of capital adds up rental income and profits, net of depreciation, relative to the capital stock:  $APK = (r^K + Y/K(1 - 1/\mu))/\zeta - \delta$ . Taking expectations and substituting  $r^{K,e}$ , we obtain an expression for the expected average return to productive capital  $APK^e$ :

$$(1) \quad APK^e = r^s + KRP + \frac{Y}{\zeta K} \left(1 - \frac{1}{\mu}\right) - (1 - \delta)g_\zeta^e.$$

Since the average return of productive capital  $APK$  has remained stable (Fact #2) while the safe interest rate  $r^s$  has decreased (Fact #1), a wedge has grown between the two series. According to equation (1), this wedge must be accounted for by an increase in risk premia  $KRP$ , an increase in rents  $\mu$ , or a more rapid expected decline in the price of investment goods  $g_\zeta^e$ . While the relative price of investment goods  $\zeta$  can be directly observed, risk premia  $KRP$  and rents  $\mu$  cannot and instead must be inferred.<sup>1</sup>

Assume further that the aggregate production function exhibits a constant elasticity of substitution between capital and labor, so that  $Y = \left[\alpha_k (A_K K)^{\frac{\sigma-1}{\sigma}} + (1 - \alpha_K) (A_N N)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$ . In this expression  $\sigma$  denotes the elasticity of substitution between capital and labor. The terms  $A_K$ ,  $A_N$ ,  $\alpha_K$  capture different forms of technical change:  $A_K$  and  $A_N$  represent capital-augmenting and labor-augmenting technical change used in many models;  $\alpha_K$  captures the process of automation introduced in some recent task-based models.

The labor share can then be expressed as  $s_N = (1 - \alpha_K^\sigma (\mu r^K / A_K)^{1-\sigma}) / \mu$ . After some manipulations this can be solved as:

$$(2) \quad \frac{A_K}{\mu} \mathbb{E} \left[ \left( \frac{1 - \mu s_N}{\alpha_K^\sigma} \right)^{\frac{1}{1-\sigma}} \right] = r^{K,e} \\ = \zeta (r^s + \delta + KRP - (1 - \delta)g_\zeta^e).$$

When  $\sigma = 1$ ,  $s_N = (1 - \alpha_K) / \mu$ , and the decline in the labor share (Fact #3) must be accounted

<sup>1</sup>It is also possible that part of the wedge be explained by a growing under-estimation of the capital stock, perhaps because of the rise of mis-measured intangible capital, or by an increase in depreciation associated with IPP capital.

for by an increase in rents  $\mu$  or an increase in automation  $\alpha_K$ . When  $\sigma > 1$ , a decline in the relative price of investment goods  $\zeta$ , a decline in the risk-free rate  $r^s$  (Fact #1), or capital-biased technical change  $A_K$  also contribute to the decline in the labor share, while an increase in the capital risk premium  $KRP$  pushes in the other direction. These effects are reversed when  $\sigma < 1$ . These different factors have been emphasized as potential driving forces for the decline in the labor share in an emerging literature but their relative importance remains debated.<sup>2</sup>

Eqs. (1) and (2) form a system of two equations in four unobserved variables: the capital risk premium  $KRP$ , the goods markup  $\mu$ , the capital-augmenting productivity term  $A_K$ , and the automation term  $\alpha_K$ . We propose to solve the system under two polar hypotheses: (a) with no role for capital-biased technical change or automation ( $A_K = 1$  and  $\alpha_K$  constant), and with a maximal role for rents  $\mu$ ; (b) or alternatively with no role for rents ( $\mu = 1$ ), and a maximal role for and capital-biased technical change  $A_K$  and automation  $\alpha_K$ .

