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investment: theory and evidence of
heterogeneous effects across firms**

Denis Fougère, Rémy Lecat and Simon Ray

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Real estate prices and corporate investment: theory and evidence of heterogeneous effects across firms

Abstract

In this paper, we investigate the effect of real estate prices on productive investment. We build a simple theoretical framework of firms' investment with credit rationing and real estate collateral. We show that real estate prices affect firms' borrowing capacities through two channels. An increase in real estate prices raises the value of the firms' pledgeable assets and mitigates the agency problem characterizing the creditor-entrepreneur relationship. It simultaneously cuts the expected profit due to the increase in the cost of inputs. While the literature only focuses on the first channel, the identification of the second channel allows for heterogeneous effects of real estate prices on investment across firms. We test our theoretical predictions using a large French database. We do find heterogeneous effects of real estate prices on productive investment depending on the position of the firms in the sectoral distributions of real estate holdings. Our preferred estimates indicate that a 10% increase in real estate prices causes a 1% decrease in the investment rate of firms in the first decile of the distribution but a 6% increase in the investment rate of firms belonging to the last decile.

JEL Classification: D22, G30, O52, R30

Keywords: Firms' investment, Real estate prices, Collateral channel, Financial constraints

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Rents, Technical Change, and Risk Premia

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

Ricardo J. Caballero, Emmanuel Farhi, and Pierre-Olivier Gourinchas*

March 21, 2017

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 insights into the economic forces that might be at work.

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1 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 2016. 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 business and total capital exclusive of capital gains, defined as aftertax capital income (observed in the NIPA) divided by an estimate of the stock of capital. We adjust their estimates of the capital stock for intangible intellectual property products (IPP) introduced in the national accounts by the BEA after 2013. Figure 1(b) shows that the real return to business capital has remained quite stable around 6.5%, 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 labor share by Koh, Santaeuillia-Llopis and Zheng (2016) with and without adjustment for intangibles. The U.S. aggregate labor share is stable until the early 2000s and then goes through a decline of 4%.

It is important to also bear in mind that as documented by Karabarbounis and Neiman (2014) based on the the Penn World Table, 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 δ , the relative price of investment goods ζ and its expected growth rate g_ζ^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 and otherwise use the symbol \mathbb{E} .

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 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 $r^{K,e}$ yields

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

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 μ , or a more rapid expected decline in the price of investment goods g_ζ^e . While the relative price of investment goods ζ can be directly observed, risk premia KRP and rents μ cannot and instead must be inferred.¹

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 σ denotes the elasticity of substitution between capital and labor. The terms A_K , A_N , α_K capture different forms of technical change: A_K and A_N represent capital-augmenting and labor-augmenting technical change used in many models; α_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

¹It is also possible that part of the wedge be explained by a growing under-estimation of the capital stock. The share of IPP capital in total capital increased from 4% to 7% between 1980 and 2000. However, we are using estimates of the return to capital adjusted for IPP intangible capital.

manipulations this transformed into

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

When $\sigma = 1$, $s_N = (1 - \alpha_K)/\mu$, and the decline in the labor share (Fact #3) must be accounted for by an increase in rents μ or an increase in automation α_K . When $\sigma > 1$, a decline in the relative price of investment goods ζ , 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.²

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

Inspecting the system, we see that when $\sigma = 1$ there is no role for capital-augmenting

²Some 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)) by adopting a different focus and relying on the cross-country variation in changes in the labor share. Even under their estimate of an elasticity of substitution between capital and labor of 1.25, which is higher than most estimates in the literature, we find that this is not sufficient to account for the increase in the wedge between risk free returns and the average return to capital. Finally, some authors (e.g. Koh et al. (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). Our estimates, like Koh et al. (2016), incorporate IPP adjustments.

technological progress A_K . Conversely, when $\sigma \neq 1$, capital-biased technical change A_K cannot be separately identified from automation α_K . Hence we report two solutions, under two different hypotheses: hypothesis (b1) loads entirely on capital-biased technical change A_K ; hypothesis (b2) loads entirely on automation α_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 σ .

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 directly measure ζ using the price of investment divided by the price of consumption from the Penn World Tables (Mark 7.1). We set the expected growth rate $g_\zeta^e = -1.38\%$ to the observed growth rate of ζ over the sample. With an annual depreciation rate $\delta = 0.073$ consistent with Gomme et al. (2011), this pins down the output-capital ratio $Y/\zeta K = (APK^e + \delta)/(1 - s_N)$.³ We further set the baseline value of α_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 μ , capital-augmenting technical change A_K , automation α_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 $\sigma \in \{1.25, 1, 0.8\}$.⁴ 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 μ : from 1.017 before 2000 to 1.064 after 2008. We also find a sizable increase in the capital risk premium KRP : from 1.28% to 6.63%. Under hypothesis (b), there is no increase in markups and instead there is an increase in automation α_K . The associated increase in the capital risk premium KRP is larger: from 1.94% to 8.93%.

When $\sigma = 1.25$, the estimated value of Karabarbounis and Neiman (2014), under hy-

³The rate of depreciation of IPP is higher than that of traditional capital. Koh et al. (2016) report a depreciation rate above 15% for IPP and 4% for traditional capital. Our depreciation rate is intermediate.

⁴For the latter period, we exclude the acute period of the global financial crisis, from 2008Q3 to 2009Q3.

