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[This draft includes the Online Appendix]

Abstract

This paper empirically and theoretically investigates the relation between labor rigidity and the value premium. Aggregate labor rigidity shifts dividend risk towards the short horizon and enhances the pricing of short-run risk. In turn, shorter duration equity deserves a premium over longer duration equity, that is the value premium obtains. Consistently, labor-share variation strongly explains the contemporaneous and intertemporal excess return of value firms over growth firms. A closed-form general equilibrium model reproduces the term-structure effect of labor rigidity and naturally gives rise to the value premium and its dynamics. The model is robust to many features of financial markets.

Keywords: value premium, labor rigidity, term-structure, predictability, duration
JEL Classification: D51, E21, G12

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1 Introduction

The value premium, since Graham and Dodd (1934), is usually defined as the excess return of firms with high price relative to fundamentals (value) over firms with low price relative to fundamentals (growth). Actual data suggests that the value premium is positive and sizeable. This stylized fact is puzzling because, as shown by Fama and French (1992) among others, standard asset pricing models (e.g. CAPM) cannot account for the value premium. Moreover, there is still no conclusive consensus in the literature about the macroeconomic foundation of the value premium and its time-series dynamics, which is the core of the present paper.

The main contribution of the paper is twofold. First, I propose a simple general equilibrium model where labor rigidity shifts dividend risk towards the short horizon and, hence, naturally gives rise to the value premium. Second, I provide empirical support to the main model mechanism: on the one hand, labor rigidity explains the timing of dividend risk and, on the other hand, variation in the labor-share strongly forecasts the dynamics of the value premium, consistently with the model. The rationale beyond the model mechanism is the following. Labor rigidity –due to either bargaining negotiations or infrequent wage resettling or search and other frictions– leads to an explicit or implicit income insurance from shareholders to workers which takes places within the firm.[1] Thus, the labor-share has counter-cyclical dynamics and, in turn, firm profits and shareholders' remuneration become more pro-cyclical and volatile. Beyond such a *cyclicality effect* of labor rigidity, also a *term-structure effect* obtains (Marfè, 2013b). The stationarity of the labor-share implies that the income insurance mechanism only concerns the transitory component of the firm's output (Lettau and Ludvigson, 2005, 2014). Consequently, workers' and shareholders' remunerations load respectively less and more than output on transitory risk. This has implications for the *timing* of wage and dividend risk. The former is upward-sloping and the latter is downward-sloping. In equilibrium, value firms, whose cash-flows weigh more on the short-run, are riskier than growth firms, whose cash-flows weigh more on the long-run. Consequently, the model generates an equilibrium value premium with dynamics driven by variation in the aggregate labor-share. The idea that markets do compensate short-run (i.e. business cycle) risk is consistent with the empirical findings of Koijen, Lusting, and van Nieuwerburgh (2014).

An empirical investigation supports the main model mechanism. On the one hand, I provide evidence of both the *cyclicality* and *term-structure effects* of labor rigidity in the post-war US non-financial corporate sector. The bulk of the gap between the slightly upward-sloping term-

[1] The idea that distributional risk is at the heart of labor relations and, also, that the very role of the firm is that of insurance provider have a long tradition since Knight (1921) as well as Baily (1974), Azariadis (1978), Boldrin and Horvath (1995), Gomme and Greenwood (1995) and Danthine and Donaldson (2002). They suggest that workers' remuneration is partially fixed in advance and, hence, shareholders bear most of aggregate risk but, in exchange of income insurance, gain flexibility in labor supply. More recently, Guiso, Pistaferri, and Schivardi (2005), Shimer (2005) and Ríos-Rull and Santaeulàlia-Llopis (2010) provide empirical support.

structure of value added variance-ratios and the strongly downward-sloping term-structure of dividends variance-ratios should be imputed to aggregate wages. On the other hand, I document that variation in the aggregate labor-share is a main driver of the value premium dynamics. Consistently with the model predictions, i) labor-share changes are negatively related with the contemporaneous excess return of value firms over growth firms (Fama and French (1992)'s HML return hereafter); and ii) the labor-share level strongly positively forecasts cumulative HML returns over long horizons.

The model consists of three simple ingredients. First, wages and dividends are modelled as potentially concave and convex functions of the transitory component of total resources (Marfè, 2013b; Greenwald, Lettau, and Ludvigson, 2014). This allows to qualitatively and quantitatively model the cyclicality and term-structure effects of labor rigidity. Second, market participants feature recursive preferences (Epstein and Zin, 1989) and, for labor rigidity strong enough, the term-structure of equity premia is downward-sloping under preference for the early resolution of uncertainty. Third, a cross-section of firms is introduced by means of heterogeneity in the duration of cash-flows (Lettau and Wachter, 2007). Thus, value firms are interpreted as shorter duration equity than growth firms. Finally, labor rigidity enhances the pricing of short-term risk and generates an equilibrium value premium, which is intertemporally related to the labor-share, in line with the actual data.

The model calibration exploits the information from the term-structures of macroeconomic risk to infer about the role of aggregate labor rigidity on the timing of dividend risk. The term-structure effect of labor rigidity is included in the model calibration by setting its operating leverage effect on dividends in order to match the increasing, flat and decreasing term-structures respectively of wage, consumption and dividend risk (Marfè, 2013b). Under standard preferences, the model reconciles a number of standard asset pricing facts (i.e. low and smooth risk-free rate, high equity premium and excess return volatility over fundamentals, price-dividend ratio level and volatility) with the term-structures of equity as well as the value premium. Namely, the model generates, as an equilibrium outcome, the dynamic relation between the labor-share and the value premium documented from the data. After a negative transitory shock, labor rigidity leads to an increase in the labor-share and a decrease in the dividend-share In turn, dividend risk shifts toward the short-horizon and, hence, the value premium increases. The persistence of the labor-share dynamics leads to the long-horizon predictability of the value premium.

Since the model is kept simple for the sake of exposition, it cannot *quantitatively* match the magnitude and the variation of the value premium. However, I show that those results simply obtain by including in the model either firm-specific labor rigidity or heteroscedasticity in fundamentals. These model extensions enhance the main model mechanism, that is the differential in equity compensations due to the effect of aggregate labor rigidity on the timing of dividend risk.

The paper is related to the large literature which aims to link the value premium to the firms fundamentals. Among others, Berk, Green, and Naik (1999), Gomes, Yaron, and Zhang (2003) and Zhang (2005) focus on the investment decision. In particular, Zhang (2005) examines in partial equilibrium the interaction of time-varying price of risk and asymmetric adjustment costs, concluding that value firms deserve high compensations in bad times. Similarly to these works, I also build on the operating leverage hypothesis of Carlson, Fisher, and Giammarino (2004), which has found empirical support in Novy-Marx (2011). However, the present paper is complementary to and differs from these works because it focuses on the role of *aggregate* labor rigidity in general equilibrium and finds strong support concerning the time-series dynamics of the value premium.

Similarly to Santos and Veronesi (2004) and Lettau and Wachter (2007), the concept of cash-flows duration is used to build a cross-section of firms. Among others, Dechow, Sloan, and Soliman (2004) find empirical support to the idea that growth stocks have larger duration than value stocks (see also Campbell and Mei (1993), Leibowitz and Kogelman (1993), Cornell (1999) and Berk, Green, and Naik (2004)).[2] Differently from those works, the present paper exploits the link between labor rigidity and the timing of dividend risk to explain the dynamics of the value premium in general equilibrium. Instead, Lettau and Wachter (2007, 2011) generate a value premium through exogenously specified correlations between the price of risk and expected dividend growth in partial equilibrium.

A number of works investigates the role of labor relations on asset prices. Labor rigidity leads to risky equity returns and can obtain as a result of distributional risk, as in Danthine and Donaldson (1992, 2002) and Marfè (2013b), infrequent wage resettling, as in Favilukis and Lin (2015), search frictions, as in Kuehn, Petrosky-Nadeau, and Zhang (2012), or labor mobility, as in Donangelo (2014). The present paper builds on the *term-structure effect* of aggregate labor rigidity and, in turn, recognizes the labor-share as a main driver of the value premium dynamics. Therefore, the model mechanism is different and complementary to the works that focus on idiosyncratic productivity to build cross-sectional heterogeneity in labor rigidity (Gourio (2008), Favilukis and Lin (2015), Donangelo, Gourio, and Palacios (2015)).[3]

Finally, the present paper is related to the recent works which aim to find a macroeconomic explanation of the term-structure of equity. Ai, Croce, Diercks, and Li (2015), Kogan and Papanikolaou (2015), Belo, Collin-Dufresne, and Goldstein (2015) and Hasler and Marfè

[2]Notice that the concept of cash-flows duration should not necessarily be interpreted as the expected life of the firm. Short duration allows to model the cash-flows of the fraction of firms whose core business is well represented by current cash-flows risk. Whereas long duration allows to model the cash-flows of firms, whose core business is better represented by future cash-flows risk.

[3]A model extension explores how cross-sectional heterogeneity in labor rigidity enhances and interact with the main model mechanism: the value premium increases as long as firm-specific labor rigidity in negatively related cash-flows duration.

(2015) focus on investment and financing decisions and rare disasters and provide potential explanations for the findings of van Binsbergen, Brandt, and Koijen (2012) and van Binsbergen, Hueskes, Koijen, and Vrugt (2013). I focus on the role of labor rigidity similarly to Marfè (2013b), who documents that, at the aggregate level, the timing of dividend risk should be largely imputed to a mechanism of income insurance from shareholders to workers.

The paper is organized as follows. Section 2 provides empirical support to the main model mechanism. Section 3 describes the model and the main analytical results. Section 4 proposes a calibration, discusses the model predictions and highlights some model extensions. Section 5 concludes.

2 Empirical Support

2.1 Non-Financial Corporate Sector Data

The key variables are from the current account of the non-financial US corporate sector. Data are yearly on the sample 1945:2013 and are collected from the Flow of Funds, Integrated macroeconomic accounts, table S.5.a. Namely, I consider the net value added (V), the compensations to employees (W), the net interests paid (B), the net dividends paid (D), the net operating surplus (S), the gross fixed capital formation (I), and total assets (A). I define W/V, B/V and D/V respectively as the shares of workers', bondholders' and shareholders' remuneration. S/A and I/A are used as measures of profitability and investment. Data of real GDP are from NIPA table 1.1.6. Data of the value premium, i.e. HML returns, the size premium, i.e. SMB returns, and equity market are from Kenneth French's webpage. Data of price-earnings and price-dividends ratios on the S&P500 are from Robert Shiller's webpage.

Table 1: Non-financial corpotate sector: current account 1945-2013

			% share
(a)		Gross value added	100
	(a.1)	- Capital depreciation	(11.6)
(b)		= Net value added	88.4
	(b.1)	- Compensations to employees	(62.9)
	(b.2)	- Taxes on production and imports less subsidies	(8.7)
(c)		= Net operating surplus	16.8
	(c.1)	- net interest paid	(2.5)
	(c.2)	- net dividends paid	(4.0)
	(c.3)	- net reinvestment of earnings	(-0.8)
(d)		= Net national income	11.1
	(d.1)	- Current taxes on income, wealth, and other transfers	(5.8)
(e)		= Net disposable income	5.3
	(e.1)	- Capital transfers	(0.0)
(f)		= Net saving	5.3

Summary of Integrated macroeconomic accounts, table S.5.a

Table 1 reports the sample average shares from the current account of the non-financial US corporate sector.

2.2 Labor Rigidity and Dividend Risk

This section investigates the effect of aggregate labor rigidity on dividend risk. In presence of labor rigidity, the total cost of labor does not equal the labour productivity but incorporate an explicit or implicit insurance component. Such an insurance mechanism from shareholders to workers obtains within the firm and makes wages smoother than output. On the other hand, payouts to shareholders become more volatile and pro-cyclical. A number of contributions suggests that labor rigidity (due to heterogeneity as in Danthine and Donaldson (1992, 2002) and Marfè (2013b) or to frictions as in Favilukis and Lin (2015) and Kuehn, Petrosky-Nadeau, and Zhang (2012)) leads to risk-sharing among workers and shareholders and investigates the implications for dividends and equity.

Consistently with such an interpretation we should observe the *cyclicality effect* of labor rigidity: i) changes in the labor-share should be negatively correlated with changes in output; and ii) variation in the labor-share should negatively drives variation in the dividend-share.

The upper panels of Figure 1 document both those stylized facts. The counter-cyclical dynamics of the labor-share is in line with the findings of Boldrin and Horvath (1995) and Ríos-Rull and Santaeulàlia-Llopis (2010): the correlation between $\Delta L/V$ and $\Delta \log V$ is about -.25. Moreover, the labor-share is strongly negatively correlated with the dividend-share: their correlation is about -.65. The mechanism of income insurance due to labor rigidity is consistent with the empirical fact that the labor-share (and profitability) Granger causes the dividend-share, whereas investment and financing decisions do not. Indeed, we have that in the following regression:

$$\begin{aligned}
D/V_t = \underset{(3.07)}{.15} &+ \underset{(2.52)}{.29}\, D/V_{t-1} + \underset{(2.77)}{.31}\, D/V_{t-2} && \text{(shareholders' remuneration)}\\
&+ \underset{(-1.04)}{-.27}\, B/V_{t-1} + \underset{(.70)}{.18}\, B/V_{t-2} && \text{(bondholders' remuneration)}\\
&+ \underset{(2.01)}{.69}\, I/A_{t-1} + \underset{(-2.07)}{-.74}\, I/A_{t-2} && \text{(investment)}\\
&+ \underset{(-2.91)}{-.94}\, S/A_{t-1} + \underset{(2.08)}{.73}\, S/A_{t-2} && \text{(profitability)}\\
&+ \underset{(-3.11)}{-.51}\, W/V_{t-1} + \underset{(1.96)}{.33}\, W/V_{t-2} && \text{(workers' remuneration)}\\
&+ \epsilon_t && R^2 = 73.6\%,
\end{aligned}$$

the coefficient on the lagged labor-share is negative and highly statistically significant.[4]

Now the focus turns on the timing of dividend risk. The term-structures of variance ratios

[4]Notice that labor-share and profitability Granger cause the dividend-share at a 1% significance level (i.e. a test of the null hypothesis that the estimated coefficients on the lagged values of each variable are jointly zero). Instead, we cannot reject the hypothesis that B/V and I/A do not Granger cause the dividend-share.

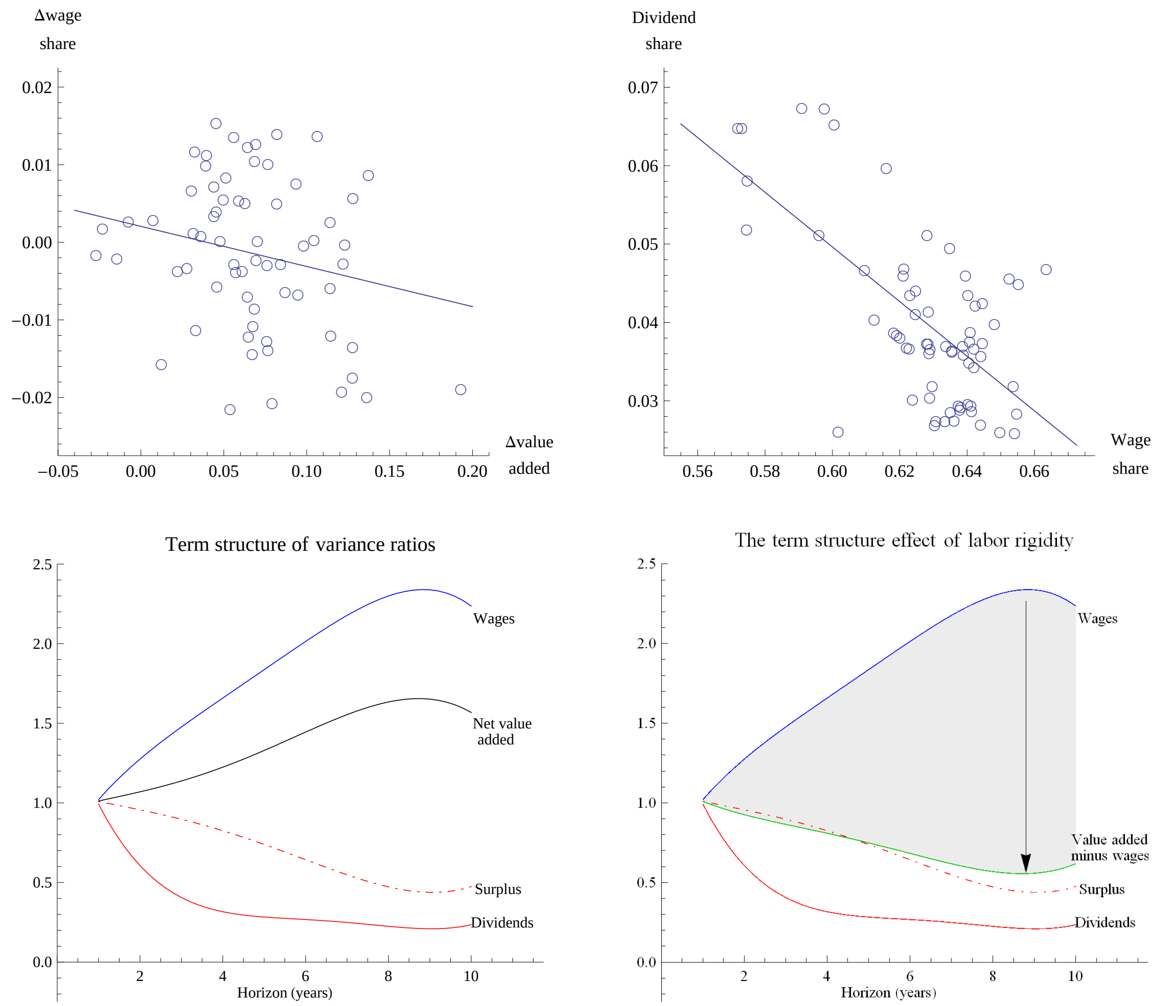


Figure 1: The cyclicality and term-structure effects of labor rigidity

Upper panels: Scatter plots of the changes in the log value added and the wage-share (left) and the levels of the wage- and dividend-share (right). Lower panels: Variance-ratios of value added (black), wages (blue), operating surplus (red dashed), dividends (red solid) and value added minus wages (green) as a function of the horizon. Data are yearly on the sample 1946:2013. The variance ratio procedure uses the theoretical exposition of Campbell, Lo and MacKinlay (1997, pp. 48-55), which accounts for heteroscedasticity and overlapping observations.

(VR's) capture whether the variance of a given variable increases linearly with the observation interval. Hence, downward-sloping VR's below unity imply that risk concentrates at short horizons. Vice-versa, upward-sloping VR's above unity imply that risk concentrates at long horizons. The lower panels of Figure 1 provide a number of insights.