Inspecting the system, we see that when  $\sigma = 1$  there is no role for capital-augmenting technological progress  $A_K$ . Conversely, when  $\sigma \neq 1$ , capital-biased technical change  $A_K$  cannot be separately identified from automation  $\alpha_K$ . Hence we report two solutions, under two differ-

<sup>2</sup>Some authors have emphasized capital-biased technical change and automation (see e.g. Acemoglu and Restrepo (2016)). Others have pushed the idea that an increase in concentration is the main driving force, either because of an associated increase in rents of the form that we have modeled here (see e.g. Autor, Dorn, Katz, Patterson and Van Reenen (2017)) or because the increase in concentration happens to have increased the relative size of capital-intensive firms, a compositional effect perhaps more akin to an increase in automation in our framework. Barkai (2017) estimates the part of the capital share accounted for by the profit share and finds a larger increase in the latter than in the former, suggesting a large increase in rents; however his conclusion is partly driven by an estimate of the user cost of capital which builds on the assumption that expected return on capital decreases over time with the risk-free rate. Yet others have argued that the decrease in the relative price of investment goods is the main culprit (see e.g. Karabarbounis and Neiman (2014)) but this line of explanation relies on an elasticity of substitution between capital and labor (around 1.25) higher than most estimates in the literature. Finally, some authors (e.g. Koh, Santaullia-Llopis and Zheng (2016)) argue that the treatment of intangible capital, such as IPP capital, shows up as a form of capital-biased technical change, which can rationalize the decline in the labor share with a high elasticity of substitution (around 1.1).

ent hypotheses: hypothesis (b1) loads entirely on capital-biased technical change  $A_K$ ; hypothesis (b2) loads entirely on automation  $\alpha_K$ . Both solutions lead to the same value of the capital risk premium  $KRP = APK^e - r^s + (1 - \delta)g_\zeta^e$ , regardless of the value of  $\sigma$ .

Facts #1, #2, and #3 document the evolutions over time of safe real interest rates  $r^s$ , the average return to productive capital  $APK^e$ , and the labor share  $s_N$ . We also directly measure the evolutions of the relative price of investment goods  $\zeta$  and its expected growth rate  $g_\zeta^e$ , assumed equal to the observed average growth rate of  $\zeta$ . With an annual depreciation rate  $\delta = 0.073$  consistent with Gomme et al. (2011), this pins down the output-capital ratio  $Y/\zeta K = (APK^e + \delta)/(1 - s_N)$ . We further set the baseline value of  $\alpha_K$  so as to match the observed labor share in 1980 assuming no capital-biased technical change ( $A_K = 1$ ), no rents ( $\mu = 1$ ) and a level of the capital risk premium equal to its historical average ( $KRP = 4\%$ ).

Table 1 reports the resulting estimates of rents  $\mu$ , capital-augmenting technical change  $A_K$ , automation  $\alpha_K$ , and capital risk premium  $KRP$ , under assumptions (a), (b1) and (b2) for three sub-periods: 1980 to 1999, 2000 to 2007 and 2008 to 2015 and  $\sigma \in \{1.1, 1, 0.9\}$ .<sup>3</sup> For each period, we equate the expected average return to capital  $APK^e$  with the corresponding empirical average.

We start with the case  $\sigma = 1$  under hypothesis (a). We find a substantial increase in gross markups  $\mu$ : from 1.025 before 2000 to 1.108 after 2008. We also find a sizable increase in the capital risk premium  $KRP$ : from 2.37% to 7.16%. Under hypothesis (b), there is no increase in markups and instead there is an increase in automation  $\alpha_K$ . The associated increase in the capital risk premium  $KRP$  is larger: from 3.29% to 10.71%.

When  $\sigma = 1.1$ , under hypothesis (a), the increase in rents  $\mu$  is smaller, and the increase in the capital risk premium  $KRP$  is correspondingly higher. Under hypothesis (b), the increase in the capital risk premium  $KRP$  is identical, but now capital-biased technical change can also rationalize the behavior of the labor share.