Table 1: Risk Premium vs. Rents vs. Technical Change

		Variable	Period		
			1980-1999	2000-2007	2008-2015
Data		APK^e (percent)	6.33	7.13	7.35
		s_N	0.645	0.642	0.617
		r^s (percent)	3.11	0.29	-2.85
		ζ	0.86	0.70	0.68
		$Y/(\zeta K)$	0.38	0.40	0.38
		EY (percent)	6.89	4.33	5.34
		g^e (percent)	2.52	3.21	2.56
$\sigma = 1.25$	(a)	μ	0.999	0.986	1.016
		KRP (percent)	1.98	6.14	8.34
	(b1)	A_K	0.990	0.881	1.136
	(b2)	α_K	0.284	0.277	0.292
$\sigma = 1$	(a)	μ	1.017	1.023	1.064
		KRP (percent)	1.28	4.65	6.63
	(b2)	α_K	0.355	0.358	0.383
$\sigma = 0.8$	(a)	μ	1.040	1.067	1.119
		KRP (percent)	0.47	3.03	4.85
	(b1)	A_K	0.741	0.603	0.429
	(b2)	α_K	0.468	0.493	0.537
	(b)	KRP (percent)	1.94	5.56	8.93
	(EY)	KRP (percent)	2.08	3.24	4.87

Note: The table reports estimates of μ , A_K , α_K and KRP that satisfy Eqs. (1) and (2) or Eq. (3). Other parameters are: $\delta = 0.073$, $g_\zeta^e = -1.38\%$, $b = 0.2$ and $\kappa = 0.5$.

pothesis (a), rents μ barely change and the increase in the capital risk premium KRP is correspondingly higher, from 1.98% to 8.34%. Under hypothesis (b), the increase in the capital risk premium KRP is independent of σ , but now capital-biased technical change A_K can also rationalize the behavior of the labor share.

Finally, when $\sigma = 0.8$, under hypothesis (a), the increase in rents μ is much larger, from 1.040 to 1.119, and the increase in the capital risk premium KRP is correspondingly lower, from 0.47% to 4.85%, while hypothesis (b) requires either a larger increase in automation or capital-biased technical regress (to be interpreted as labor-biased technical progress).

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 κ . 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, $\sigma = 1$, and under hypothesis (a), the levered equity risk premium would be 1.92% prior to 2000, and between 6.98% and 9.95% afterwards.⁵

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.⁶

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 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

⁵Estimates 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).

⁶Other studies report broadly similar results. See for example Daly (2016). Campbell (2008) documents similar evolutions but of a smaller magnitude.

distributed as dividend, then we have

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

where g^e denotes the expected rate of growth of future earnings.⁷ 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 2.08% to 4.87%. This is broadly in line with our macro estimates.

2 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 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.⁸

⁷Empirically, 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 $b = 0.2$.

⁸Lopez-Salido, Stein and Zakrajsek (2017) offers evidence of segmentation between credit markets and

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 stock markets by showing that empirical predictors of returns in one market have essentially no predictive power for the other.

stabilization.⁹

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.

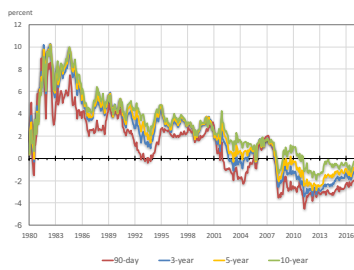
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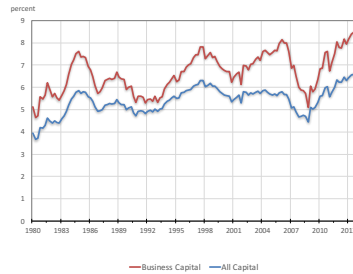
⁹A separate but crucial point is that independently of the view one takes of the evolution of the *ERP* over time, the *ERP* is *endogenous* to policies and is a key determinant of their effectiveness at the ZLB.

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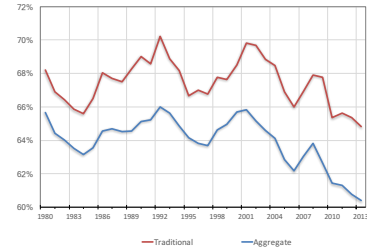
Figure 1: Macro and Finance Facts



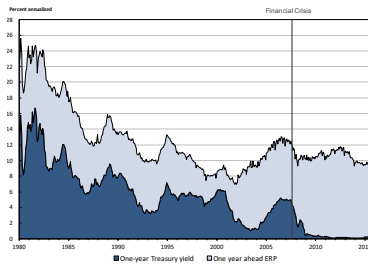
(a) Real Return U.S. Treasuries



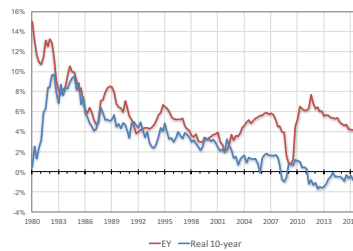
(b) Real Return to U.S. Capital



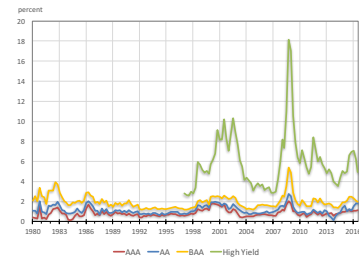
(c) The U.S. Labor Share



(d) U.S. Equity Risk Premium



(e) Earnings Yield S&P 500 and 10-year U.S. Treasury Yield



(f) Corporate Spreads, U.S.

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) and adjusted for the share of intangibles in total capital from Koh et al. (2016). The real after-tax return to capital is constructed as total after-tax capital income, net of depreciation divided by the previous period’s value of 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 Koh et al. (2016). The “Traditional” labor share includes only capital income from traditional capital. The “Aggregate” labor share includes intangibles using post-2013 BEA revision data. 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.