Aggregate dividends (as well as the operating surplus) feature strongly decreasing VR's below unity. Instead, the term-structures of VR's of value added and wages are respectively slightly and markedly increasing above unity. To understand those results it is important to notice that the above mentioned variables are co-integrated. Hence, the heterogeneity among their VR's should be imputed to heterogeneity in transitory risk, whereas those variables share the same exposition to permanent risk. Similarly to Marfè (2013b), I argue that the upward-sloping wage risk and downward-sloping dividend risk are a joint implication of labor rigidity The rationale for such a *term-structure effect* of labor rigidity is as follows. Given co-integration, the mechanism of income insurance only concerns transitory shocks.[5] Therefore, after a negative transitory shock, the fraction of total resources devoted to workers' remuneration is partially insured by a decrease of the resources devoted to shareholders' remuneration. Such an insurance mechanism implies that the labor- and dividend-shares are respectively concave and convex in the transitory component of value added. Consequently, wages and dividends load on transitory risk respectively less and more than value added. This produces VR's of wages and dividends which are respectively increasing and decreasing, as in the lower left panel of Figure 1.

The lower right panel of Figure 1 provides a strong empirical support to the *term-structure effect* of labor rigidity and its quantitative magnitude. Indeed, when we look at the term-structure of risk of the remainder of value added minus wages, we essentially recover the negative slope of the term-structures of both operating surplus and dividends. This means that the bulk of the distance between the slightly upward-sloping term-structure of value added and the downward-sloping term-structure of dividends is due to wages. Instead, alternative channels such as investment (suggested by Ai, Croce, Diercks, and Li (2015) and Kogan and Papanikolaou (2015)) or financial leverage (suggested by Belo, Collin-Dufresne, and Goldstein (2015)) have likely a minor impact on the timing of aggregate dividend risk.[6]

The model of Section 3 captures the above stylized facts by assuming that consumption, wages and dividends are co-integrated with consumption featuring both a permanent and a transitory shock. Wages and dividends load on the same permanent shock but their shares are respectively concave and convex in the transitory shock. A *single* curvature parameter represents labor rigidity and allows to jointly capture i) the term-structures of VR's observed in the data; as well as ii) the counter-cyclical and pro-cyclical dynamics of the wage- and dividend-shares; iii) the smooth and strongly persistent dynamics of wages growth rates; and iv) the volatile and weakly persistent dynamics of dividends growth rates. I will show that such a simple framework is able to reproduce in equilibrium the *dynamic* relation between aggregate labor rigidity and the value premium, which I empirically document below.

[5]Notice, that a mechanism of income insurance concerning permanent shocks would be inconsistent with both the idea that the representative firm of the economy is a non-defaultable entity as well as a stationary equilibrium. Moreover, Guiso, Pistaferri, and Schivardi (2005) empirically document that risk-sharing among workers and shareholders likely does not concern permanent shocks.

[6]Notice that the cyclicality effect and the term-structure effect of labor rigidity are the two sides of the same coin: both these effects reflect how labor rigidity alters the exposition of wages and dividends to the transitory component of aggregate risk.

2.3 Labor Rigidity and the Value Premium

Now the focus turns on the relation between labor rigidity and value premium. The model mechanism is the following. After a negative transitory shock, labor rigidity leads to i) an increase of the share of workers remuneration and a decrease of shareholders remuneration (the *cyclicality effect*); and ii) an increase in the spread between the upward-sloping term-structure of wage risk and the downward-sloping term structure of dividend risk (the *term-structure effect*). In turn, dividend distributions are more volatile and pro-cyclical and their risk concentrates at short horizons. Finally, shorter duration equity is riskier than long duration equity and, hence, an increase in the value premium obtains. Vice-versa, after a positive transitory shock, dividend risk shifts toward the long horizon and the value premium decreases. Consequently, the value premium is counter-cyclical, consistently with the empirical evidence (Petkova and Zhang (2005)). Since the wage-share is stationary and strongly persistent, I investigate the following model predictions.

Hypothesis I**:** changes in the wage-share are negatively related with the contemporaneous excess return of value firms over growth firms.

Hypothesis II**:** the level of the wage-share positively predicts the cumulative excess return of value firms over growth firms.

I investigate *Hypothesis I* by regressing the HML return on the change of the wage-share (ΔW/V) as well as a number of macroeconomic and financial controls. Table 2 reports the estimation results. In regression (1), ΔW/V is the only independent variable and its coefficient is negative and highly significant, consistently with the model. The economic effect is sizeable (about -30%) and the adjusted R^2 is about 7%. In regression (2), I add the lagged level of the wage-share as a regressor: as expected, ΔW/V and W/V are respectively negatively and positively related to the HML return. In regressions (3) and (4), I add the changes and the lagged levels of bondholders' remuneration (B/V), shareholders' remuneration (D/V), investment (I/A) as well as the changes in net value added (Δ log V) and GDP (Δ log Y). Those macroeconomic controls account for the main firm decisions beyond the remuneration of human capital (i.e. investment and financing decisions, return on equity and productivity) and for the business cycle. The coefficient on the change of the wage-share is still negative and highly significant and the economic effect is similar to regression (1). In regression (5), I consider a battery of financial controls, such as the lag of the three Fama and French (1992) factors, their squares as well as the vaulation ratios based on earnings and dividends. Consistently with the model, ΔW/V is significantly and negatively related to the HML return. Finally in regression (6), I include both macroeconomic and financial controls: the negative relation between the value premium and the expected change in the wage-share is still significant and the economic effect is essentially unchanged from regression (1).

Table 2: Labor Rigidity and Value Premium

The table reports the estimates of the regression

$$\text{HML}_t = b_0 + b_1 \Delta W/V_t + b_2' \text{ macro controls} + b_3' \text{ financial controls} + \epsilon_t$$

where the dependent variable is the high minus low return (Fama and French (1992)) at time t; the independent variables are the change and the lagged value of the wage-share ($\Delta W/V_t$ and W/V_{t-1}), the change and the lagged value of the bondholders' remuneration ($\Delta B/V_t$ and B/V_{t-1}), the change and the lagged value of the shareholders' remuneration ($\Delta D/V_t$ and D/V_{t-1}), the change and the lagged value of investments to assets ($\Delta I/A_t$ and I/A_{t-1}), the log changes in value added ($\Delta \log V$) and GDP ($\Delta \log Y$), the lag and its square of the three Fama and French (1992) return factors (HML, SMB, MKT), and the lag of the price-earnings and price-dividends ratios (P/E and P/D). Data are yearly on the sample 1946-2013. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)	(5)	(6)
Δ W/V workers' remuneration	-3.88***	-3.53**	-3.64**	-4.00*	-3.22**	-3.65*
t-stat	(-2.90)	(-2.55)	(-2.06)	(-1.94)	(-2.17)	(-1.85)
economic significance	-0.29	-0.26	-0.27	-0.29	-0.24	-0.27
Macroeconomic controls						
lag W/V		0.99*		0.45		-0.31
t-stat		(1.99)		(0.43)		(-0.31)
Δ B/V bondholders' remuneration			-4.35	-3.53		-4.05
t-stat			(-0.75)	(-0.65)		(-0.66)
lag B/V				0.07		-0.32
t-stat				(0.06)		(-0.20)
Δ D/V shareholders' remuneration			0.99	-0.39		-0.21
t-stat			(0.77)	(-0.22)		(-0.16)
lag D/V				-3.29		-4.07**
t-stat				(-1.59)		(-2.05)
Δ I/A investment to assets			-4.04	-1.46		1.32
t-stat			(-0.82)	(-0.28)		(0.23)
lag I/A				-2.65		-3.93
t-stat				(-1.14)		(-1.49)
Δ log V value added			-0.32	-0.75		-0.72
t-stat			(-0.71)	(-1.45)		(-1.18)
Δ log Y real GDP			1.11	1.29*		1.88***
t-stat			(1.59)	(2.00)		(3.34)
Financial controls						
lag HML value minus growth excess return					-0.21**	-0.26***
t-stat					(-2.20)	(-2.78)
lag HML^2					0.77**	0.99*
t-stat					(2.09)	(1.93)
lag SMB small minus big excess return					0.29	0.28
t-stat					(1.19)	(1.10)
lag SMB^2					-0.50	-0.35
t-stat					(-0.62)	(-0.39)
lag MKT market excess return					-0.19*	-0.29***
t-stat					(-1.87)	(-3.17)
lag MKT^2					0.52*	0.50
t-stat					(1.96)	(1.66)
lag log P/E price to earnings					0.05	0.03
t-stat					(0.45)	(0.14)
lag log P/D price to dividends					-0.09	-0.04
t-stat					(-0.97)	(-0.23)
R^2	0.08	0.10	0.13	0.18	0.23	0.35
adj-R^2	0.07	0.07	0.04	0.04	0.11	0.11

Now I consider the intertemporal relationship between labor rigidity and value premium by investigating *Hypothesis II*. Since movements in the wage-share are highly persistent, also the model mechanism described above should be observable for a while before to disappear. Therefore, I verify whether the level of the wage share (W/V) forecasts the cumulative HML return over several horizons from one to 10 years. Table 3 reports the estimation results. In panel A, W/V is the only independent variable and its coefficient is positive and highly significant up to 7 years horizon, consistently with the model. The economic effect is sizeable and ranges from about 20% to more than 40%. The adjusted R^2 is quite large at medium horizons (about 18% at 5 years).

In panel B, I add a battery of controls to the regression. Namely, the levels of D/V, B/V and I/A account for the role of shareholders' remuneration as well as financing and investment decisions. In addition, the valuation ratios based on earnings and dividends are included in the regression since they are among the most used and powerful predictors of financial returns in the literature. Consistently with the model prediction, the relation between the future value premium and the current wage-share level is positive and highly significant for any horizon. The economic effect is large and ranges from about 20% to 60%. B/V and I/A provide some additional explanatory power at long horizons only.

The Online Appendix provides further robustness: the explanatory power of the wage share survives to additional controls, such as the financial leverage, the corporate bond credit spread, the term spread and the real short interest rate. Tables A to F report the horse race regressions for each control variable and each horizon. Tables G and H show that the predictive power of the wage share is robust to the time trend and sub-samples.[7]

The results of Table 2 and 3 offer empirical support to the model mechanism. Figure 2 summarizes the empirical findings. The upper panels report the standardized time-series and the scatter plot of the wage share change and the contemporaneous HML return, whereas the lower panels report the standardized time-series and the scatter plot of the wage-share level and the cumulative HML return over the subsequent 5 years. The former and the latter plots shows respectively the negative and the positive relationship of *Hypotheses I* and *II*.

2.4 Robustness: Value Premium and Short-Run Risk

The previous sections provide empirical support to the idea that labor rigidity drives the value premium dynamics since, by enhancing the short-run risk of dividends, it gives rise to a differential in the compensations of short and long duration equity.

This section provides further support to the model economic mechanism. I document that

[7] The financial leverage is corporate bonds relative to equity from the Flows of Funds; the Moody's Baa-Aaa credit spread is from the Federal Reserve; and the 10 years term spread and the short interest rate are from Robert Shiller's webpage.

Table 3: Long-Horizon Value Premium Predictability

The table reports the estimates of the regression

$$\sum_{i=1}^{n} \mathrm{HML}_{t+i} = b_0 + b_1 W/V_t + b_2' \,\text{controls} + \epsilon_t$$

where the dependent variable is the cumulative high minus low return (Fama and French (1992)) from time t over the horizon of 1, 2, 3, 5, 7 and 10 years; the independent variables are the time t wage-share (W/V_t) in Panel A, and the time t wage-share (W/V_t), bondholders' remuneration (B/V_t), shareholders' remuneration (D/V_t), investments to assets (I/A_t) and price-earnings and price-dividends ratios ($\mathrm{P/E}_t$ and $\mathrm{P/D}_t$) in Panel B. Data are yearly on the sample 1946-2013. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

Panel A	Horizon					
	1	2	3	5	7	10
W/V workers' remuneration	1.31**	3.09***	5.11***	7.20***	6.63***	3.52
t-stat	(2.52)	(2.67)	(3.12)	(3.46)	(2.83)	(1.23)
economic significance	0.19	0.30	0.40	0.44	0.37	0.17
R^2	0.04	0.09	0.16	0.20	0.13	0.03
adj-R^2	0.02	0.08	0.15	0.18	0.12	0.01

Panel B	Horizon					
	1	2	3	5	7	10
W/V workers' remuneration	1.41**	4.23***	6.93***	9.75***	7.91***	6.47***
t-stat	(2.08)	(3.16)	(3.49)	(3.71)	(3.14)	(2.98)
economic significance	0.20	0.41	0.55	0.60	0.44	0.31
B/V bondholders' remuneration	0.07	0.18	-1.10	-6.44	-8.96**	-11.45**
t-stat	(0.03)	(0.06)	(-0.34)	(-1.57)	(-2.35)	(-2.26)
D/V shareholders' remuneration	-2.04	1.57	3.52	0.11	-5.17	-12.64*
t-stat	(-1.02)	(0.48)	(0.80)	(0.03)	(-1.36)	(-1.73)
I/A investment to assets	-4.31	-3.35	-0.75	4.75	11.97***	18.29***
t-stat	(-1.35)	(-0.57)	(-0.11)	(0.96)	(3.00)	(2.71)
log P/E price to earnings	-0.06	-0.20	-0.41	-0.78	-0.62	-0.17
t-stat	(-0.34)	(-0.72)	(-1.24)	(-1.63)	(-1.45)	(-0.40)
log P/D price to dividends	0.06	0.15	0.33	0.75	0.61	0.23
t-stat	(0.40)	(0.62)	(1.13)	(1.66)	(1.49)	(0.57)
R^2	0.07	0.13	0.21	0.26	0.29	0.43
adj-R^2	-0.02	0.04	0.13	0.18	0.21	0.36

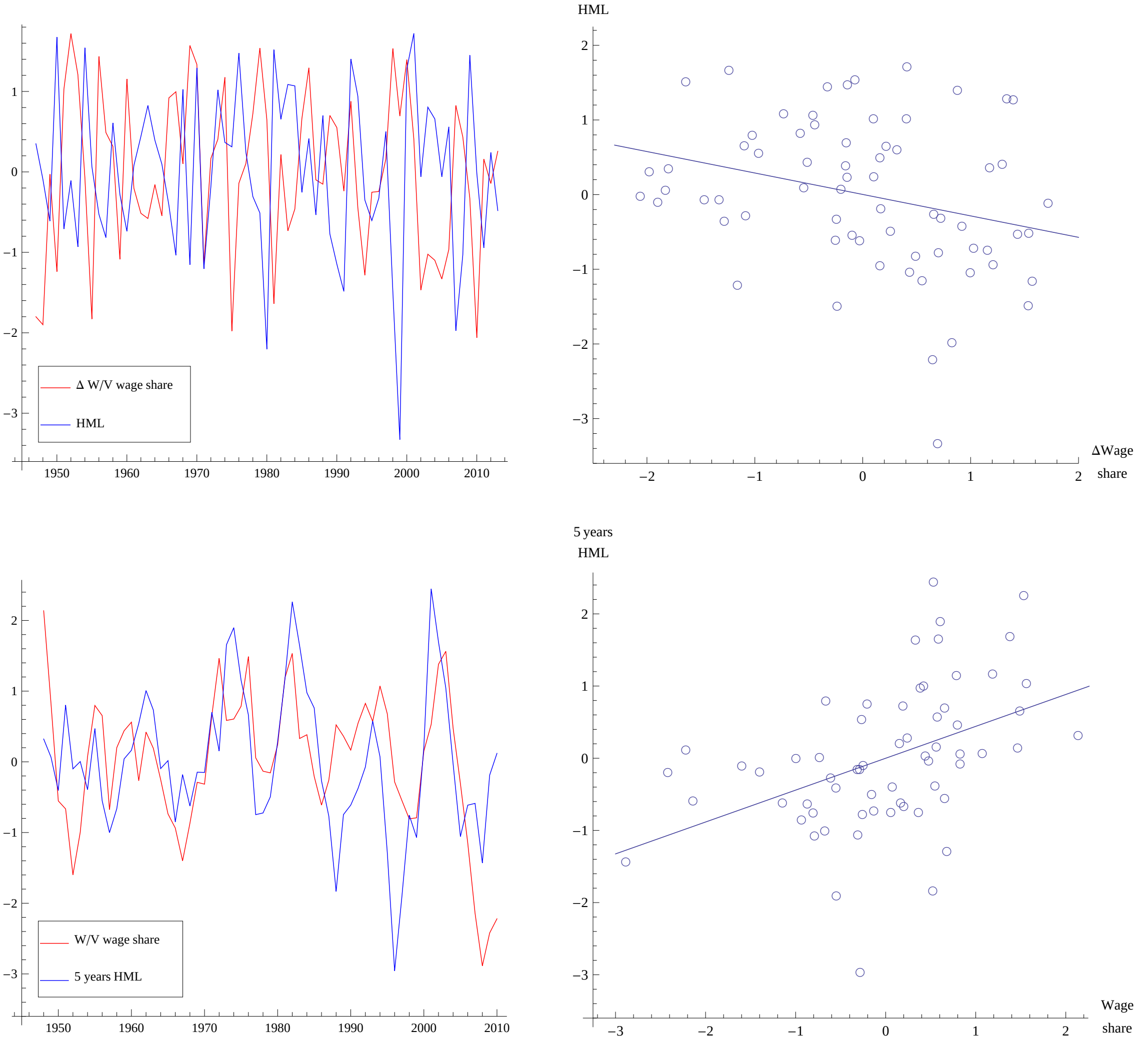


Figure 2: Labor rigidity and the value premium

Upper panels: time-series (left) and scatter plot (right) of contemporaneous standardized wage-share changes and HML returns. Lower panels: time-series (left) and scatter plot (right) of standardized wage-share levels and future cumulative HML returns over 5 years horizon. Data are yearly on the sample 1946:2013.

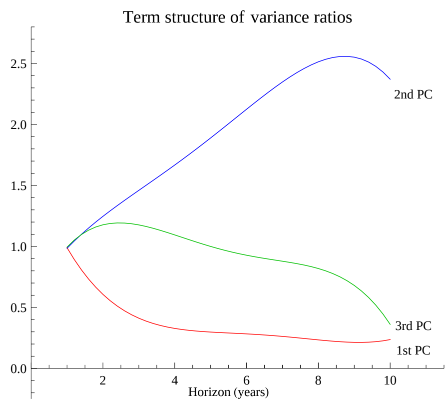
the value premium predictability of Table 3 obtains from "short-run risk" in macroeconomic fundamentals. The analysis consists of four steps. First, I perform a principal component analysis (PCA) of the growth rates of value added, wages and dividends. Results are reported in Panel A of Table 4. The first principal component (PC) weighs mostly on dividends and explains about 90% of total variation. The second PC weighs more on value added and wages and explain about 10%. The third PC explains the residual variance.

Second, I compute the variance ratios of the PC's to infer about the timing of macroeconomic risk. Results are reported in Panel B of Table 4. The first and the third PC's feature markedly downward-sloping term-structures of variance ratios, whereas the second PC is characterized by strongly upward-sloping variance ratios. This allows to interpret the first and the third PC's as news about macroeconomic "short-run risk", which is orthogonal to the "long-run risk" implied by the second PC.

Third, I make use of the PC's and of the PCA weighting matrix to compute the wage share implied by the first and the third PC's only ($W/V^{(1,3)}$). This variable captures the variation in the wage share which can be imputed to "short-run risk". Then, I regress the original wage share on $W/V^{(1,3)}$. Panel C of Table 4 reports the estimates and shows that "short-run risk" leads to an almost perfect fit (the adjusted R^2 is 99.7%).