Finally, when  $\sigma = 0.9$ , under hypothesis (a),

<sup>3</sup>For the latter period, we exclude the acute period of the global financial crisis, from 2008Q3 to 2009Q3.

the increase in rents  $\mu$  is larger, and the increase in the capital risk premium  $KRP$  is correspondingly lower, starting at 2.27%, while hypothesis (b) requires either a larger increase in automation or capital-biased technical regress.

The estimate of  $KRP$  reported in Table 1 represents the risk premium on un-levered equity. To go from the capital risk premium to the equity risk premium, we need an estimate of the debt to equity ratio, which we denote  $\kappa$ . Assuming that the corporate structure remains constant over time, the (levered) expected equity risk premium  $ERP$  is related to the un-levered risk premium  $KRP$  as follows:  $ERP = (1 + \kappa)KRP$ . For instance, with a debt-equity ratio around 0.5 and  $\sigma = 1$ , the levered equity risk premium would be 3.5% prior to 2000, and between 4.1 and 10.7% afterwards.<sup>4</sup>

Our simple macro decomposition delivers a robust conclusion: regardless of the underlying assumptions (a), (b1) or (b2), the estimates suggest a substantial increase in capital and equity risk premia since 2000 and especially since 2008.

These macro-based results are broadly in line with more sophisticated finance-based estimates. Figure 1(d) from Duarte and Rosa (2015) reports the first principal component estimated across twenty models of the  $ERP$ , using different methods ranging from time-series VAR models that seek to estimate expected dividend growth in the spirit of the simple Gordon dividend growth model, to cross-sectional models that seek to estimate the market price of risk. The levered expected equity risk premium is 6.67% between 1980 and 1999, 6.53% between 2000 and 2007 and 10.07% post 2007. Of course, appropriate standard errors should be placed around these point estimates.<sup>5</sup>

While these estimates are based on more sophisticated econometric methods, a simple back-of-the-envelope calculation based on the earnings yield on the S&P500 is also useful.

• **Fact 4: Decreasing then stabilizing earnings yield.**

Figure 1(e) displays the behavior of the S&P500

<sup>4</sup>Estimates of the debt to assets or debt to capital ratios have been relatively stable between 40 and 50% since 1990. See Graham, Leary and Roberts (2014).

<sup>5</sup>Other studies report broadly similar results. See for example Daly (2016). Campbell (2008) documents similar evolutions but of a smaller magnitude.

TABLE 1—RISK PREMIUM VS. RENTS VS. TECHNICAL CHANGE

|                | Variable                 | Period    |           |           |
|----------------|--------------------------|-----------|-----------|-----------|
|                |                          | 1980-1999 | 2000-2007 | 2008-2015 |
| Data           | $APK^e$ (percent)        | 6.64      | 7.58      | 7.86      |
|                | $s_N$                    | 0.631     | 0.615     | 0.584     |
|                | $r^s$ (percent)          | 3.11      | 0.29      | -2.85     |
|                | $\zeta$                  | 0.86      | 0.70      | 0.68      |
|                | $g_\zeta^e$ (percent)    | -1.76     | -0.13     | -2.15     |
|                | $Y/(\zeta K)$            | 0.37      | 0.39      | 0.36      |
|                | $EY$ (percent)           | 6.89      | 4.33      | 5.34      |
|                | $g^e$ (percent)          | 2.52      | 3.21      | 2.56      |
| $\sigma = 1.1$ | (a) $\mu$                | 1.020     | 1.024     | 1.085     |
|                | $KRP$ (percent)          | 2.77      | 3.78      | 8.08      |
|                | (b1) $A_K$               | 1.311     | 1.564     | 3.716     |
|                | (b2) $\alpha_K$          | 0.331     | 0.337     | 0.364     |
| $\sigma = 1$   | (a) $\mu$                | 1.025     | 1.052     | 1.108     |
|                | $KRP$ (percent)          | 2.37      | 2.77      | 7.16      |
|                | (b2) $\alpha_K$          | 0.369     | 0.385     | 0.416     |
| $\sigma = 0.9$ | (a) $\mu$                | 1.024     | 1.076     | 1.108     |
|                | $KRP$ (percent)          | 2.27      | 1.92      | 7.06      |
|                | (b1) $A_K$               | 0.553     | 0.285     | 0.140     |
|                | (b2) $\alpha_K$          | 0.420     | 0.452     | 0.489     |
|                | (b) $KRP$ (percent)      | 3.29      | 4.68      | 10.71     |
|                | ( $EY$ ) $KRP$ (percent) | 2.09      | 3.23      | 4.84      |