Fourth and finally, similarly to Panel A of Table 3, I perform the long-horizon regressions of cumulative HML retuns on the current level of $W/V^{(1,3)}$. Results are reported in Panel D of Table 4. As expected, the wage share based on "short-run risk" recovers the large explanatory power of the original wage share at both short and long horizons.

Figure 3 summarizes the findings of this section. The left panel displays the term-structures of variance ratios of the three PC's. The right panel reports the scatter plot of the original wage share and the wage share based on "short-run risk" only. In a nutshell, the empirical analysis supports the core idea of the paper, that is the *timing of risk* of workers' and shareholders' remunerations is at the heart of the value premium dynamics.



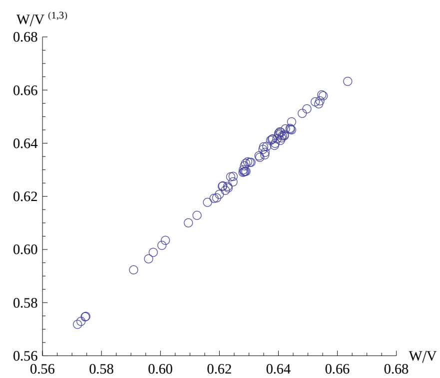


Figure 3: Wage share and short run risk

Left panel: Variance-ratios of the principal components as a function of the horizon. Right panel: Scatter plot of the wage share and the wage share implied by the first and the third principal components only. Data are yearly on the sample 1946:2013. The variance ratio procedure uses the theoretical exposition of Campbell, Lo and MacKinlay (1997, pp. 48-55), which accounts for heteroscedasticity and overlapping observations.

Table 4: Value Premium Predictability and Short-Run Risk

Panel A reports the estimates coefficients and the explained variances of a principal component analysis of the growth rates of value added (V), wages (W) and dividends (D). Panel B reports the variance ratios of the principal components on the horizons from 2 to ten years. Panel C reports the regressions estimates of the wage share (W/V) on the wage share ($W/V^{(1,3)}$) implied by the principal components 1 and 3 only. Panel D reports the regressions estimates of the cumulative future HML returns from one to 10 years on the current wage share ($W/V^{(1,3)}$) implied by the principal components 1 and 3 only. Data are yearly on the sample 1946-2013. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

Panel A – Principal Component Analysis

Principal	Λ, weights on:			Explained
components	$\Delta \log V$	$\Delta \log W$	$\Delta \log D$	variance
1st	-0.058	-0.048	-0.997	0.893
2nd	0.709	0.701	-0.075	0.103
3rd	-0.703	0.711	0.006	0.004

Panel B – Variance Ratios of Principal Components

Horizon:	2	3	4	5	6	7	8	9	10
1st	0.57	0.44	0.32	0.31	0.28	0.25	0.23	0.23	0.23
2nd	1.22	1.44	1.67	1.92	2.23	2.18	2.50	2.66	2.33
3rd	1.16	1.19	1.09	1.02	0.93	0.85	0.82	0.70	0.35

Panel C – Wage-share and short-run risk

$$W/V_t = b_0 + b_1 W/V_t^{(1,3)} + \epsilon_t$$

where: $$W/V_1^{(1,3)} = W/V_1, \qquad W/V_t^{(1,3)} = W/V_1 \frac{\exp(\sum_{\tau=2}^{t} \Delta \log W_\tau^{(1,3)})}{\exp(\sum_{\tau=2}^{t} \Delta \log V_\tau^{(1,3)})} \quad \forall t \geq 2,$$

and $$\begin{pmatrix} \Delta \log V_\tau^{(1,3)} \\ \Delta \log W_\tau^{(1,3)} \\ \Delta \log D_\tau^{(1,3)} \end{pmatrix} = \begin{pmatrix} \mathbb{E}\Delta \log V_\tau \\ \mathbb{E}\Delta \log W_\tau \\ \mathbb{E}\Delta \log D_\tau \end{pmatrix} + \left[\Lambda' \cdot \begin{pmatrix} 1 & 0 & 1 \\ 1 & 0 & 1 \\ 1 & 0 & 1 \end{pmatrix} \right] \begin{pmatrix} \text{1st PC}_\tau \\ \text{2nd PC}_\tau \\ \text{3rd PC}_\tau \end{pmatrix}.$$

b_0	t-stat	b_1	t-stat	adj-R^2
0.016***	(3.70)	0.972***	(136.93)	0.997

Panel D – Value premium and short-run risk

$$\sum_{i=1}^{n} \text{HML}_{t+i} = b_0 + b_1 W/V_t^{(1,3)} + \epsilon_t$$

Horizon:	1	2	3	5	7	10
$W/V^{(1,3)}$	1.24**	2.94***	4.88***	6.86***	6.19**	2.68
t-stat	(2.42)	(2.68)	(3.10)	(3.32)	(2.55)	(0.86)
economic significance	0.18	0.29	0.40	0.43	0.35	0.13
R^2	0.03	0.09	0.16	0.19	0.12	0.02
adj-R^2	0.02	0.07	0.14	0.17	0.11	-0.00

3 Model

The economy is structured as follows. A representative firm produces an operational cash-flows, which can be interpreted as the total output minus investments: $C = Y - I$. Such an operational cash-flows represents the total resources shared by workers and shareholders: the former receive wages (W) and the latter receive dividends (D). The resource constraint requires $C = W + D$. To keep the model simple, I assume limited market participation such that workers do not access the financial markets and consume their wages. Consequently, shareholders act as a representative agent on the stock market and consume dividends.[8]

3.1 Preferences

Shareholders feature recursive preferences in spirit of Kreps and Porteus (1979), Epstein and Zin (1989) and Weil (1989). For the sake of tractability, I assume their continuous time counterpart which takes the form of stochastic differential utility, as in Duffie and Epstein (1992). These preferences allow for the separation between the elasticity of intertemporal substitution (EIS) and the coefficient of relative risk aversion (RRA). Given a consumption process C, the utility at each time t is defined as

$$J_t = \mathbb{E}_t \int_{u \geq t} f(C_u, J_u) du, \qquad \forall t \geq 0, \tag{1}$$

where $\mathbb{E}_t$ is the expectation operator under full information and $f(c, j)$ is an aggregator function. Under usual technical conditions, the aggregator is given by

$$f(C, J) = \beta \chi J \big(C^{1-1/\psi} ((1-\gamma)J)^{-1/\chi} - 1 \big), \tag{2}$$

where $\chi = \frac{1-\gamma}{1-1/\psi}$, γ is RRA, ψ is EIS and β is the time-discount rate. Power utility obtains for $\psi \to 1/\gamma$.

3.2 Dynamics

Aggregate Consumption, Wages and Dividends

Workers and shareholders receive income from two sources, wages and dividends, and where the mix between these two sources of income varies over time.

[8]The endogenous determination of market participants goes beyond the scope of this paper. The assumption of limited market participation allows for tractability and for comparability with most of endowment economy equilibrium models. Recently, Berk and Walden (2013) show that labor markets provide risk-sharing to workers, such that their consumption endogenously equals their wages and limited market participation obtains.

Aggregate consumption dynamics is modelled as the product of a permanent and a transitory shock. The former features time-variation in expected growth, in spirit of long-run risk literature, and induces an upward-sloping effect on the term-structure of risk. The latter is usually considered in the real business cycle literature and induces a downward-sloping effect. Then, the two shocks jointly lead to flexibility at modelling the timing of risk.

Namely, aggregate consumption $C = XZ$ has dynamics given by:

$$
\begin{aligned}
d\log C_t &= dx_t + dz_t, && (3)\\
d\log X_t = dx_t &= \mu_t dt + \sigma_x dB_{x,t}, && (4)\\
d\mu_t &= \lambda_\mu(\bar{\mu} - \mu_t)dt + \sigma_\mu dB_{\mu,t}, && (5)\\
d\log Z_t = dz_t &= -\lambda_z z_t dt + \sigma_z dB_{z,t}, && (6)
\end{aligned}
$$

Those processes feature homoscedasticity and independent Brownian shocks for the sake of exposition and tractability.

Aggregate consumption and dividends are co-integrated in levels. Then, the excess volatility of dividends over consumption obtains by a levered exposition $(1+\phi)$ to the transitory shock:

$$D_t = \alpha X_t Z_t^{1+\phi}, \tag{7}$$

where $X_t \equiv e^{x_t}$, $Z_t \equiv e^{z_t}$, $\alpha \in (0,1)$ and $\phi \geq 0$. The steady-state dividend-share is $D/C = \alpha$. Such a specification of dividends allows to capture not only co-integration and excess volatility but also other features of the data: i) the upward- and downward-sloping risk of consumption and dividends risk; ii) the pro-cyclical dynamics of the fraction of total resources devoted to shareholders' remuneration; iii) the negative correlation between the dividend- and the labor-share; iv) the upward-sloping risk of wages.

The above dynamics can be understood in terms of "distributional risk" between shareholders and workers, due to labor rigidity. Denote wages as the reminder of consumption $W = C - D$, then we have:

$$W_t = X_t Z_t - \alpha X_t Z_t^{1+\phi} = C_t(1 - \alpha Z_t^{\phi}), \tag{8}$$

and, therefore, the dividend- and labor-shares, D_t/C_t and W_t/C_t, are respectively a convex and a concave function of the transitory shock z_t. Let denote the labor-share as[9]

$$\omega(z_t) = 1 - \alpha e^{\phi z_t}, \tag{9}$$

[9] As long as z_t has Ornstein-Uhlenbeck dynamics, $\omega(z_t)$ is not bounded in $(0,1)$. However under plausible parameters the probability that $\omega(z_t) < 0$ is negligible since α is small and z_t is smooth ($\mathbb{P}(\omega(z_t) < 0) \approx 1{\times}10^{-43}$ in the baseline calibration of section 4.1). Hence, hereafter I assume $1 > \alpha e^{\phi z_t}$, $\forall t$.

The non-linearity is governed by the parameter ϕ, which can be interpreted as the degree of labor rigidity. In presence of a negative transitory shock ($z_t < 0$), workers are partially insured because the fraction of total resources devoted to wages increases, whereas shareholders suffer twice since the dividend-share decreases. Such an insurance mechanism has two main implications. On the one hand, a *cyclicality and leverage effect*: insurance makes dividends riskier in bad times and, hence, provides a rationale for a high equity premium. On the other hand, a *term-structure effect*: jointly with co-integration,[10] insurance induces high short-term risk to dividends and high long-run risk to wages. In turn the former and the latter feature term-structures of risk respectively decreasing and increasing with the horizon.

Lemma 1. *Under labor rigidity, the instantaneous volatility of consumption, wages and dividends growth rates satisfy*

$$\sigma_{W,t} < \sigma_{C,t} < \sigma_{D,t}. \tag{10}$$

Define the moment generating function of consumption, wages and dividends as $\mathbb{C}_t(\tau, n) = \mathbb{E}_t[C^n_{t+\tau}]$, $\mathbb{W}_t(\tau, n) = \mathbb{E}_t[W^n_{t+\tau}]$ and $\mathbb{D}_t(\tau, n) = \mathbb{E}_t[D^n_{t+\tau}]$. Then, the term-structures of growth rates variance are given by

$$\sigma^2_C(t,\tau) = \tfrac{1}{\tau}\log\left(\tfrac{\mathbb{C}_t(\tau,2)}{\mathbb{C}_t(\tau,1)^2}\right), \quad \sigma^2_W(t,\tau) = \tfrac{1}{\tau}\log\left(\tfrac{\mathbb{W}_t(\tau,2)}{\mathbb{W}_t(\tau,1)^2}\right), \quad \sigma^2_D(t,\tau) = \tfrac{1}{\tau}\log\left(\tfrac{\mathbb{D}_t(\tau,2)}{\mathbb{D}_t(\tau,1)^2}\right). \tag{11}$$

Long-run growth μ_t and transitory shock z_t induce respectively an upward- and a downward-sloping effect to all these term-structures. Interestingly, labor rigidity alters the slopes of wage and dividend risk.

Lemma 2. *The stronger labor rigidity, the larger in magnitude the (positive) slope of wage risk and the (negative) slope of dividend risk:*

$$\tfrac{\partial^2}{\partial\phi\,\partial\tau}\sigma^2_W(t,\tau) > 0, \qquad \tfrac{\partial^2}{\partial\phi\,\partial\tau}\sigma^2_D(t,\tau) < 0. \tag{12}$$

Therefore, labor rigidity shifts wage risk toward the long-horizon and dividend risk toward the short horizon. A natural metric to measure such an effect is the term-structure of variance ratios, that is the ratio of horizon-τ growth rates variances relative to short horizon growth rates variances:

$$VR_C(t,\tau) = \tfrac{\sigma^2_C(t,\tau)}{\sigma^2_C(t,\tau_0)}, \quad VR_W(t,\tau) = \tfrac{\sigma^2_W(t,\tau)}{\sigma^2_W(t,\tau_0)}, \quad VR_D(t,\tau) = \tfrac{\sigma^2_D(t,\tau)}{\sigma^2_D(t,\tau_0)},$$

where τ_0 usually denotes one-quarter or one year. For $\phi > 0$, the variance ratios of wages and dividends lie respectively above and below those of aggregate consumption.

[10]Co-integration can be interpreted economically as the incapability for the representative firm to provide insurance to the workers concerning permanent shocks. Indeed, those contracts can be not affordable to a non-defaultable entity, such as the representative firm.

Dividends of Value and Growth Firms

Now the focus turns on the dividend dynamics of single firms. In spirit of Lynch (2003) and Menzly, Santos, and Veronesi (2004), I define a share process for the firm dividends, that is the fraction of aggregate dividends paid by a single firm. The share process is voluntarily kept simple and intends to capture the life-cycle of the firm. The model can be eventually augmented by including either firm-specific exposition to z_t or idiosyncratic risk: both these ingredients do not alter the main result of the paper and then are excluded for the sake of exposition.

Namely, the share process is such that dividends paid by existing firms sum up to aggregate dividends at each point in time. As in Lettau and Wachter (2007, 2011), the share process deterministically depends on the residual life of the firm T. The distribution of firms is stable over time: there exists a continuum of firms defined by their residual life $T \in (0, T^{\max})$ and at each point in time the firm with zero residual life is replaced by a new one with maximal residual life $T^{\max}$. The share process $s(T)$ is a hump-shaped function of residual life which peaks at $T^{\max}/2$, similarly to Lettau and Wachter (2007):

$$s(T) = \tfrac{\pi}{2T^{\max}} \sin(\pi T/T^{\max}), \qquad \forall\, T \in (0, T^{\max}), \tag{13}$$

with $\int_0^{T^{\max}} s(T)dT = 1$. The dividends of the firm with residual life T are simply given by $D_t^T = s(T)D_t$.

Single firm dividends share the same exposition than consumption to the permanent shock x_t and the same levered exposition than aggregate dividends to the transitory shock z_t. This is made voluntarily in order to model, as the only firm-specific characteristic, the duration T of payouts to shareholders.

Similarly to Lettau and Wachter (2011), I define value firms as shorter-horizon equity than growth firms. Therefore, firms with small residual life T are hereafter interpreted as value firms, since their equity (i.e. the claim on their dividend stream) weighs more toward the present. Vice-versa, firms with large residual life T are hereafter interpreted as growth firms, since their equity weighs more toward the future.

Notice that the above simple form for D_t^T implies that the term-structure of dividend growth rates variance is unaffected by residual life:

$$\sigma^2_{D^{T'}}(t,\tau) = \sigma^2_{D^{T''}}(t,\tau) = \sigma^2_D(t,\tau), \quad \forall\, \tau \le T' \le T''.$$

This property implies that any differential between equity returns of value and growth firms would arise as an *endogenous* result at equilibrium. A firm-specific exposition to z_t would induce cross-sectional heterogeneity in the term-structures of risk. While I do not argue that such a firm-specific characteristic actually does not exist, I avoid to model it in order to isolate and point out the main model mechanism. That is labor rigidity leads in equilibrium to a value premium simply because value firms have shorter duration cash-flows than growth firms.

3.3 Equilibrium and Asset Prices

State-Price Density

The exponential affine dynamics of shareholders' consumption and preferences in Eq. (1) guarantee a model solution which emphasizes the role of long-run growth μ_t and transitory shock z_t in the price formation and preserves tractability. A first order approximation of the consumption-wealth ratio around its (endogenous) steady-state provides closed form solutions for prices and return moments up to such approximation. In particular, I follow Benzoni, Collin-Dufresne, and Goldstein (2011).

Proposition 1. *The shareholders' utility process under preferences in Eq. (1) and dynamics in Eq. (3)-(7) is given by*

$$J(X_t, \mu_t, z_t) = \tfrac{1}{1-\gamma_s} X_t^{1-\gamma} \exp\left(u_0 + u_\mu \mu_t + (u_z + (1-\gamma)) z_t\right), \tag{14}$$

where u_0,

$$u_\mu = \frac{1-\gamma}{e^{cq} + \lambda_\mu}, \qquad u_z = \frac{\lambda_z(\gamma - 1)}{e^{cq} + \lambda_z}(1+\phi),$$

and $cq = \mathbb{E}[cq_t]$ are endogenous constants derived in the Appendix. The shareholders' consumption-wealth ratio is equal to

$$cq_t = \log\beta - \chi^{-1}(u_0 + u_\mu \mu_t + u_z z_t). \tag{15}$$

The consumption-wealth ratio equals the market dividend-price ratio under limited market participation and, as usual, it reduces to β when $\psi \to 1$. The unconditional level of the consumption-wealth ratio and both the prices of risk and the growth rate of wealth are determined by the coefficients u_0 and $\{u_\mu, u_z\}$.

Under limited market participation, the shareholders' marginal utility is the valid state-price density (Duffie and Epstein (1992)):

$$\xi_{t,u} = e^{\int_t^u f_J(D_\tau, J_\tau)d\tau} \frac{f_C(D_u, J_u)}{f_C(D_t, J_t)}, \qquad \forall u \geq t. \tag{16}$$

Thus, the price of a payoff stream $\{F_u, u \in (t, \infty)\}$ equals $\mathbb{E}_t[\int_t^\infty \xi_{t,u} F_u du]$. The economy leads to a stationary equilibrium, although the equilibrium state-price density is an involved function of the integrated process D_t. Stationarity is a necessary condition to produce realistic testable implications.

Proposition 2. *The equilibrium state price density has dynamics given by*

$$\frac{d\xi_{0,t}}{\xi_{0,t}} = \frac{df_C}{f_C} + f_J dt = -r(t)dt - \theta_x(t)dB_{x,t} - \theta_\mu(t)dB_{\mu,t} - \theta_z(t)dB_{z,t}, \tag{17}$$

where the instantaneous risk-free rate satisfies

$$r(t) = r_0 + r_\mu \mu_t + r_z z_t, \tag{18}$$

with r_0 derived in the Appendix, $r_\mu = \frac{1}{\psi}$, $r_z = -\frac{\lambda_z}{\psi}(1+\phi)$, and the instantaneous prices of risk are given by

$$\theta_x(t) = -\frac{\partial_X f_C}{f_C} X_t \sigma_x = \gamma\, \sigma_x, \tag{19}$$

$$\theta_\mu(t) = -\frac{\partial_\mu f_C}{f_C} \sigma_\mu = \frac{\gamma - 1/\psi}{e^{cq} + \lambda_\mu} \sigma_\mu, \tag{20}$$

$$\theta_z(t) = -\frac{\partial_z f_C}{f_C} \sigma_z = \left(\gamma - \frac{\lambda_z(\gamma - 1/\psi)}{e^{cq} + \lambda_z}\right)(1+\phi)\sigma_z. \tag{21}$$

The risk-free rate is affine in μ_t and z_t. Coefficients r_μ and r_z are respectively positive and negative and both decrease in magnitude with ψ, as usual under recursive preferences. Moreover, r_z increases in magnitude with reversion λ_z and labor rigidity ϕ.

The price of risk due to the permanent shock, $\theta_x(t)$, has the usual form and is a price for transient risk (i.e. a price for the contribution of x_t to the instantaneous volatility of shareholders' consumption). The price of risk due to long-run growth, , is similar in long-run risk models and is a price for non-transient risk (i.e. a price for the contribution of μ_t to the variation in the continuation utility value). This term vanishes under power utility ($\psi \to \gamma^{-1}$), increases with the preference for the early resolution of uncertainty, $\gamma - 1/\psi$, and decreases in magnitude with the reversion in long-run growth. The price of risk due to the transitory shock, $\theta_z(t)$, has two components. The first, $\gamma(1+\phi)\sigma_z$, is a positive price for transient risk (i.e. the contribution of z_t to the instantaneous volatility of shareholders' consumption). The second, $\theta_z(t) - \gamma(1+\phi)\sigma_z$, is a price for non-transient risk (i.e. a price for the contribution of z_t to the variation in the continuation utility value). The latter term is negative and increases with the reversion of z_t under preferences for the early resolution of uncertainty, whereas it disappears under power utility. Both components of $\theta_z(t)$ increase in magnitude with ϕ: *the risk of owning capital due to labor rigidity is priced in equilibrium.* Under the usual parametrization $\gamma > \psi > 1$, z_t has a positive price for its effect on the current shareholders' consumption and a negative price for its effect on the evolution of the utility process.

Dividend Strips and Market Asset

Proposition 3. *The equilibrium price of the market dividend strip with maturity τ is given by*

$$P_{t,\tau} = \mathbb{E}_t\left[\xi_{t,t+\tau} D_{t+\tau}\right] = X_t e^{A_0(\tau)+A_\mu(\tau)\mu_t+A_z(\tau)z_t}, \tag{22}$$

where model parameters are such that the expectation exists finite, and A_0, A_μ and A_z are deterministic functions of time derived in the Appendix. The instantaneous volatility and premium on the dividend strip with maturity τ are given by

$$\sigma_P(t,\tau) = \sqrt{\sigma_x^2 + \tfrac{(1-e^{-\lambda_\mu\tau})^2(\psi-1)^2}{\lambda_\mu^2\psi^2}\sigma_\mu^2 + \tfrac{e^{-2\lambda_z\tau}(\psi+e^{\lambda_z\tau}-1)^2(1+\phi)^2}{\psi^2}\sigma_z^2}, \tag{23}$$

$$(\mu_P - r)(t,\tau) = \gamma\sigma_x^2 + \tfrac{(1-e^{-\lambda_\mu\tau})(1-1/\psi)(\gamma-1/\psi)}{\lambda_\mu(e^{cq}+\lambda_\mu)}\sigma_\mu^2 + \tfrac{\left(\frac{1}{\psi}(1-e^{-\lambda_z\tau})+e^{-\lambda_z\tau}\right)(\psi\gamma e^{cq}+\lambda_z)(1+\phi)^2}{\psi(e^{cq}+\lambda_z)}\sigma_z^2. \tag{24}$$

The price of the dividend strip is exponential affine in x_t, μ_t and z_t. Thus, the price relative to the dividend level is a stationary function of the states. The functions $A_\mu(\tau)$ and $A_z(\tau)$ are the semi-elasticities of the price:

$$A_\mu(\tau) = \partial_\mu \log P_{t,\tau} = \frac{(1-e^{-\lambda_\mu\tau})(1-1/\psi)}{\lambda_\mu}, \tag{25}$$

$$A_z(\tau) = \partial_z \log P_{t,\tau} = \left((1-e^{-\lambda_z\tau})/\psi + e^{-\lambda_z\tau}\right)(1+\phi). \tag{26}$$

Notice that $A_\mu(\tau)$ and $A_z(\tau)$ respectively increases and decreases with ψ. Moreover, $A_z(\tau)$ increases with labor rigidity ϕ. Thus, prices inherit the leverage effect on dividends: namely, the labor rigidity effect is amplified for $\psi < 1$ and vice-versa.

The permanent shock as well as the states μ_t and z_t contribute to the return volatility and command a premium. Permanent shocks do not lead to excess volatility. Instead, the expositions to $B_{\mu,t}$ and $B_{z,t}$, are proportional to the fundamentals' volatilities σ_μ and σ_z, but also depend on the horizon τ, the elasticity of intertemporal substitution and the persistence of the states. Namely, the exposition to long-run growth is increasing in ψ and decreasing in reversion λ_μ. The reverse holds for the exposition to the transitory shock, which is decreasing in ψ and increasing in λ_z. The latter is also amplified by the coefficient ϕ, which captures the leverage effect due to labor rigidity.

The dividend strip premium is the sum of three compensations. The permanent shock compensation has the usual form: $\gamma\sigma_x^2$. Such a premium is positive and is a compensation for transient risk. Instead, the compensations associated to the states μ_t and z_t depend also on the persistence of the states, the elasticity of intertemporal substitution as well as the horizon τ. The premium due to long-run growth is decreasing with reversion λ_μ and increasing with

ψ:

$$\frac{\gamma - 1/\psi}{\lambda_\mu(e^{cq} + \lambda_\mu)} A_\mu(\tau)\sigma_\mu^2. \tag{27}$$

Such a term is compensation for non-transient *long-run* risk (i.e. the contribution of μ_t to the variability of the continuation utility value of shareholders). If shareholders have preference for the early resolution of uncertainty and the intertemporal substitution effect dominates the wealth effect –i.e. the usual parametrization $\gamma > \psi > 1$– long-run growth commands a positive premium on the dividend strip. The premium due to the transitory shock z_t is the sum of two terms:

$$\gamma A_z(\tau)(1+\phi)\sigma_z^2, \qquad \text{and} \qquad -\frac{\lambda_z(\gamma - 1/\psi)}{e^{cq} + \lambda_z} A_z(\tau)(1+\phi)\sigma_z^2. \tag{28}$$

The former term is always positive, decreases with ψ and represents the compensation for transient risk. The latter term is the compensation for non-transient risk (i.e. the contribution of z_t to the variability of the continuation utility value of shareholders). This premium decreases with ψ and is negative (positive) under preference for the early (late) resolution of uncertainty. Finally, both terms increase in magnitude with the degree of labor rigidity, ϕ, and depend on the horizon τ.

Corollary 1. *The slopes of the term-structures of dividend strips' volatility and premia are given by*

$$\frac{\partial}{\partial\tau}\sigma_P^2(t,\tau) = \frac{2(\psi-1)}{\psi^2}\left(e^{-2\lambda_\mu\tau}(e^{\lambda_\mu\tau}-1)(\psi-1)\frac{\sigma_\mu^2}{\lambda_\mu} \;-\; e^{-2\tau\lambda_z}(e^{\tau\lambda_z}-1+\psi)\lambda_z(1+\phi)^2\sigma_z^2\right), \tag{29}$$

$$\frac{\partial}{\partial\tau}(\mu_P - r)(t,\tau) = \frac{\psi-1}{\psi^2}\left(\frac{(\gamma-1/\psi)e^{-\lambda_\mu\tau}\sigma_\mu^2}{e^{cq}+\lambda_\mu} \;-\; \frac{e^{-\tau\lambda_z}\lambda_z(e^{cq}\gamma\psi+\lambda_z)(1+\phi)^2\sigma_z^2}{e^{cq}+\lambda_z}\right). \tag{30}$$

Corollary 1 offers a number of insights. The slope of the term-structure of volatility depends on two terms, due respectively to the states μ_t and z_t. The former is always positive and, hence, induces an upward sloping effect. Instead, the latter term is negative if the intertemporal substitution effect dominates the wealth effect and vice-versa. Therefore, the term-structure of volatility is monotone upward sloping if $\psi < 1$, whereas it is not necessarily monotone if $\psi > 1$. A non-monotone (e.g. U-shaped) term-structure of risk obtains if labor rigidity leads to a leverage effect, ϕ, strong enough to outweigh the upward sloping effect due long-run growth, for some horizons τ.

Also the slope of the term-structure of premia depends on two terms, due respectively to the states μ_t and z_t. The former is positive if shareholders have preferences for the early resolution of uncertainty and the intertemporal substitution effect dominates the wealth effect. The latter term is negative if the intertemporal substitution effect dominates the wealth effect and vice-versa. Under the usual parametrization $\gamma > \psi > 1$, long-run growth leads to an upward-sloping effect, whereas transitory shocks lead to a downward-sloping effect. Therefore, the term-structure of equity premia is not necessarily monotone since both permanent and transitory shocks enter the model.

Lemma 3. *Provided $\gamma > \psi > 1$,*
i) the stronger labor rigidity, the smallest the slope of the term-structure of equity premia:

$$\tfrac{\partial^2}{\partial\phi\partial\tau}(\mu_P - r)(t,\tau) < 0;$$

ii) for labor rigidity strong enough, the slope of the term-structure of equity premia is negative

$$\exists\, \phi > 0 : \tfrac{\partial}{\partial\tau}(\mu_P - r)(t,\tau) < 0.$$

Thus, labor rigidity can explain in equilibrium the recent empirical findings by van Binsbergen et al. (2012), given standard preferences.

Proposition 4. *The equilibrium price of the market asset is given by*

$$P_t = \mathbb{E}_t\left[\int_t^\infty \xi_{t,u} D_u du\right] = X_t \frac{\alpha}{\beta} e^{(u_0 + u_\mu \mu_t + (u_z + \chi(1+\phi))z_t)/\chi} \tag{31}$$

where model parameters are such that the expectation exists finite, and u_0, u_μ and u_z are from Proposition 1. The instantaneous volatility and premium on the market asset are given by

$$\sigma_P(t) = \sqrt{\sigma_x^2 + \left(\frac{1-1/\psi}{e^{cq}+\lambda_\mu}\right)^2 \sigma_\mu^2 + \left(1 - \frac{(1-1/\psi)\lambda_z}{e^{cq}+\lambda_z}\right)^2 (1+\phi)^2\sigma_z^2}, \tag{32}$$

$$(\mu_P - r)(t) = \gamma\sigma_x^2 + \frac{(1-1/\psi)(\gamma - 1/\psi)}{(e^{cq}+\lambda_\mu)^2}\sigma_\mu^2 + \frac{(\gamma\psi e^{cq}+\lambda_z)(\psi e^{cq}+\lambda_z)}{(e^{cq}+\lambda_z)^2\psi^2}(1+\phi)^2\sigma_z^2. \tag{33}$$

The market price is the time integral of the dividend strip price over the infinite horizon: $P_t = \int_0^\infty P_{t,\tau} d\tau$. Therefore, the market price-dividend ratio is a stationary function of μ_t and z_t. Namely, prices increase with μ_t as long as the intertemporal substitution effect dominates the wealth effect and increase with z_t for any preference setting: $\partial_\mu P_t \gtreqless 0$ if $\psi \gtreqless 1, \forall\gamma$ and $\partial_z P_t > 0, \ \forall\psi,\gamma$.

Return volatility has three components due to the three shocks of the model. The permanent shock x_t does not lead to excess volatility. Instead, the price expositions to $B_{\mu,t}$ and $B_{z,t}$ depend on the preference parameters and are respectively increasing and decreasing in ψ. Interestingly, labor rigidity contributes to excess volatility since $\partial_z \log P_t$ increases in magnitude with ϕ.

Also the equity premium is given by three components due to the three shocks of the model. The permanent shock x_t leads to the usual positive premium $\gamma\sigma_x^2$ for transient risk. Long-run growth requires a compensation, which is positive if shareholders have preference for the early resolution of uncertainty and the intertemporal substitution effect dominates the wealth effect. Instead, z_t commands a premium which is always positive, increasing with γ and decreasing with ψ. Moreover, such a compensation term increases with the degree of labor rigidity ϕ.

Returns of Value and Growth Firms

Now the focus turns on the characterization of the equilibrium returns of the dividend claims on single firms.

Proposition 5. *The equilibrium price of the dividend claim of the firm with residual life T is given by*

$$P_t^T = \mathbb{E}_t\left[\int_0^T \xi_{t,t+\tau} D_{t+\tau}^{T-\tau} d\tau\right] = X_t \int_0^T e^{H_0(\tau,T)+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau \tag{34}$$

where model parameters are such that the expectation exists finite, and H_0, H_μ and H_z are deterministic functions of time derived in the Appendix. The instantaneous return volatility and premium are given by

$$\sigma_P^T(t) = \sqrt{\sigma_x^2 + \left(\partial_\mu \log P_t^T\right)^2 \sigma_\mu^2 + \left(\partial_z \log P_t^T\right)^2 \sigma_z^2}, \tag{35}$$

$$(\mu_P^T - r)(t) = \theta_x(t)\sigma_x + \theta_\mu(t)\left(\partial_\mu \log P_t^T\right)\sigma_\mu + \theta_z(t)\left(\partial_z \log P_t^T\right)\sigma_z. \tag{36}$$

The single-firm price is the time integral of the market dividend strip prices over the residual life weighted by dividend shares: $P_t^T = \int_0^T s(T-\tau)P_{t,\tau} d\tau$. Prices increase with μ_t if the intertemporal substitution effect dominates the wealth effect and vice-versa, and increase with z_t. The single firm price-dividend ratio is a stationary nonlinear function of the long-run growth and the transitory shock:

$$\log \frac{P_t^T}{D_t^T} = \log\left(\int_0^T e^{H_0(\tau,T)+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau\right) - \log S(T) - \log\alpha - (1+\phi)z_t.$$

Although μ_t and z_t are homoscedastic, the return moments are endogenously state-dependent.

Denote with T^{growth} and T^{value} the residual life of firms that we interpret respectively as growth and value firms. Thus, $T^{\text{growth}} > T^{\text{value}}$. The value premium is given by the difference between the return premium on value firms over growth firms:

$$\begin{aligned} VP(t) &= (\mu_P^{\text{value}} - r)(t) - (\mu_P^{\text{growth}} - r)(t) \\ &= \underbrace{\theta_\mu(t)\sigma_\mu\left(\partial_\mu \log P_t^{\text{value}} - \partial_\mu \log P_t^{\text{growth}}\right)}_{\mathcal{VP}_\mu(t),\ \text{value premium due to long-run risk}} + \underbrace{\theta_z(t)\sigma_z\left(\partial_z \log P_t^{\text{value}} - \partial_z \log P_t^{\text{growth}}\right)}_{\mathcal{VP}_z(t),\ \text{value premium due to short-run risk}}. \end{aligned} \tag{37}$$

The value premium is given by two terms. The former, $\mathcal{VP}_\mu(t)$, is due to long-run growth and the latter, $\mathcal{VP}_z(t)$, to the transitory shock. Both are proportional to the corresponding prices of risk, $\theta_\mu(t)$ and $\theta_z(t)$, and to the value-growth differential in the semi-elasticities of prices with respect to μ_t and z_t.

Lemma 4. *Provided $\gamma > \psi > 1$,*
i) long-run growth contributes negatively to the value premium:

$$\mathcal{VP}_\mu(t) < 0;$$

ii) transitory shock contributes positively to the value premium:

$$\mathcal{VP}_z(t) > 0;$$

iii) for labor rigidity strong enough, the value premium is positive:

$$\exists\, \phi > 0 : VP(t) > 0.$$

For $\gamma > \psi > 1$, both $\theta_\mu(t)$ and $\theta_z(t)$ are positive. However, since μ_t is embedded in a permanent process, X_t, the sensitivity of discounted cash-flows, $H_\mu(\tau)$, is monotone increasing with the horizon. Vice-versa, the transitory nature of z_t makes the sensitivity of discounted cash-flows, $H_z(\tau)$, monotone decreasing with the horizon. In turn, the value-growth differential in the semi-elasticities of prices with respect to μ_t and z_t are respectively negative and positive. Therefore, time-variation in long-run growth leads to a growth premium, whereas transitory shocks lead to a value premium. Such an equilibrium mechanism is consistent with Lettau and Wachter (2007, 2011): if priced risk concentrates in the short-run, the compensation $(\mu_P^T - r)(t)$ decreases with residual life T. That is, value firms deserve a higher premium than growth firms. Therefore, an economy characterized by downward-sloping term-structures of equity premia automatically feature a cross-sectional value premium. While Lettau and Wachter (2007, 2011) point out such a connection in a partial equilibrium framework with an ad-hoc pricing kernel, this paper provides an economic foundation in general equilibrium. Namely, labor rigidity enhances the price of short-run risk and shifts toward the short horizon market compensations. In turn, value firms, i.e. shorter-horizon equity, require a larger premium than growth firms, i.e. longer-horizon equity.

Lemma 5. *Provided $\gamma > \psi > 1$ and λ_z small enough, the value premium is counter-cyclical, i.e. it decreases with the transitory shock:*

$$\partial_z\, \mathcal{VP}_z(t) < 0.$$

For labor rigidity strong enough, the value premium is positive and counter-cyclical consistently with actual data. Notice that such equilibrium dynamics of the value premium is *endogenous* and obtains even if the three shocks of the model are homoscedastic. Moreover, the value premium moves positively with the labor-share and, hence, negatively with its expected change. Indeed, in presence of a negative transitory shock, on the one hand, the value premium increases and, on the other hand, labor rigidity leads to an increase of the labor-share. Given stationarity, the labor-share is expected to decrease in the future. Therefore, the value premium and the expected change of the labor-share

$$\mathbb{E}_t[d\omega(z_t)]/dt = \alpha\phi e^{\phi z_t}\left(\lambda_z z_t - \phi\sigma_z^2/2\right),$$

are negatively related most of the times, as empirically documented in Section 2 and in Table 2.

4 Discussion

4.1 Model Calibration

Model parameters are set by choosing cash-flows parameters in order to match some moments from the time-series of consumption, wages and dividends growth rates and by choosing preference parameters to provide a good fit of standard asset pricing moments.