Note: The table reports estimates of  $\mu$ ,  $A_K$ ,  $\alpha_K$  and  $KRP$  that satisfy Eqs. (1) and (2) or Eq. (3). Other parameters are:  $\delta = 0.073$ ,  $b = 0.2$  and  $\kappa = 0.5$ .

earnings yield,  $EY$ . Abstracting from the large swings in  $EY$  around the time of the global financial crisis, we observe two distinct phases: a significant decline in  $EY$  between the early 1980s and the early 2000s, from 14% to 2%, followed by a modest rebound and a stabilization around 5%.

Under the classic Gordon model, we can convert  $EY$  into a rough measure of the  $ERP$ . If we assume that a constant share  $b$  of earnings is re-invested in the firm, while the rest is distributed as dividend, then we can express  $EY$  as

$$(3) \quad EY = \frac{r^s + ERP - g^e}{1 - b}.$$

where  $g^e$  denotes the expected rate of growth of future earnings.<sup>6</sup> We can use this equation to provide a rough estimate of the  $ERP$ , which we can then convert into  $KRP = ERP/(1 + \kappa)$ .

The last row of Table 1, labeled ( $EY$ ), reports our rough estimate of the capital risk premium  $KRP$  based on the earnings yield, using the 10-year U.S. treasury yield for the risk-

free rate. According to these estimates, there is an increase in the capital risk premium  $KRP$  over the period: from 2.09% to 4.84%. This is broadly in line with our macro estimates.

## II. Taking Stock

Our simple accounting framework shows how to apportion the growing wedge between safe real rates and the real return to productive capital (Facts #1 and #2) to economic rents, capital-biased technical progress or automation and increase in risk premia, while matching the secular decline in the labor share (Fact #3) and the behavior of earnings yields (Fact #4). A robust conclusion that seems to emerge is that there has been a secular increase in capital and equity risk premia. We conclude with an important caveat and an interpretation.

We start with the caveat: some risk premia exhibit different patterns from those that we have inferred. Figure 1(f) reports the credit spread between corporate bonds of various ratings and U.S. Treasury bonds of the corresponding maturity. These spreads have remained strikingly stable over time except during the financial crisis. The different behaviors of these different risk premia could arise either because different factors are priced in these different

<sup>6</sup>Empirically, we equate  $g^e$  with the median 10-year output growth forecast from the Livingstone Survey, available after June 1990, and assume a plowback coefficient  $b = 0.2$ .

markets, or because these markets are significantly segmented with more pervasive “reach for yield” within the fixed income space which compresses the associated risk premia.<sup>7</sup> Understanding this apparent divergence is important for future research.

Finally, we offer a narrative centered on the secular evolutions of safe and risky expected rates of return as depicted in Figure 1(d). Very broadly, we identify three phases:

- 1) 1980-2000: the expected rate of return on equities declines in tandem with safe real rates, the former falling more than the latter.
- 2) 2000-2008: the expected rate of return on equities is more or less stable (with some ups and downs), but risk-free rates keep falling. The *ERP* is increasing.
- 3) 2008-now: the expected rate of return on equities is more or less stable (with some ups and downs), and the risk-free rate declines to the Zero Lower Bound. The *ERP* is increasing.

In phase (1), the decline in interest rates is driven by general supply and demand factors affecting all assets (safe and risky). In phases (2) and (3), the decline in risk-free rate is driven in large part by specific supply and demand factors affecting *safe assets*. The stable expected return on equities in phases (2) and (3) is consistent with the stable return on productive capital over that period.