The calibration procedure uses information from the term-structures of cash-flows to assess the equilibrium asset pricing implications. Namely, I exploit analytical solutions to set the cash-flows parameters. The model has eight parameters $\Theta = \{\bar{\mu}, \sigma_x, \lambda_\mu, \sigma_\mu, \lambda_z, \sigma_z, \alpha, \phi\}$, which characterize the joint dynamics of aggregate consumption, wages and dividends. I choose eight moment conditions: the relative error between the empirical and the model long-run growth of consumption (g_C), yearly volatility of consumption ($\sigma_C(1)$) and dividends ($\sigma_D(1)$) growth rates, average level of the dividend-share (δ) and its volatility (σ_δ):

$$m_1(\theta) = \frac{|g_C^{\text{empirical}} - g_C|}{g_C^{\text{empirical}}},$$
$$m_2(\theta) = \frac{|\sigma_C(1)^{\text{empirical}} - \sigma_C(1)|}{\sigma_C(1)^{\text{empirical}}},$$
$$m_3(\theta) = \frac{|\sigma_D(1)^{\text{empirical}} - \sigma_D(1)|}{\sigma_D(1)^{\text{empirical}}},$$
$$m_4(\theta) = \frac{|\delta^{\text{empirical}} - \delta|}{\delta^{\text{empirical}}},$$
$$m_5(\theta) = \frac{|\sigma_\delta^{\text{empirical}} - \sigma_\delta|}{\sigma_\delta^{\text{empirical}}},$$

and three additional conditions that capture the average relative error between the empirical and the model term-structures of variance ratios of consumption, wages and dividends over a ten years horizon:

$$m_6(\theta) = \int_1^{10} \frac{|VR_C^{\text{empirical}}(\tau) - VR_C(\tau)|}{VR_C^{\text{empirical}}(\tau)} d\tau,$$
$$m_7(\theta) = \int_1^{10} \frac{|VR_W^{\text{empirical}}(\tau) - VR_W(\tau)|}{VR_W^{\text{empirical}}(\tau)} d\tau,$$
$$m_8(\theta) = \int_1^{10} \frac{|VR_D^{\text{empirical}}(\tau) - VR_D(\tau)|}{VR_D^{\text{empirical}}(\tau)} d\tau.$$

The variance-ratios of growth rates are computed as $VR_i(\tau) = \frac{\sigma_i^2(\tau)}{\sigma_i^2(1)}$ for $i = \{C, W, D\}$. The latter three moment conditions capture the timing of the macroeconomic risk and, in particular, the term-structure effect of labor rigidity.

Finally, I obtain the parameter vector Θ by minimizing the average-relative-error:

$$\Theta = \arg\min_\theta ARE(\Theta) = \arg\min_\theta \tfrac{1}{8} \sum_{i=1}^{8} m_i(\theta).$$

The empirical moments are as follows: I set the long-run growth rate of consumption to 2% and the volatility of consumption to 2.5%, which are the usual values from the literature; the volatility of dividends is set to 15%, which is the value reported in Belo et al. (2015); the average value of the dividend-share is set to 6% and its volatility to 1.6%, which are computed using the ratio of net dividends over the sum of net dividends and wages from the US non-financial corporate sector (as in the model). These numbers are close to the values considered in Longstaff and Piazzesi (2004), Lettau and Ludvigson (2005) and Santos and Veronesi (2006). The variance-ratios of wages and dividends are computed as in Section 2: wage risk increases from one to about 2 over a 10 years horizon, whereas dividend risk decreases from one to about 0.2. Finally, the variance-ratios of consumption are computed from the growth rates in Beeler and Campbell (2012) and increase from one to about 1.5 over a 10 years horizon.

Table 5 reports the model parameters and Table 6 reports both the empirical and the model-implied moments of cash-flows. The left panel of Figure 4 shows the model implied

Table 5: Calibration – Model parameters

	Symbol	Value
volatility of permanent shock	σ_x	.001
steady-state long-run growth	$\bar{\mu}$	.020
reversion of long-run growth	λ_μ	.591
volatility of long-run growth	σ_μ	.017
reversion of transitory shock	λ_z	.300
volatility of transitory shock	σ_z	.027
steady-state dividend share	δ	.058
labor rigidity	ϕ	5.77

term-structures of variance-ratios for both aggregate consumption, wages and dividends, as well as their empirical counterparts. The model accurately captures both rise and decline

Table 6: Calibration – Cash-flows moments

	Symbol	Data	Model
long-run growth	g_C	.020	.020
one year consumption volatility	$\sigma_C(1)$	.025	.025
one year dividends volatility	$\sigma_D(1)$	.150	.161
dividend-share average	δ	.060	.058
dividend-share volatility	σ_δ	.016	.012

Variance ratios of consumption $VR_C(\tau)$

τ	2	3	4	5	6	7	8	9	10
Data	1.11	1.17	1.20	1.20	1.20	1.19	1.19	1.20	1.21
Model	1.01	1.05	1.09	1.13	1.15	1.17	1.19	1.20	1.21

Variance ratios of wages $VR_W(\tau)$

τ	2	3	4	5	6	7	8	9	10
Data	1.27	1.48	1.66	1.84	2.01	2.18	2.30	2.34	2.24
Model	1.25	1.51	1.73	1.89	2.01	2.11	2.18	2.24	2.29

Variance ratios of dividends $VR_D(\tau)$

τ	2	3	4	5	6	7	8	9	10
Data	0.61	0.41	0.32	0.28	0.27	0.25	0.23	0.21	0.24
Model	0.78	0.63	0.52	0.44	0.38	0.33	0.30	0.27	0.25

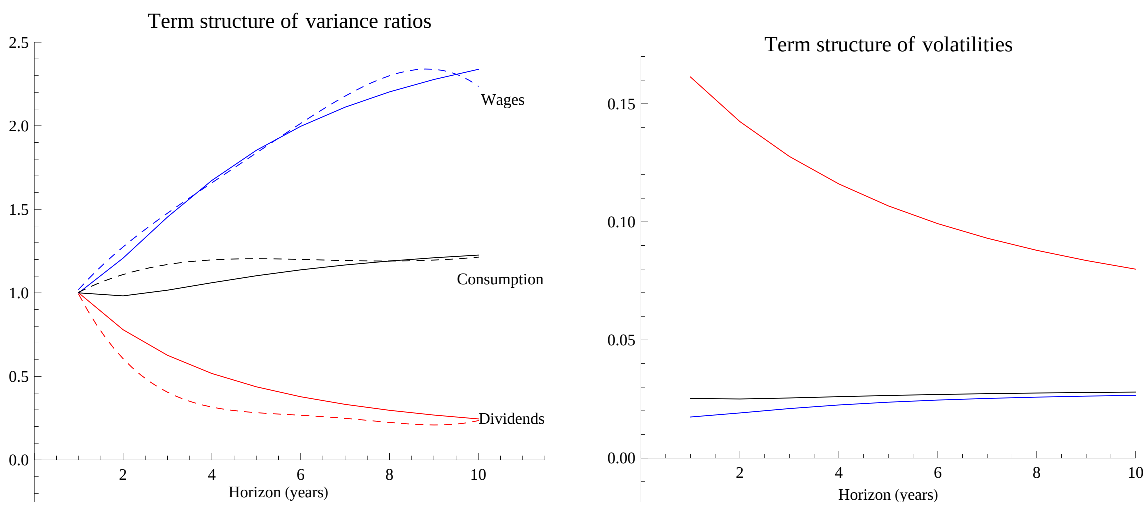


Figure 4: Term-structures of consumption, wages and dividends

Left panel: Variance-ratios of wages (blue), consumption (black) and dividends (red) as a function of the horizon. Dashed lines denote empirical data. Right panel: Volatility of wages (blue), consumption (black) and dividends (red) as a function of the horizon. Cash-flows parameters are from Table 5.

of respectively wage and dividend risk with the horizon. Therefore, the calibration procedure seems to do a good job at recovering the whole shape of the empirical term-structures and, hence, the timing of consumption, wages and dividend risk. The size of such risks is shown in the right panel of Figure 4, which plots the term-structures of the corresponding volatilities. The decline in the timing of dividend risk is due to the levered exposition of dividends to the transitory component of consumption, z_t: namely, $\phi = 5.77$ is required to obtain both i) the correct slope of the term-structure of dividends volatilities, and ii) the excess of volatility of dividends over consumption in yearly growth rates (i.e. 15% versus 2.5%). At the same time, the model leads to smooth wage growth rates (i.e. 2%).

A number of insights are noteworthy. First, although very parsimonious, the model dynamics are flexible enough to capture the main properties of the empirical data.

Second, the heterogeneity in the term-structures of risk of consumption, wages and dividends obtains from a single parameter ϕ. Consistently with the empirical findings of Section 2, matching the positive slope of wage risk allows to fill the gap between the barely flat term-structure of consumption risk and the downward-sloping one of dividend risk. Thus, the model calibration further supports the idea that labor rigidity is the main determinant of the timing of macroeconomic risk.

Third, the shape of the term-structure of dividend risk is the result of the combination of a downward-sloping effect due to z_t and an upward-sloping effect due to μ_t. One issue with asset pricing models is that often the main model mechanism essentially relies on a latent factor which is difficult to estimate. A calibration procedure which exploits the information implied by the term-structures of risk of macroeconomic variables i) allows to capture additional empirical moments, and ii) offers a way to infer about the persistence (λ_μ, λ_z) and the variance (σ_μ, σ_z) of latent factors.

Fourth, the long-run growth factor μ_t has moderately persistent and smooth dynamics ($\lambda_\mu = .59$ and $\sigma_\mu = 1.7\%$). The model does not require an excessive persistence in expected consumption growth, as suggested by Constantinides and Ghosh (2011) and Beeler and Campbell (2012).

Finally, I set shareholders' preference parameters such that they have preference for the early resolution of uncertainty ($\gamma > 1/\psi$) and the intertemporal substitution effect dominates the wealth effect ($\psi > 1$), as in most of the asset pricing literature. Namely, in the baseline calibration the pair $\gamma = 10$ and $\psi = 1.25$ belongs to the usual range of values. The time-discount rate β is set to 4%.

4.2 Dividend Strips and Market Asset

The model reconciles the evidence about the term-structure of both equity and macroeconomic variables with standard asset pricing facts. The baseline calibration ($\gamma = 10, \psi = 1.25$)

Table 7: Return moments

Data

sample	r %	σ_r %	$\mu_P - r$ %	σ_P %	SR%	$\log P/D$	$\sigma_{\log P/D}$ %
1931-2009	0.60	3.00	6.20	19.8	31.3	3.38	45.0
1947-2009	1.00	2.70	6.30	17.6	35.8	3.47	42.9

Model – Baseline calibration

γ	ψ	β %	r %	σ_r %	$\mu_P - r$ %	σ_P %	SR%	$\log P/D$	$\sigma_{\log P/D}$ %	strip premium slope	value premium
10	1.25	4	1.59	4.67	5.29	15.3	34.6	3.29	22.4	< 0	> 0

Model – Walrasian benchmark (no labor rigidity: $\phi = 0$)

γ	ψ	β %	r %	σ_r %	$\mu_P - r$ %	σ_P %	SR%	$\log P/D$	$\sigma_{\log P/D}$ %	strip premium slope	value premium
10	1.25	4	5.44	1.58	1.05	18.4	5.7	3.30	3.41	≈ 0	≈ 0

Model – Alternative preference settings

γ	ψ	β %	r %	σ_r %	$\mu_P - r$ %	σ_P %	SR%	$\log P/D$	$\sigma_{\log P/D}$ %	strip premium slope	value premium
10	.75	4	-1.38	7.79	10.70	24.0	44.7	3.11	36.4	> 0	< 0
	1	4	0.62	5.80	7.10	18.6	38.2	3.22	0.00	$= 0$	$= 0$
	1.25	4	1.59	4.67	5.29	15.3	34.6	3.29	22.4	< 0	> 0
	1.5	4	2.14	3.89	4.22	13.1	32.3	3.35	37.5	< 0	> 0
7.5	.75	4	0.01	7.79	9.38	24.0	39.1	3.10	36.4	> 0	< 0
	1	4	1.67	5.80	6.01	18.4	32.6	3.22	0.00	$= 0$	$= 0$
	1.25	4	2.39	4.67	4.45	15.3	29.1	3.30	22.4	< 0	> 0
	1.5	4	2.81	3.89	3.50	13.1	26.8	3.36	37.5	< 0	> 0
5	.75	4	1.45	7.79	8.00	24.0	33.4	3.08	36.4	> 0	< 0
	1	4	2.65	5.80	5.07	18.6	32.2	3.22	0.00	$= 0$	$= 0$
	1.25	4	3.19	4.67	3.63	15.3	23.7	3.31	22.4	< 0	> 0
	1.5	4	3.47	3.89	2.80	13.1	21.4	3.38	37.5	< 0	> 0

accurately matches the unconditional level of the equity premium, which is about 5.3%, quite close to the real data. Such a result is particularly remarkable since neither stochastic volatility and jumps nor unrealistically high and time-varying risk aversion are required. The return volatility is about 15.5%, which is also close to the real data. Moreover, return volatility leads to a large excess-volatility over consumption and dividends on the whole term-structure, including the long-horizon. The model produces a Sharpe ratio (about 35%), which accurately matches the real data. Such a result is peculiar and due short-run but persistent risk, magnified by labor rigidity. The model leads to a risk-free rate (about 1.5%) and a relatively low volatility (about 4.5%), quite line with the real data. The model also captures quite well the level and the volatility of the price-dividend ratio (about exp(3.3) and 22.5%). Table 7 summarizes the empirical and the model-implied moments and reports the asset pricing moments for many pairs (γ, ψ). A low risk-free rate and high levels of the first two return moments of the market asset obtain for $(\gamma = 10, \psi = 1.25)$, $(\gamma = 7.5, \psi = 1)$ and $(\gamma = 5, \psi = .75)$. Decreasing the elasticity of intertemporal substitution leads to an increase in the equity premium but a price-dividend ratio and a risk-free rate which are respectively too smooth and too volatile in comparison with the data. Hence, the choice ($\gamma = 10, \psi = 1.25$) seems preferable. The leverage effect due to labor rigidity not only is crucial to the modeling of the term-structures but also helps to match the standard asset pricing moments. The premium increases with ϕ and decreases with ψ, all else being equal. The latter relation has the following rationale. The correct calibration of the timing of macroeconomic risk implies that in equilibrium the price for short-run but persistent risk dominates the price of long-run variations in long-run growth.

The benchmark or Walrasian case with no labor rigidity ($\phi = 0$) and, hence, constant labor-share does not give rise to a value premium. Moreover, it fails to describe both the risk-free rate and equity premium puzzle as well as the downward-sloping term-structure of equity.

The intertemporal substitution effect dominates the wealth effect ($\psi > 1$) and shareholders have preference for the early resolution of uncertainty ($\gamma > 1/\psi$). The term structures of both premia and return volatility decrease with the maturity at short and medium horizons –in which the downward-sloping effect due to the transitory shock dominates the upward-sloping effect due to long-run growth– and are approximatively flat at long horizons –in which the two effects offset each other. The left panel of Figure 5 shows the term structures of equity premia and volatility as a function of the horizon. The slope of the term structures depends on the

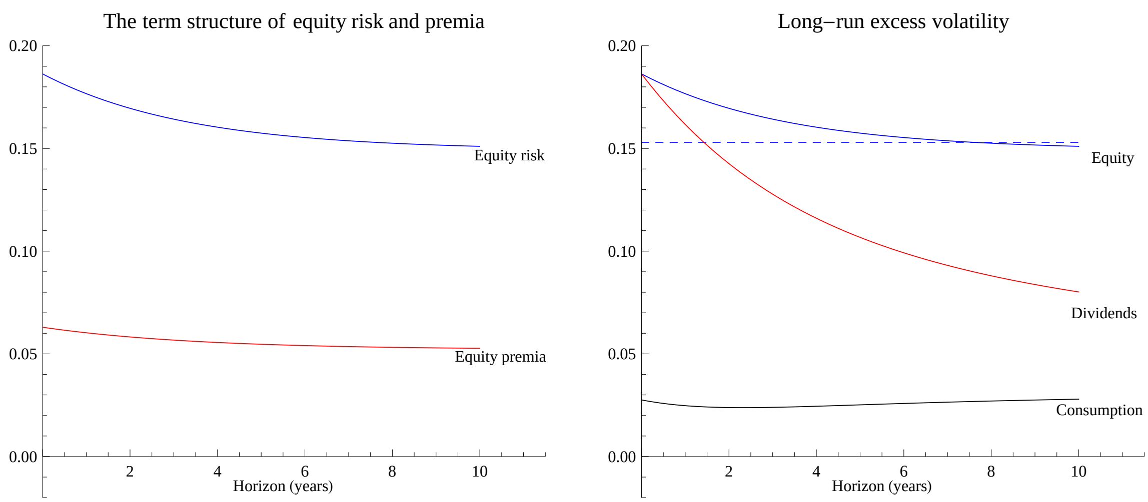


Figure 5: Term-structures of equity, consumption, and dividends

Left panel: Equity volatility (blue) and equity premium (red) as a function of the horizon. Right panel: Equity volatility (blue, solid and dashed line denote respectively dividend strip and stock), dividend volatility (red) and consumption volatility (black) as a function of the horizon. Cash-flows parameters are from Table 5 and $\gamma = 10, \psi = 1.5$ and $\beta = 4\%$.

degree of labor rigidity, ϕ. A larger parameter ϕ increases the leverage effect on dividends and, in turn, the price associated to transitory risk. Consequently, for $\psi > 1$ the term-structures of equity volatility and premia would decrease over a longer horizon and slopes would be larger in magnitude.

Equity features excess volatility over dividends at any horizon and approaches a value above fundamentals' risk in the long-run, as shown in right panel of Figure 5. Such a result obtains endogenously and although homoscedasticity of fundamentals. The model long-run excess volatility of equity over dividends is in line with the recent empirical evidence about the decreasing variance ratios of dividends, documented by Belo, Collin-Dufresne, and Goldstein (2015) and Marfè (2013a). Instead, many asset pricing models imply payouts to shareholders riskier than equity returns, as pointed out by Beeler and Campbell (2012).

4.3 Returns of Value and Growth Firms

Firm dividends are as in Section 3.2 and in spirit of Lettau and Wachter (2011). The share process and, equivalently, the (stable) distribution of firms is plotted in the upper left panel of Figure 6. Firms whose cash-flows weigh more on the short horizon are interpreted as value firms, whereas firms whose cash-flows weigh more on the long horizon are interpreted as growth firms. Indeed, equilibrium price-dividend ratios are increasing with residual life T. As shown in the upper right panel of Figure 6, ratios of prices over fundamentals are larger for growth firms than for value firms, as in the actual data. Notice that this also holds in absence of labor rigidity ($\phi = 0$). Instead, income insurance due to labor rigidity is important in the determination of equilibrium equity volatility and premia. Steady-state return volatility and premia are plotted as a function of the firm residual life in the lower panels of Figure 6.

In presence of labor rigidity ($\phi > 0$) and under standard preferences ($\gamma > \psi > 1$), priced risk shifts toward the short-run and, hence, short-run cash-flows deserve a substantial compensation. Then, equilibrium premia and volatilities decrease with the firm residual life. In line with the actual data, value firms require larger premia than growth firms. Hence, labor rigidity helps to jointly explain in general equilibrium the value premium, the term-structures of risk of macroeconomic variables, the term-structures of equity as well as standard asset pricing facts. Vice-versa, in absence of labor rigidity ($\phi = 0$), the price of transitory risk dramatically diminishes and, in turn, short-run cash-flows do not require a larger compensation of long-run cash-flows. Hence, the value premium disappears. Moreover, under a model calibration with stronger long-run growth persistence, the reverse mechanism takes place and a growth premium would obtain.

The range of variation of premia over the firm life-cycle is relatively small (1% versus the empirical value premium which is about 4-5% in the actual data). This can be due to the fact that i) the share-process is assumed to be deterministic; ii) the state-variables are assumed to be homoscedastic; and iii) the model does not account for cross-sectional heterogeneity in the degree of labor rigidity. However, such assumptions are made for the sake of simplicity

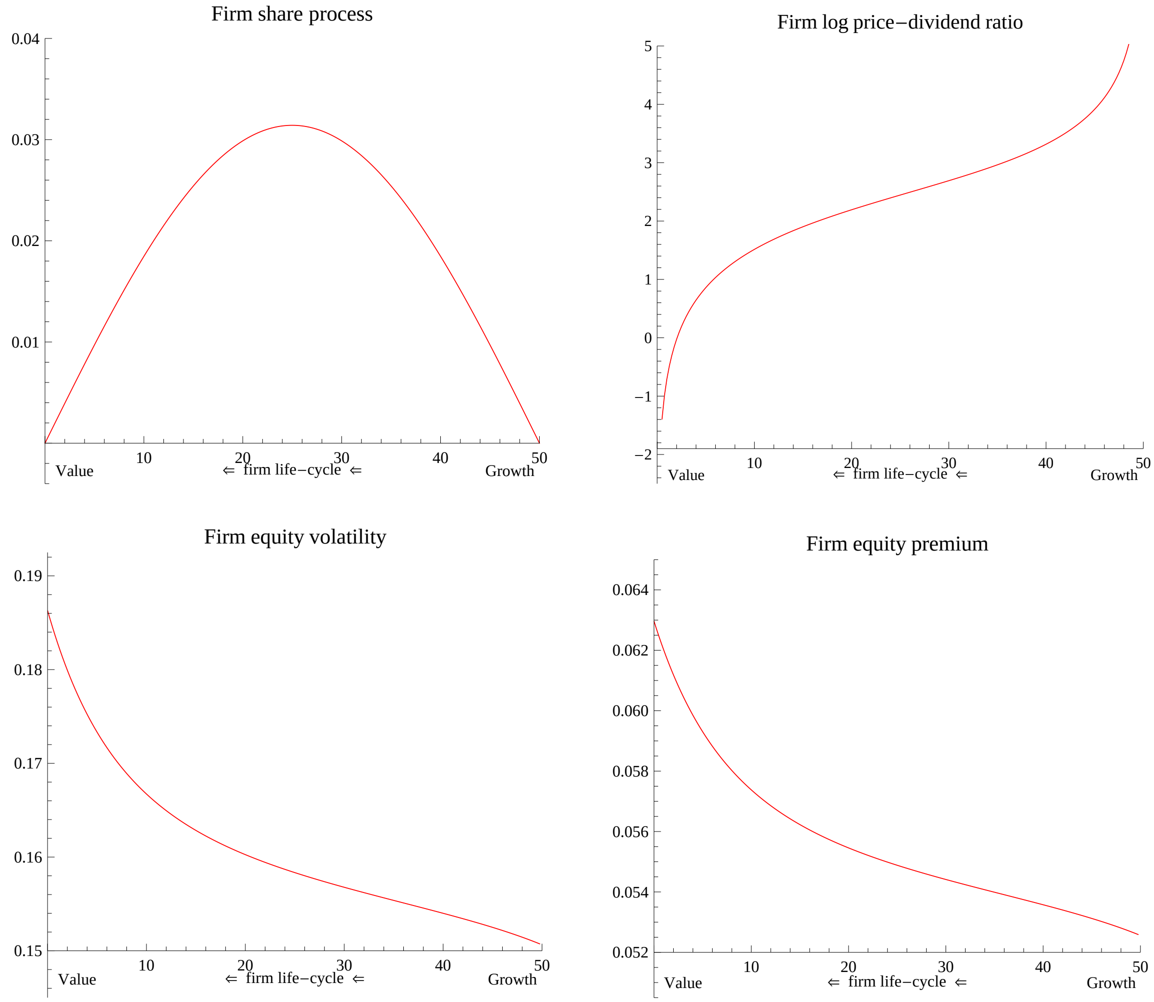


Figure 6: Equity returns of value and growth firms

Upper left panel: Firm dividend-shares as a function of the firm life-cycle T. Upper right panel: Log price-dividend ratio as a function of the firm life-cycle T. Lower left panel: Firm equity volatility as a function of the firm life-cycle T. Lower right panel: Firm equity premium as a function of the firm life-cycle T. Cash-flows parameters are from Table 5 ($T^{\max} = 50$) and $\gamma = 10, \psi = 1.5$ and $\beta = 4\%$.

and exposition and can be relaxed without altering the qualitative implications of the model, which provides an equilibrium explanation to the empirical findings of Section 2. Some model extensions are discussed in Section 4.4.

The rationale for the value premium differs from Lettau and Wachter (2007). Their paper proposes a partial equilibrium model: the state-price density is exogenously specified and features a time-varying price of risk uncorrelated with fundamentals –which is an assumption difficult to obtain in general equilibrium. Here, instead, the value premium obtains for a state-price density derived in general equilibrium and motivated by the *cyclicality* and *term-structure effects* of labor rigidity.

Moreover, the model does not need a time-varying price of risk either to generate the value premium or to generate its counter-cyclical dynamics and its dynamic relation with the labor-share.[11] Indeed, the model leads to an equity compensation for value firms over growth firms which is decreasing with the transitory shock z_t. Consequently, under labor rigidity ($\phi > 0$), the model value premium is negatively related with the expected change of the labor-share and positively related with the current level of the labor-share. The left and right panels of Figure 7 depict these relationships, which are consistent with the empirical findings of Section 2.3 and Figure 2.

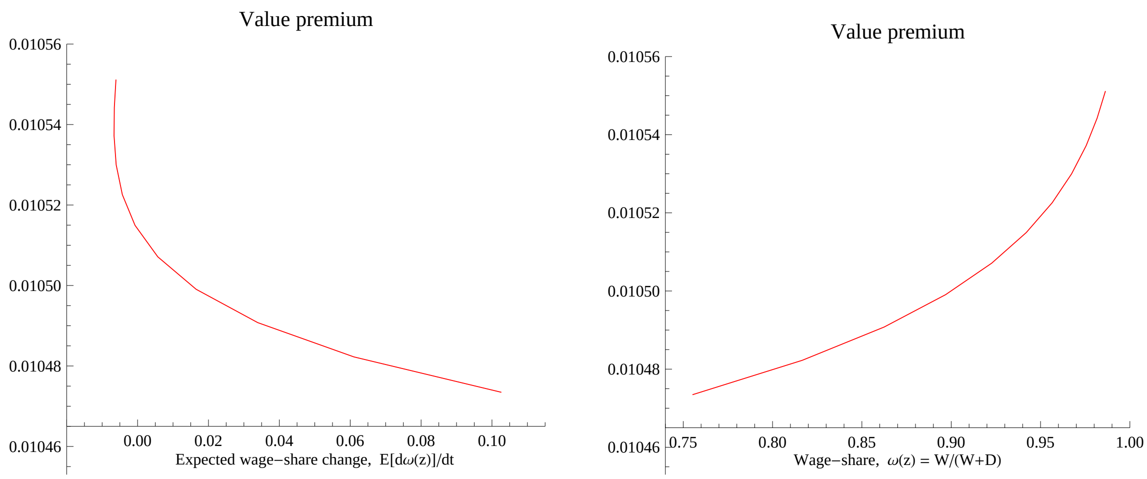


Figure 7: Value premium and wage share

Value premium as a function of the expected change in the labor share (left panel) and of the current level of the labor share (right panel). Cash-flows parameters are from Table 5 ($T^{\max} = 50$) and $\gamma = 10, \psi = 1.5$ and $\beta = 4\%$.

4.4 Remarks and Model Extensions

The model shows that labor rigidity shifts dividend risk toward the short horizon. Such a *term-structure effect*, on the one hand, enhances the pricing at equilibrium of short-run risk and, on the other hand, generates cross-sectional heterogeneity in the market compensation of shorter and longer duration equities. This provides a rationale for the value premium. In addition, consistently with the actual data, the model mechanism generates a dynamic positive

[11] While I do not argue that the price of risk is constant, the model shows that a counter-cyclical price of risk is not a *necessary* building block to generate the value premium (as suggested instead by Zhang (2005) and Lettau and Wachter (2011)). The model extension of Section 4.4 shows that a counter-cyclical price of risk helps to *quantitatively* match the value premium and its dynamics. Notice that the model assumption of Eq. (7) jointly with fundamentals' homoscedasticity automatically leads to constant price of risk. However, labor rigidity leads to *endogenously* counter-cyclical price of risk as long as a slightly different (non-exponential-affine) specification of D_t is assumed. For instance, by setting $D_t = C_t - (1-\alpha)X_t Z_t^{1-\phi}$, then $\phi > 0$ can still be interpreted as the leverage effect on dividends due to labor rigidity and the price of risk $\theta_z(t)$ becomes a decreasing function of z_t under standard preferences. I avoid such a specification for the sake of analytical tractability under recursive utility.

relation between the current level of the labor-share and the expected premium of value firms over growth firms. Unfortunately the magnitude of the value premium and its variation are quite limited under the simple assumptions of the model.

Two ways to improve the *quantitative* results of the model are: i) introducing cross-sectional heterogeneity in the degree of labor rigidity; and ii) introducing heteroscedasticity in fundamentals. The former concerns the pricing of single firm claims, whereas the latter also affects the equilibrium discount rates.[12]

Cross-sectional labor rigidity

In order to model cross-sectional heterogeneity in labor rigidity, consistently with the main model, I assume a firm-specific exposition of dividends to the transitory shock z_t. Namely, I define the firm dividends as:

$$D_t^{T,\rho} = D_t s(T, \rho, z_t)$$

where

$$s(T, \rho, z_t) = s(T) \times \frac{e^{\rho z_t}}{\int_{\rho \in \mathcal{R}} e^{\rho z_t} dF(\rho)}$$

and $F(.)$ is the distribution of the firm specific labor rigidity ρ.[13]

I consider the baseline calibration of Section 4.1 and I assume cross-sectional labor rigidity through a normal distribution $\rho \sim \mathcal{N}(0, \sigma_\rho)$ centered at zero. Figure 8 reports the firm equity premium as a function of residual life T and firm-specific labor rigidity ρ. We observe that for firms whose cash-flows weigh on the short-horizon (small T) the premium is strongly increasing with ρ. Instead, for firms whose cash-flows weigh on the long-horizon (large T) the premium is almost insensitive to ρ. This is due to the fact that long-run cash-flows are barely affected by transitory risk.

Figure 8 shows that the aggregate labor rigidity channel of the value premium is enhanced (weakened) if firm-specific labor rigidity ρ is negatively (positively) correlated with the firm life-cycle T. In particular, the value premium implied by the (low-T, high-ρ)-(high-T, low-ρ) diagonal in Figure 8 is about five times larger than the value premium in the main model (lower right panel of Figure 6) and quite in line with the actual data (about 5%). Favilukis and Lin

[12]The model can be further extended by introducing cross-sectional heterogeneity in fundamentals' idiosyncratic volatility. The model would be likely able to produce cross-sectional alpha's and beta's in conditional CAPM regressions, in line with actual data. Such an extension goes beyond of the scope of the paper (i.e. the dynamic relation between *aggregate* labor rigidity and value premium) and, hence, is left to future research.

[13]Notice that $(\int_{\rho \in \mathcal{R}} e^{\rho z_t} dF(\rho))^{-1}$ can be arbitrarily approximated as a sum of power functionals by a Taylor series around the steady-state of e^{z_t}: $\sum_{j=0}^{n} q_j e^{j z_t}$ for some constants q_j which depend on the parametric choice for $F(.)$. Therefore, up to such an approximation, the dividend process $D_t^{T,\rho}$ can be written as a sum of exponential affine functions of x_t and z_t. In turn, the firm equity price and return moments have analytical solutions. In the example of this section, $n = 3$ provides an almost perfect approximation over the stationary distribution of z_t.

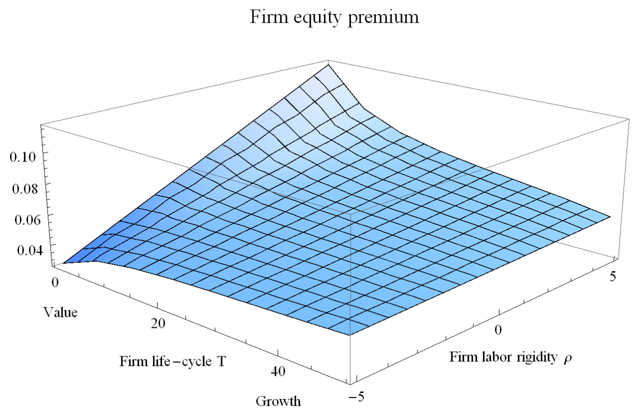


Figure 8: Value premium and cross-sectional labor rigidity

Value premium as a function of the firm life-cycle T and the firm-specific labor rigidity ρ. Cash-flows parameters are from Table 5 ($T^{\max} = 50, \sigma_\rho = 3/2$) and $\gamma = 10, \psi = 1.5$ and $\beta = 4\%$.

(2015) document that value firms have larger operational costs due to labor than growth firms, which is consistent with a negative correlation between T and ρ.

Counter-cyclical heteroscedasticity

I introduce counter-cyclical heteroscedasticity in fundamentals by substituting the dynamics of Eq. (6) with

$$Z_t = e^{z_t} = e^{\bar{z}-\hat{z}_t}, \qquad \text{with} \qquad d\hat{z}_t = \lambda_z(\bar{z} - \hat{z}_t) + \hat{\sigma}_z\sqrt{\hat{z}_t}dB_{z,t},$$

where $\hat{\sigma}_z = \sigma_z/\sqrt{\bar{z}}$ and $\bar{z} > 0$ such that z_t is still a zero-mean reverting process but its volatility is decreasing with z_t, i.e. it is counter-cyclical. Since z_t is still in the affine class, the model can be solved with the same methodology of the previous sections.

At the aggregate level the above dynamics for z_t leads to a price of transitory risk decreasing with z_t (i.e. $\partial_z\theta_z(t) < 0$) and, in turn, to counter-cyclical Sharpe ratios and equity premium. Moreover, the *term-structure effect* of labor rigidity strengthens in bad times and diminishes in good times. As a consequence, we expect that the range of variation of the value premium over z_t and, hence, over the labor share $\omega(z_t)$ increases in comparison with the homoscedastic model of the previous sections.

I consider the same calibration of Table 5 and the baseline preference parameters $\gamma = 10, \psi = 1.25$ and $\beta = 4\%$. The only additional parameter is $\bar{z} = .1$. The upper left panel of Figure 9 reports the model-implied and the empirical term-structures of risk of consumption, wages and dividends. Similarly to the homoscedastic model in Figure 4, also the heteroscedastic model does a good job at matching the timing of macroeconomic risk. Heteroscedasticity does not deteriorate the model predictions about standard asset pricing facts. Namely, the

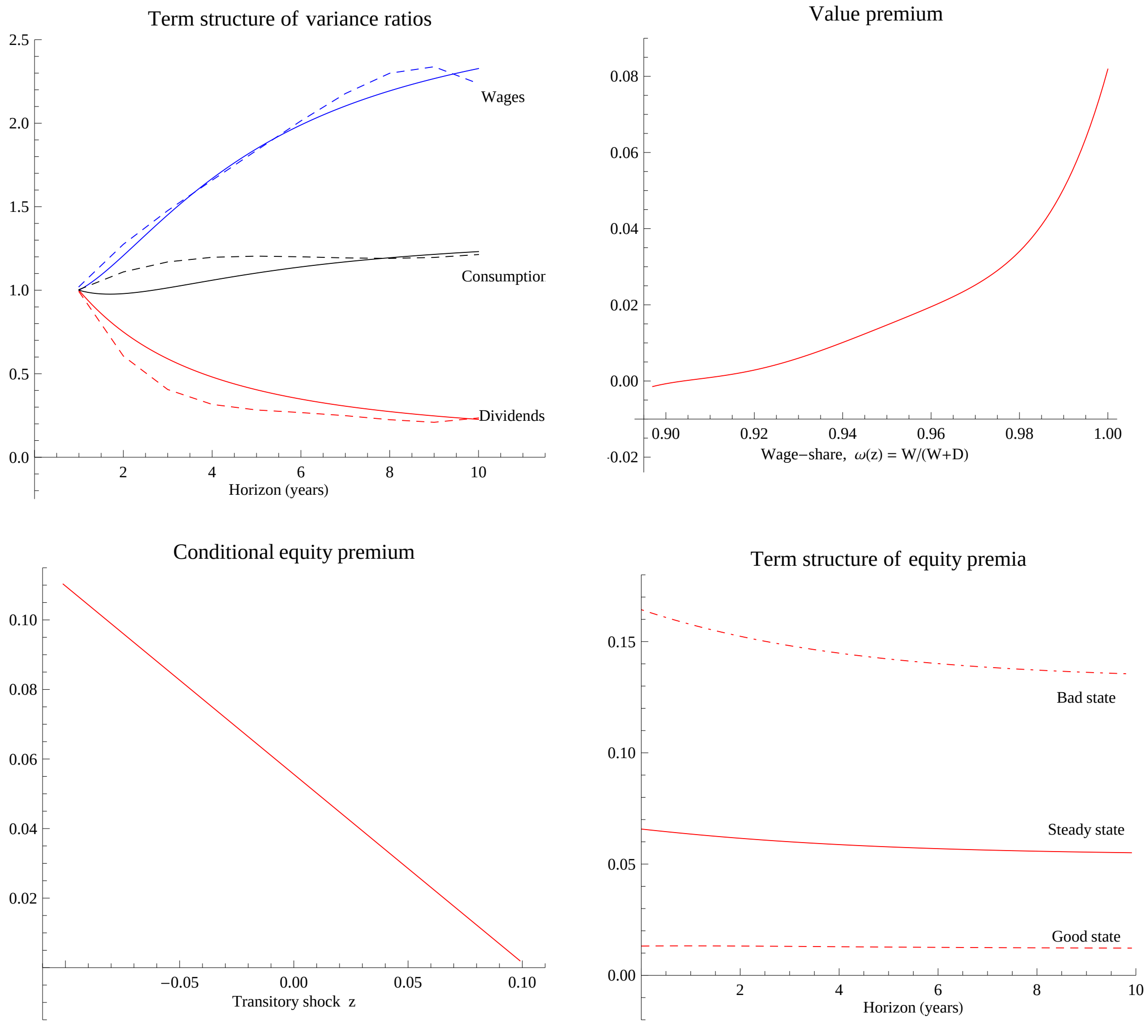


Figure 9: Counter-cyclical heteroscedasticity

Upper left panel: Variance-ratios of wages (blue), consumption (black) and dividends (red) as a function of the horizon. Dashed lines denote empirical data. Upper right panel: Value premium as a function of the wage share. Lower left panel: Conditional equity premium as a function of the transitory shock. Lower right panel: Term-structure of equity premia as a function of the horizon for high, steady-state and low transitory shock. Cash-flows parameters are from Table 5 ($T^{\max} = 50$ and $\bar{z} = .1$) and $\gamma = 10, \psi = 1.5$ and $\beta = 4\%$.

model leads to a risk-free rate of 1.3% with 3.5% volatility, an equity premium of 5.6%, a return volatility of 15.3%, a Sharpe-ratio of 36.3%, and a log price-dividend ratio of 3.29 with volatility 22.1%.