Phase (2) corresponds to the intensification of the “global savings glut,” with China coming on-line, and the rise in international reserve accumulation across emerging markets in the aftermath of the Asian financial crisis. It seems that a substantial share of the desired demand for assets was for *safe assets*, explaining the divergence between safe and risky returns.

The safe asset shortage intensifies in phase (3) through a combination of factors: increased global risk aversion after the financial crisis; regulatory changes for banks and insurance companies at a global level; and declines in the supply

of safe assets (sovereign debt crisis, collapse in private supply). The economy hits the ZLB and poses challenges to macro stabilization.<sup>8</sup>

We develop these points in our papers. Caballero, Farhi and Gourinchas (2008) focused on general asset market factors behind the decline in interest rates in phase (1). Caballero and Farhi (2015), Caballero, Farhi and Gourinchas (2015) and Caballero, Farhi and Gourinchas (2016) analyze both general asset market factors and factors specific to safe asset markets to account for phases (2) and (3).

These developments must have been accompanied either by increases in rents, by capital-biased technical change, or by automation. Disentangling the relative importance of the different mechanisms behind the increase in rents, technical change, and risk premia, using a combination of macro data and financial data (as in this paper) as well as micro data defines an important research agenda.

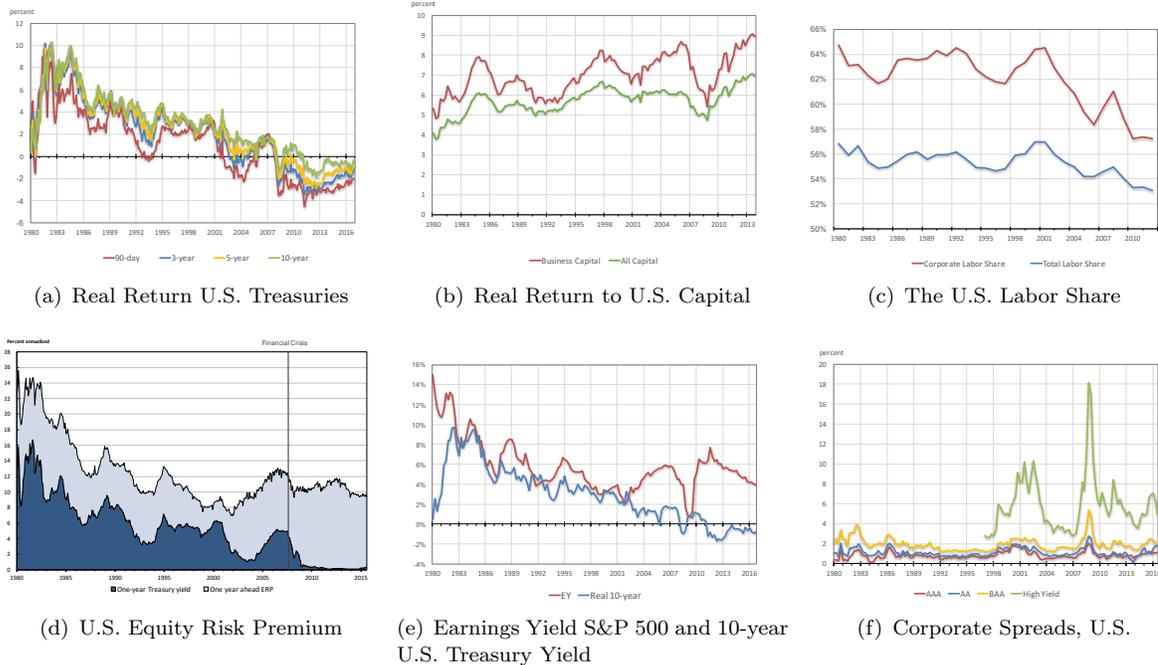
## REFERENCES

- Acemoglu, Daron and Pascual Restrepo**, “The race between man and machine,” NBER Working Papers 22252 May 2016.
- Autor, David, David Dorn, Lawrence Katz, Christina Patterson, and John Van Reenen**, “Concentrating on the Fall of the Labor Share,” Working Paper 2017.
- Barkai, Simcha**, “Declining Labor and Capital Shares,” University of Chicago Working Paper 2017.
- Caballero, Ricardo J. and Emmanuel Farhi**, “The Safety Trap,” NBER Working Papers 19927 February 2015.
- , -, and Pierre-Olivier Gourinchas**, “An Equilibrium Model of “Global Imbalances” and Low Interest Rates,” *American Economic Review*, March 2008, 98 (1), 358–93.
- , -, and -**, “Global Imbalances and Currency Wars at the ZLB,” NBER Working Papers 21670 October 2015.

<sup>7</sup>Lopez-Salido, Stein and Zakrajsek (2017) offers evidence of segmentation between credit markets and stock markets by showing that empirical predictors of returns in one market have essentially no predictive power for the other.

<sup>8</sup>A separate but crucial point is that independently of the view one takes of the evolution of the *ERP* over time, the *ERP* is *endogenous* to policies and is a key determinant of their effectiveness at the ZLB.