The upper right panel of Figure 9 reports the value premium as a function of the labor-share. Consistently with the empirical findings of Section 2 and similarly to the model prediction in Figure 7, we observe a positive relation between the labor-share and the expected premium of value firms over growth firms. However, the heteroscedastic model leads to a large range of variation, whereas it is much more limited in the homoscedastic model of the previous sections.

Overall, heteroscedasticity in fundamentals helps to *quantitatively* explain the dynamic relation between workers remuneration and the value premium due to labor rigidity. In addition, the model improves on the description of both the conditional return moments of equity (lower left panel of Figure 9) and the term-structure of equity premia (lower right panel). In particular, the slope of equity premia is constant in the homoscedastic model, whereas it is pro-cyclical in the heteroscedastic model. Indeed, consistently with van Binsbergen et al. (2013) and van Binsbergen and Koijen (2015) –which refines the findings of van Binsbergen et al. (2012)– the term-structure of equity premia has a dynamic slope which turns from flat or slightly positive in good times to strongly negative in bad times.

5 Conclusion

This paper documents that i) wages and dividends feature respectively upward- and downward sloping term-structures of risk; and ii) variation in the labor-share strongly explains the value premium dynamics. A simple general equilibrium model rationalizes these stylized facts: aggregate labor rigidity gives rise to the value premium by means of a term-structure effect on wage and dividend risk. Therefore, labor rigidity provides a macroeconomic foundation to the partial equilibrium framework of Lettau and Wachter (2007, 2011). A calibration –which exploits information from the term-structures of macroeconomic risk– captures the dynamic relation between the labor-share and the value premium, as well as reconciles standard asset pricing facts with the term-structures of both equity and macroeconomic variables. Heteroscedasticity in fundamentals and firm-specific labor rigidity help to improve the quantitative predicitons of the model.

Appendix

For the easy of notation, throughout the appendix I define $d_0 \equiv \log \alpha$ and $d_z \equiv 1 + \phi$, such that $\log D_t = x_t + d_0 + d_z(z_t - \bar{z})$ (with $\bar{z} \equiv \mathbb{E}(z_t)$). Moreover, I denote with $C_{s,t}$ and $Q_{s,t}$ shareholders' consumption and wealth respectively. Recall that under limited market participation in equilibrium $C_{s,t} = D_t$ and $Q_{s,t} = P_t$.

Proof of Proposition 1 and 2: Under the infinite horizon, the utility process J satisfies the following Bellman equation: $\mathcal{D}J(X, \mu, z) + f(C_s, J) = 0$, where $\mathcal{D}$ denotes the differential operator. Then we have

$$0 = J_X \mu X + \tfrac{1}{2} J_{X,X} \sigma_x^2 X^2 + J_\mu \lambda_\mu (\bar{\mu} - \mu) + \tfrac{1}{2} J_{\mu,\mu} \sigma_\mu^2 + J_z \lambda_z (\bar{z} - z) + \tfrac{1}{2} J_{z,z} \sigma_z^2 + f(C_s, J).$$

Guess a solution of the form $J(X,\mu,z)=\frac{1}{1-\gamma}X^{1-\gamma}g(\mu,z)$. The Bellman equation reduces to

$$0=\mu-\tfrac{1}{2}\gamma\sigma_x^2+\tfrac{g_\mu}{g}\tfrac{\lambda_\mu(\bar{\mu}-\mu)}{1-\gamma}+\tfrac{1}{2}\tfrac{g_{\mu,\mu}}{g}\tfrac{\sigma_\mu^2}{1-\gamma}+\tfrac{g_z}{g}\tfrac{\lambda_z(\bar{z}-z)}{1-\gamma}+\tfrac{1}{2}\tfrac{g_{z,z}}{g}\tfrac{\sigma_z^2}{1-\gamma}+\tfrac{\beta}{1-1/\psi}\left(g^{-1/\chi}e^{(1-1/\psi)(d_0+d_z z)}-1\right). \tag{A1}$$

Under limited market participation ($C_{s,t}=D_t$) and stochastic differential utility, the pricing kernel has dynamics given by

$$d\xi_{0,t}=\xi_{0,t}\tfrac{df_C}{f_C}+\xi_{0,t}f_J dt=-r(t)\xi_{0,t}-\theta_x(t)\xi_{0,t}dB_{x,t}-\theta_\mu(t)\xi_{0,t}dB_{\mu,t}-\theta_z(t)\xi_{0,t}dB_{z,t}, \tag{A2}$$

where, by use of Itô's Lemma and Eq. (A1), we get

$$r(t)=-\tfrac{\partial_X f_C}{f_C}\mu X-\tfrac{1}{2}\tfrac{\partial_{X,X}f_C}{f_C}\sigma_x^2X^2-\tfrac{\partial_\mu f_C}{f_C}\lambda_\mu(\bar{\mu}-\mu)-\tfrac{1}{2}\tfrac{\partial_{\mu,\mu}f_C}{f_C}\sigma_\mu^2-\tfrac{\partial_z f_C}{f_C}\lambda_z(\bar{z}-z)-\tfrac{1}{2}\tfrac{\partial_{z,z}f_C}{f_C}\sigma_z^2-f_J,$$

$$\theta_x(t)=-\tfrac{\partial_X f_C}{f_C}\sigma_x X,\qquad \theta_\mu(t)=-\tfrac{\partial_\mu f_C}{f_C}\sigma_\mu,\qquad \theta_z(t)=-\tfrac{\partial_z f_C}{f_C}\sigma_z,$$

An exact solution for $g(\mu,z)$ satisfying Eq. (A1) does not exist for $\psi\neq 1$. Therefore, I look for a solution of $g(\mu,z)$ around the unconditional mean of the consumption-wealth ratio. Aggregate wealth is given by

$$Q_{s,t}=\mathbb{E}_t\left[\int_t^\infty \xi_{t,u}C_{s,u}du\right],$$

and, applying Fubini's Theorem and taking standard limits, the consumption-wealth ratio satisfies

$$\tfrac{C_{s,t}}{Q_{s,t}}=r(t)-\tfrac{1}{dt}\mathbb{E}_t\left[\tfrac{dQ}{Q}\right]-\tfrac{1}{dt}\mathbb{E}_t\left[\tfrac{d\xi}{\xi}\tfrac{dQ}{Q}\right]. \tag{A3}$$

Guess

$$Q_{s,t}=C_{s,t}\beta^{-1}\big(g(\mu_t,z_t)e^{(\gamma-1)(d_0+d_z z_t)}\big)^{1/\chi}$$

and apply Itô's Lemma to get $\frac{dQ}{Q}$. Then, plug in the wealth dynamics, the risk-free rate and the pricing kernel into Eq. (A3): after tedious calculus you can recognize that the guess solution is correct. Notice that the consumption-wealth ratio approaches to β when $\psi\to 1$ as usual.

Denote $cq=\mathbb{E}[\log C_{s,t}-\log Q_{s,t}]$, hence, a first-order approximation of the consumption-wealth ratio around cq produces

$$\tfrac{C_{s,t}}{Q_{s,t}}=\beta g(\mu_t,z_t)^{-1/\chi}e^{(1-1/\psi)(d_0+d_z z_t)}\approx e^{cq}\left(1-cq+\log\beta-\tfrac{1}{\chi}\big(\log g(\mu_t,z_t)+(\gamma-1)(d_0+d_z z_t)\big)\right).$$

Using such approximation in the Bellman equation (A1) leads to

$$\begin{aligned}0=\mu-\tfrac{1}{2}\gamma\sigma_x^2&+\tfrac{g_\mu}{g}\tfrac{\lambda_\mu(\bar{\mu}-\mu)}{1-\gamma}+\tfrac{1}{2}\tfrac{g_{\mu,\mu}}{g}\tfrac{\sigma_\mu^2}{1-\gamma}+\tfrac{g_z}{g}\tfrac{\lambda_z(\bar{z}-z)}{1-\gamma}+\tfrac{1}{2}\tfrac{g_{z,z}}{g}\tfrac{\sigma_z^2}{1-\gamma}\\&+\tfrac{1}{1-1/\psi}\left(e^{cq}\left(1-cq+\log\beta-\tfrac{1}{\chi}\log g(\mu,z)+(1-1/\psi)(d_0+d_z z)\right)-\beta\right),\end{aligned}$$

which has exponentially affine solution $g(\mu,z)=e^{u_0+(1-\gamma)d_0+u_\mu\mu+(u_z+(1-\gamma)d_z)z}$, where u_0,u_μ and u_z have explicit solutions and the endogenous constant cq satisfies $cq=\log\beta-\chi^{-1}(u_0+u_\mu\bar{\mu}+u_z\bar{z})$

(recall $\bar{z} = \mathbb{E}[z_t] = 0$). The risk-free rate and the prices of risk take the form:

$$\begin{aligned} r_0 &= \tfrac{1}{2}\Bigg(\tfrac{2\left(\beta\psi^2(\gamma-1)^2+e^{cq}((1-\psi)u_0+\psi(cq-1-\log(\beta))(\gamma-1))(\psi\gamma-1)\right)}{\psi(1-\psi)(\gamma-1)} + \tfrac{2\bar{z}(u_z-\psi(u_z-d_z(\gamma-1))\gamma)\lambda_z}{\psi(-1+\gamma)} \\ &\qquad - \tfrac{2\bar{\mu}u_\mu(\psi\gamma-1)\lambda_\mu}{\psi(\gamma-1)} - \gamma\left(1+\gamma\right)\sigma_x^2 - \tfrac{(u_z-\psi(u_z-d_z(\gamma-1))\gamma)^2\sigma_z^2}{\psi^2(\gamma-1)^2} - \tfrac{u_\mu^2(\psi\gamma-1)^2\sigma_\mu^2}{(\psi-\psi\gamma)^2}\Bigg), \\ r_\mu &= \tfrac{\psi(\gamma-1)\gamma+u_\mu(\psi\gamma-1)(e^{cq}+\lambda_\mu)}{\psi(\gamma-1)}, \\ r_z &= \tfrac{-\psi d_z(\gamma-1)\gamma\lambda_z+u_z(\psi\gamma-1)(e^{cq}+\lambda_z)}{\psi(\gamma-1)}, \end{aligned}$$

$$\theta_x(t) = \gamma\sigma_x, \qquad \theta_\mu(t) = \frac{u_\mu\left(\gamma-\frac{1}{\psi}\right)}{1-\gamma}\sigma_\mu, \qquad \theta_z(t) = \left(d_z\gamma + \tfrac{u_z(1-\psi\gamma)}{\psi(\gamma-1)}\right)\sigma_z,$$

and the results of Proposition 2 easily follow. $\square$

Proposition A. *The following conditional expectation has exponential affine solution:*

$$\mathcal{M}_{t,\tau}(\bar{c}) = \mathbb{E}_t[e^{c_0+c_1\log\xi_{0,t+\tau}+c_2x_{t+\tau}+c_3\mu_{t+\tau}+c_4z_{t+\tau}}] = \xi_{0,t}^{c_1}X_t^{c_2}e^{\ell_0(\tau,\bar{c})+\ell_\mu(\tau,\bar{c})\mu_t+\ell_z(\tau,\bar{c})z_t}, \tag{A4}$$

where $\bar{c} = (c_0, c_1, c_2, c_3, c_4)$, model parameters are such that the expectation exists finite and ℓ_0, ℓ_μ and ℓ_z are deterministic functions of time.

Proof of Proposition A: Consider the following conditional expectation:

$$\mathcal{M}_{t,\tau}(\bar{c}) = \mathbb{E}_t[e^{c_0+c_1\log\xi_{0,t+\tau}+c_2\log X_{t+\tau}+c_3\mu_{t+\tau}+c_4z_{t+\tau}}] \tag{A5}$$

where $\bar{c} = (c_0, c_1, c_2, c_3, c_4)$ is a coefficient vector such that the expectation exists. Guess an exponential affine solution of the kind:

$$\mathcal{M}_{t,\tau}(\bar{c}) = e^{c_1\log\xi_{0,t}+c_2\log X_t+\ell_0(\tau,\bar{c})+\ell_\mu(\tau,\bar{c})\mu_t+\ell_z(\tau,\bar{c})z_t}, \tag{A6}$$

where $\ell_0(\tau,\bar{c}), \ell_\mu(\tau,\bar{c})$ and $\ell_z(\tau,\bar{c})$ are deterministic functions of time. Feynman-Kac gives that $\mathcal{M}$ has to meet the following partial differential equation

$$\begin{aligned} 0 = {} & \mathcal{M}_t - \mathcal{M}_\xi(r_0 + r_\mu\mu + r_z z) + \tfrac{1}{2}\mathcal{M}_{\xi,\xi}(\theta_x(t)^2 + \theta_\mu(t)^2 + \theta_z(t)^2) + \mathcal{M}_X(\mu X) + \tfrac{1}{2}\mathcal{M}_{X,X}\sigma_x^2X^2 \\ & + \mathcal{M}_\mu\lambda_\mu(\bar{\mu}-\mu) + \tfrac{1}{2}\mathcal{M}_{\mu,\mu}\sigma_\mu^2 + \mathcal{M}_z\lambda_z(\bar{z}-z) + \tfrac{1}{2}\mathcal{M}_{z,z}\sigma_z^2 - \mathcal{M}_{\xi,X}\theta_x(t)\sigma_x X \\ & - \mathcal{M}_{\xi,\mu}\theta_\mu(t)\sigma_\mu - \mathcal{M}_{\xi,z}\theta_z(t)\sigma_z, \end{aligned}$$

where the arguments have been omitted for ease of notation. Plugging the resulting partial derivatives from the guess solution into the pde and simplifying gives a linear function of the states μ and z. Hence, we get three ordinary differential equations for $\ell_0(\tau,\bar{c}), \ell_\mu(\tau,\bar{c})$ and $\ell_z(\tau,\bar{c})$:

$$\begin{aligned} 0 = {} & \ell_0'(\tau,\bar{c}) - c_1r_0 + \tfrac{1}{2}c_1(c_1-1)(\theta_x(t)^2 + \theta_\mu(t)^2 + \theta_z(t)^2) + \tfrac{1}{2}c_2(c_2-1)\sigma_x^2 + \ell_\mu(\tau,\bar{c})\lambda_\mu\bar{\mu} \\ & + \tfrac{1}{2}\ell_\mu(\tau,\bar{c})^2\sigma_\mu^2 + \ell_z(\tau,\bar{c})\lambda_z\bar{z} + \tfrac{1}{2}\ell_z(\tau,\bar{c})^2\sigma_z^2 - c_1c_2\theta_x(t)\sigma_x - c_1\ell_\mu(\tau,\bar{c})\theta_\mu(t)\sigma_\mu \\ & - c_1\ell_z(\tau,\bar{c})\theta_z(t)\sigma_z \\ 0 = {} & \ell_\mu'(\tau,\bar{c}) - c_1r_\mu + c_2 - \ell_\mu(\tau,\bar{c})\lambda_\mu \\ 0 = {} & \ell_z'(\tau,\bar{c}) - c_1r_z - \ell_z(\tau,\bar{c})\lambda_z \end{aligned}$$

with initial conditions: $\ell_0(0,\bar{c}) = c_0, \ell_\mu(0,\bar{c}) = c_3$ and $\ell_z(0,\bar{c}) = c_4$. Explicit solutions are avaliable. $\square$

Proof of Lemma 1: The result immediately follows by an application of Itô's Lemma to Eq. (7) and (8). $\square$

Proof of Lemma 2: The conditional moment generating function $\mathbb{D}_t(\tau, n)$ obtains as a special case of $\mathcal{M}_{t,\tau}(\bar{c})$ with $\bar{c} = (nd_0, 0, n, 0, nd_z)$. Therefore, it is given by $\mathbb{D}_t(\tau, n) = X_t^n e^{B_0(\tau,n)+B_\mu(\tau,n)\mu_t+B_z(\tau,n)z_t}$, with

$$\begin{aligned}
B_0(n,\tau) =& \ell_0(\tau,\bar{c}) = \tfrac{1}{4}n\left(4d_0 + 4\left(1-e^{-\tau\lambda_z}\right)\bar{z}d_z + 4\bar{\mu}\left(\tau + \tfrac{-1+e^{-\tau\lambda_\mu}}{\lambda_\mu}\right) + 2(-1+n)\tau\sigma_x^2\right.\\
&\left. + \tfrac{e^{-2\tau(\lambda_z+\lambda_\mu)}n\left(e^{2\tau\lambda_\mu}\left(-1+e^{2\tau\lambda_z}\right)d_z^2\lambda_\mu^3\sigma_z^2 + e^{2\tau\lambda_z}\lambda_z\left(-1+4e^{\tau\lambda_\mu}+e^{2\tau\lambda_\mu}(-3+2\tau\lambda_\mu)\right)\sigma_\mu^2\right)}{\lambda_z\lambda_\mu^3}\right),\\
B_\mu(n,\tau) =& \ell_\mu(\tau,\bar{c}) = \tfrac{n-e^{-\tau\lambda_\mu}n}{\lambda_\mu},\\
B_z(n,\tau) =& \ell_z(\tau,\bar{c}) = e^{-\tau\lambda_z}nd_z,
\end{aligned}$$

and $B_0(0,n) = nd_0$, $B_\mu(0,n) = 0$ and $B_z(0,n) = nd_z$. Therefore,

$$\sigma_D^2(t,\tau) = v_{D,\tau,x}\sigma_x^2 + v_{D,\tau,\mu}\sigma_\mu^2 + v_{D,\tau,z}\sigma_z^2,$$

where the coefficients are given by

$$v_{D,\tau,x} = 1, \quad v_{D,\tau,\mu} = \tfrac{4e^{-\lambda_\mu\tau}-e^{-2\lambda_\mu\tau}+2\lambda_\mu\tau-3}{2\lambda_\mu^3\tau}, \quad v_{D,\tau,z} = \tfrac{e^{-\lambda_z\tau}\sinh(\lambda_z\tau)d_z^2}{\lambda_z\tau}.$$

Finally, by taking the mixed partial derivative with respect τ and ϕ we get:

$$\frac{\partial^2}{\partial\phi\partial\tau}\sigma_D^2(t,\tau) = \frac{\sigma_z^2(\phi+1)e^{-2\lambda_z\tau}\left(2\lambda_z\tau - e^{2\lambda_z\tau}+1\right)}{\lambda_z\tau^2} < 0, \qquad \forall\tau > 0.$$