FIGURE 1. MACRO AND FINANCE FACTS



Panel (a): ex-ante real yields on U.S. Treasury Securities constructed using median expected price changes from the University of Michigan's Survey of Consumers. Source: FRED. Panel (b): real after-tax returns to business capital and all capital, computed by Gomme et al. (2011). The real after-tax return to business capital is constructed as total after-tax business capital income, net of depreciation divided by the previous period's value of business capital. Business capital includes nonresidential fixed capital (structures, equipment, and intellectual property) and inventories. All capital includes business capital and residential capital. Panel (c): from Karabarbounis and Neiman (2014). Corporate labor share: compensation of employees in the corporate sector divided by corporate gross value added; Total labor share: compensation of employees divided by GDP. Panel (d): one-year Treasury yield from Federal Reserve H.15; ERP from Duarte and Rosa (2015). Panel (e): Inverse of the S&P500 Price Earnings ratio, computed using index price divided by 12-months trailing reporting earnings, from GFD and 10-year real Treasury from (a). Panel (f): Moody's corporate AAA, AA, BAA yields and BofA Merrill Lynch US high yield option-adjusted spread minus 30-year constant maturity US government bond yield. Source: GFD, FRED.

., ., and ., "Safe Asset Scarcity and Aggregate Demand," *American Economic Review*, May 2016, 106 (5), 513–18.

**Campbell, John**, "Estimating the Equity Premium," *Canadian Journal of Economics*, February 2008, 41 (1), 1–21.

**Daly, Kevin**, "A Secular Increase in the Equity Risk Premium," *International Finance*, 2016.

**Duarte, Fernando M. and Carlo Rosa**, "The equity risk premium: a review of models," Staff Reports 714, New York Fed 2015.

**Gomme, Paul, B. Ravikumar, and Peter Rupert**, "The Return to Capital and the Business Cycle," *Review of Economic Dynamics*, April 2011, 14 (2), 262–278.

**Graham, John, Mark Leary, and Michael**

**Roberts**, "A Century of Capital Structure: The Leveraging of Corporate America," NBER Working Papers 19910 2014.

**Karabarbounis, Loukas and Brent Neiman**, "The Global Decline of the Labor Share," *The Quarterly Journal of Economics*, 2014, 129 (1), 61–103.

**Koh, Dongya, Raul Santaullia-Llopis, and Yu Zheng**, "Labor Share Decline and Intellectual Property Products Capital," Working Papers 927, BGSE September 2016.

**Lopez-Salido, J. David, Jeremy C. Stein, and Egon Zakrajsek**, "Credit-Market Sentiment and the Business Cycle," *forthcoming in the Quarterly Journal of Economics*, 2017.