Using wages in Eq. (8), we have the following results:

$$\mathbb{E}_t\left[W_{t+\tau}\right] = \mathbb{E}_t\left[X_{t+\tau}\left(e^{z_{t+\tau}} - \alpha e^{(1+\phi)z_{t+\tau}}\right)\right] = \mathcal{M}_{t,\tau}(\bar{c}) - \mathcal{M}_{t,\tau}(\bar{c}'),$$

where $\bar{c} = (0,0,1,0,1)$ and $\bar{c}' = (\log\alpha, 0, 1, 0, 1+\phi)$, and

$$\mathbb{E}_t\left[W_{t+\tau}^2\right] = \mathbb{E}_t\left[X_{t+\tau}^2\left(e^{z_{t+\tau}} - \alpha e^{(1+\phi)z_{t+\tau}}\right)^2\right] = \mathcal{M}_{t,\tau}(\bar{c}) - 2\mathcal{M}_{t,\tau}(\bar{c}') + \mathcal{M}_{t,\tau}(\bar{c}''),$$

where $\bar{c} = (0,0,2,0,2)$, $\bar{c}' = (\log\alpha, 0, 2, 0, 2+\phi)$ and $\bar{c}'' = (2\log\alpha, 0, 2, 0, 2(1+\phi))$. With this results in hand, it is possible to show after tedious calculus that $\frac{\partial^2}{\partial\phi\partial\tau}\sigma_W^2(t,\tau) > 0$, as long as $z_t < -\log(\alpha)/\phi$ (see footnote 9). $\square$

Proof of Proposition 3: The equilibrium price of the market dividend strip with maturity τ of Eq. (22) obtains as a special case of $\mathcal{M}_{t,\tau}(\bar{c})$ with $\bar{c} = (d_0, 1, 1, 0, d_z)$. Therefore, it is given by $P_{t,\tau} = \xi_{0,t}^{-1}\mathcal{M}_{t,\tau}(\bar{c}) = X_t e^{A_0(\tau)+A_\mu(\tau)\mu_t+A_z(\tau)z_t}$ with

$$\begin{aligned}
A_\mu(\tau) =& \ell_\mu(\tau,\bar{c}) = \tfrac{1+e^{-\tau\lambda_\mu}(-1+r_\mu)-r_\mu}{\lambda_\mu},\\
A_z(\tau) =& \ell_z(\tau,\bar{c}) = \tfrac{-r_z+e^{-\tau\lambda_z}(r_z+d_z\lambda_z)}{\lambda_z},
\end{aligned}$$

$$
\begin{aligned}
A_0(\tau) = \ell_0(\tau,\bar{c}) = \tfrac{1}{4} \Big(& -\tfrac{4e^{-\tau\lambda_\mu}\bar{\mu}(-1+r_\mu)(1+e^{\tau\lambda_\mu}(-1+\tau\lambda_\mu))}{\lambda_\mu} + \tfrac{e^{-2\tau(\lambda_z+\lambda_\mu)}}{\lambda_z^3\lambda_\mu^3} \\
& \times \Big(-e^{2\tau\lambda_\mu}\left(r_z+d_z\lambda_z\right)^2\lambda_\mu^3\sigma_z^2 + 4e^{\tau(\lambda_z+2\lambda_\mu)}\left(r_z+d_z\lambda_z\right)\lambda_\mu^3\left(-\bar{z}\lambda_z^2+\sigma_z\left(\theta_z\lambda_z+r_z\sigma_z\right)\right) \\
& -e^{2\tau\lambda_z}\left(-1+r_\mu\right)^2\lambda_z^3\sigma_\mu^2 + 4e^{\tau(2\lambda_z+\lambda_\mu)}\left(-1+r_\mu\right)\lambda_z^3\sigma_\mu\left(\theta_\mu\lambda_\mu+\left(-1+r_\mu\right)\sigma_\mu\right) \\
& +e^{2\tau(\lambda_z+\lambda_\mu)}\Big(\lambda_\mu^3\Big(4\lambda_z^2\left(\bar{z}\left(r_z+\left(d_z-\tau r_z\right)\lambda_z\right)+\lambda_z\left(d_0-\tau\left(r_0+\theta_x\sigma_x\right)\right)\right)-4\theta_z\lambda_z\left(r_z+\left(d_z-\tau r_z\right)\lambda_z\right)\sigma_z \\
& +\left(d_z^2\lambda_z^2-2d_zr_z\lambda_z+r_z^2\left(2\tau\lambda_z-3\right)\right)\sigma_z^2\Big)+4\left(r_\mu-1\right)\theta_\mu\lambda_z^3\lambda_\mu\left(\tau\lambda_\mu-1\right)\sigma_\mu+\left(r_\mu-1\right)^2\lambda_z^3\left(2\tau\lambda_\mu-3\right)\sigma_\mu^2\Big)\Big)\Big),
\end{aligned}
$$

and $A_0(0) = d_0, A_\mu(0) = 0$ and $A_z(0) = d_z$. Itô's Lemma gives the dynamics of the market dividend strip price:

$$
dP_{t,\tau} = [\cdot]dt + \partial_x P_{t,\tau}\sigma_x dB_{x,t} + \partial_\mu P_{t,\tau}\sigma_\mu dB_{\mu,t} + \partial_z P_{t,\tau}\sigma_z dB_{z,t}.
$$

Therefore the return volatility is given by

$$
\begin{aligned}
\sigma_P(t,\tau) &= P_{t,\tau}^{-1}\sqrt{(\partial_x P_{t,\tau}\sigma_x)^2 + (\partial_\mu P_{t,\tau}\sigma_\mu)^2 + (\partial_z P_{t,\tau}\sigma_z)^2} = \sqrt{\sigma_x^2 + (A_\mu(\tau)\sigma_\mu)^2 + (A_z(\tau)\sigma_z)^2}, \\
(\mu_P - r)(t,\tau) &= -\tfrac{1}{dt}\left\langle \tfrac{d\xi_{0,t}}{\xi_{0,t}}, \tfrac{dP_{t,\tau}}{P_{t,\tau}} \right\rangle = \theta_x(t)\sigma_x + \theta_\mu(t)A_\mu(\tau)\sigma_\mu + \theta_z(t)A_z(\tau)\sigma_z.
\end{aligned}
$$

□

Proof of Corollary 1 and Lemma 3: Given the results of Proposition 3, the slopes of the return volatility and premium for the market dividend strip obtain by standard calculus:

$$
\begin{aligned}
\partial_\tau \sigma_P^2(t,\tau) &= \partial_\tau\left(\sigma_x^2 + (A_\mu(\tau)\sigma_\mu)^2 + (A_z(\tau)\sigma_z)^2\right), \\
\partial_\tau(\mu_P - r)(t,\tau) &= \partial_\tau\left(\theta_x(t)\sigma_x + \theta_\mu(t)A_\mu(\tau)\sigma_\mu + \theta_x(t)A_z(\tau)\sigma_z\right).
\end{aligned}
$$

The results of Lemma 3 automatically follow. □

Proof of Proposition 4: Under the assumption of limited market participation, the shareholders act as a representative agent on the financial markets and, hence, the equilibrium price of the market asset is equal to the shareholders' wealth. Therefore, using the results of Proposition 1, the market asset price can be written as

$$
P_t = Q_{s,t} = C_{s,t}e^{-cq_t} = X_t e^{-\log\beta + u_0\chi^{-1} + d_0 + u_\mu\chi^{-1}\mu_t + (u_z\chi^{-1}+d_z)z_t}.
$$

The dynamics of the market asset price obtains by applying Itô's Lemma to P_t:

$$
dP_t = [\cdot]dt + \partial_x P_t\sigma_x dB_{x,t} + \partial_\mu P_t\sigma_\mu dB_{\mu,t} + \partial_z P_t\sigma_z dB_{z,t}.
$$

Therefore the return volatility and premium are given by

$$
\begin{aligned}
\sigma_P(t) &= P_t^{-1}\sqrt{(\partial_x P_t\sigma_x)^2 + (\partial_\mu P_t\sigma_\mu)^2 + (\partial_z P_t\sigma_z)^2} = \sqrt{\sigma_x^2 + (u_\mu\chi^{-1}\sigma_\mu)^2 + ((u_z\chi^{-1}+d_z)\sigma_z)^2}, \\
(\mu_P - r)(t) &= -\tfrac{1}{dt}\left\langle \tfrac{d\xi_{0,t}}{\xi_{0,t}}, \tfrac{dP_t}{P_t} \right\rangle = \theta_x(t)\sigma_x + \theta_\mu(t)u_\mu\chi^{-1}\sigma_\mu + \theta_z(t)\big(u_z\chi^{-1}+d_z\big)\sigma_z.
\end{aligned}
$$

□

Proof of Proposition 5: Using the definition of the share process in Eq. (13) and of the price of a dividend claim on a firm with residual life T in Eq. (34), we get

$$P_t^T = \int_0^T s(T-\tau)\mathbb{E}_t[\xi_{t,t+\tau} D_{t+\tau}]d\tau,$$

since $D_{t+\tau}^{T-\tau} = s(T-\tau)D_{t+\tau}$ and $s(T)$ is deterministic. Therefore, we can use the results of Proposition 3 to obtain:

$$P_t^T = \int_0^T s(T-\tau)P_{t,\tau}d\tau \approx X_t \int_0^T s(T-\tau)e^{A_0(\tau)+A_\mu(\tau)\mu_t+A_z(\tau)z_t}d\tau.$$

By setting $H_0(\tau,T) = \log s(T-\tau) + A_0(\tau)$, $H_\mu(\tau) = A_\mu(\tau)$ and $H_z(\tau) = A_z(\tau)$, the final result automatically follows. The dynamics of the single firm price obtains by applying Itô's Lemma to P_t^T:

$$dP_t^T = [\cdot]dt + \partial_x P_t^T \sigma_x dB_{x,t} + \partial_\mu P_t^T \sigma_\mu dB_{\mu,t} + \partial_z P_t^T \sigma_z dB_{z,t}.$$

Therefore the return volatility and premium are given by

$$\sigma_P^T(t) = \left(P_t^T\right)^{-1}\sqrt{(\partial_x P_t^T\sigma_x)^2 + (\partial_\mu P_t^T\sigma_\mu)^2 + (\partial_z P_t^T\sigma_z)^2},$$
$$(\mu_P^T - r)(t) = -\frac{1}{dt}\left\langle \frac{d\xi_{0,t}}{\xi_{0,t}}, \frac{dP_t^T}{P_t^T}\right\rangle = \theta_x(t)\sigma_x + \theta_\mu(t)\frac{\partial_\mu P_t^T}{P_t^T}\sigma_\mu + \theta_z(t)\frac{\partial_z P_t^T}{P_t^T}\sigma_z.$$

□

Proof of Lemma 4 and 5: Provided $\gamma > \psi > 1$, $\theta_\mu(t) > 0$ and, hence,

$$\text{sign}(\mathcal{VP}_\mu(t)) = \text{sign}\left(\partial_\mu \log P_t^{\text{value}} - \partial_\mu \log P_t^{\text{growth}}\right).$$

Then, we look at the sign of

$$\frac{\int_0^{T^{\text{value}}} H_\mu(\tau)e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}{\int_0^{T^{\text{value}}} e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau} - \frac{\int_0^{T^{\text{growth}}} H_\mu(\tau)e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}{\int_0^{T^{\text{growth}}} e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}$$

Since $H_\mu(\tau) > 0$, $\forall \tau > 0$ we can rearrange the above difference as

$$\frac{\int_0^{T^{\text{growth}}} e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}{\int_0^{T^{\text{value}}} e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau} - \frac{\int_0^{T^{\text{growth}}} H_\mu(\tau)e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}{\int_0^{T^{\text{value}}} H_\mu(\tau)e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}$$

which is equal to

$$1 + \frac{\int_{T^{\text{value}}}^{T^{\text{growth}}} e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}{\int_0^{T^{\text{value}}} e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau} - 1 - \frac{\int_{T^{\text{value}}}^{T^{\text{growth}}} H_\mu(\tau)e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}{\int_0^{T^{\text{value}}} H_\mu(\tau)e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}.$$

Multiplying and dividing by $H_\mu(T^{\text{value}})$ we get

$$\frac{\int_{T^{\text{value}}}^{T^{\text{growth}}} H_\mu(T^{\text{value}})e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}{\int_0^{T^{\text{value}}} H_\mu(T^{\text{value}})e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau} - \frac{\int_{T^{\text{value}}}^{T^{\text{growth}}} H_\mu(\tau)e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}{\int_0^{T^{\text{value}}} H_\mu(\tau)e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t}d\tau}.$$

Since $H_\mu(\tau)$ is monotone increasing the above difference is always negative and, hence, $\mathcal{VP}_\mu(t) < 0$.

Provided $\gamma > \psi > 1$, $\theta_z(t) > 0$ and, hence,

$$\text{sign}(\mathcal{VP}_z(t)) = \text{sign}\left(\partial_z \log P_t^{\text{value}} - \partial_z \log P_t^{\text{growth}}\right).$$

Then, we look at the sign of

$$\frac{\int_0^{T^{\text{value}}} H_z(\tau) e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau}{\int_0^{T^{\text{value}}} e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau} - \frac{\int_0^{T^{\text{growth}}} H_z(\tau) e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau}{\int_0^{T^{\text{growth}}} e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau}$$

Since $H_z(\tau)$ is positive and monotone decreasing $\forall \tau > 0$, using the same steps as before we find that $\mathcal{VP}_z(t) > 0$. Part iii) of Lemma 4 immediately follows.

Provided $\gamma > \psi > 1$, $\theta_z(t) > 0$ and, hence,

$$\text{sign}(\partial_z \mathcal{VP}_z(t)) = \text{sign}\left(\partial_{zz} \log P_t^{\text{value}} - \partial_{zz} \log P_t^{\text{growth}}\right).$$

Then, we look at the sign of

$$\left[\frac{\int_0^{T^{\text{value}}} H_z^2(\tau) e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau}{\int_0^{T^{\text{value}}} e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau} - \left(\frac{\int_0^{T^{\text{value}}} H_z(\tau) e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau}{\int_0^{T^{\text{value}}} e^{H_0(\tau,T^{\text{value}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau}\right)^2\right] -$$
$$\left[\frac{\int_0^{T^{\text{growth}}} H_z^2(\tau) e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau}{\int_0^{T^{\text{growth}}} e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau} - \left(\frac{\int_0^{T^{\text{growth}}} H_z(\tau) e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau}{\int_0^{T^{\text{growth}}} e^{H_0(\tau,T^{\text{growth}})+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau}\right)^2\right].$$

The two terms in the square brackets are positive and can be interpreted as the variance of the function $h_z(\tau)$ respectively over the support $(0, T^{\text{value}})$ and $(0, T^{\text{growth}})$ and densities

$$g(\tau, T) = \frac{e^{H_0(\tau,T)+H_\mu(\tau)\mu_t+H_z(\tau)z_t}}{\int_0^T e^{H_0(\tau,T)+H_\mu(\tau)\mu_t+H_z(\tau)z_t} d\tau}$$

for $T = \{T^{\text{value}}, T^{\text{growth}}\}$. Notice that i) $H_z(\tau)$ is positive, monotonically decreasing and convex (recall: $\partial_\tau H_z(\tau) = -(1+\phi)e^{-\lambda_z\tau}\lambda_z(1-1/\psi)$); ii) for plausible parameters $g(\tau, T)$ inherits the humped shape of $s(T-\tau)$ (i.e. $g(\tau, T) = 0$ for $\tau = \{0, T\}$ and $g(\tau, T) > 0$ for $\tau \in (0, T)$); iii) T^{value} is small relative to T^{growth}: indeed, $T^{\text{value}} \ll T^{\max}/2 \ll T^{\text{growth}}$. Consequently, it exists a threshold λ_z^* such that: for $\lambda_z > \lambda_z^*$, $|\partial_\tau H_z(\tau)| \approx 0$ for $\tau > T^{\text{value}}$ and, hence, $\partial_z \mathcal{VP}_z(t) > 0$; for $\lambda_z < \lambda_z^*$, $|\partial_\tau H_z(\tau)| \approx 0$ for $\tau \gg T^{\text{value}}$ and, hence, $\partial_z \mathcal{VP}_z(t) < 0$. □

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Online Appendix of

"Labor Rigidity and the Dynamics of the Value Premium"

Roberto Marfè

Table OA.A: One Year Horizon Value Premium Predictability

The table reports the estimates of the regression

$$\mathrm{HML}_{t+1} = b_0 + b_1 W/V_t + b_2' \,\mathrm{controls} + \epsilon_t$$

where the dependent variable is the high minus low return (Fama and French (1992)) from time t over the horizon of one year; the independent variables are the time t wage-share (W/V_t), bondholders' remuneration (B/V_t), shareholders' remuneration (D/V_t), investments to assets (I/A_t), price-earnings, price-dividends ratios ($\mathrm{P/E}_t$ and $\mathrm{P/D}_t$), financial leverage (FL_t), credit spread (CS_t), term spread (TS_t) and one year short real rate (SR_t). Data are yearly on the sample 1946-2013. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
W/V	1.31**	1.32**	0.94	1.78***	1.16*	1.16*	1.22**	1.46***	1.56***	1.30**	1.09
t-stat	(2.52)	(2.56)	(1.45)	(2.96)	(1.99)	(1.81)	(2.41)	(2.79)	(3.14)	(2.43)	(1.60)
economic significance	0.19	0.19	0.13	0.25	0.17	0.17	0.18	0.21	0.22	0.19	8.19
B/V		0.36									-3.94**
t-stat		(0.34)									(-2.39)
D/V			-1.11								-2.74
t-stat			(-0.69)								(-1.49)
I/A				-3.56*							-2.61
t-stat				(-1.82)							(-0.81)
log P/E					-0.03						0.40**
t-stat					(-0.71)						(2.59)
log P/D						-0.02					-0.24*
t-stat						(-0.50)					(-1.69)
FL							0.11				0.34
t-stat							(0.45)				(0.89)
CS								0.09***			0.25***
t-stat								(4.44)			(5.80)
TS									0.01*		0.01
t-stat									(1.67)		(1.16)
SR										0.16	0.12
t-stat										(0.40)	(0.26)
R^2	0.04	0.04	0.04	0.06	0.04	0.04	0.04	0.12	0.05	0.04	0.24
adj-R^2	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.09	0.02	0.01	0.10

Table OA.B: 2 Years Horizon Value Premium Predictability

The table reports the estimates of the regression

$$\sum_{i=1}^{2} \text{HML}_{t+i} = b_0 + b_1 W/V_t + b_2' \,\text{controls} + \epsilon_t$$

where the dependent variable is the cumulative high minus low return (Fama and French (1992)) from time t over the horizon of 2 years; the independent variables are the time t wage-share (W/V_t), bondholders' remuneration (B/V_t), shareholders' remuneration (D/V_t), investments to assets (I/A_t), price-earnings, price-dividends ratios (P/E$_t$ and P/D$_t$), financial leverage (FL_t), credit spread (CS_t), term spread (TS_t) and one year short real rate (SR_t). Data are yearly on the sample 1946-2013. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
W/V	3.09***	3.08***	3.43***	3.73**	2.90**	2.96**	3.03**	3.22***	3.03**	3.10**	3.74***
t-stat	(2.67)	(2.84)	(2.89)	(2.62)	(2.37)	(2.35)	(2.57)	(3.36)	(2.57)	(2.56)	(2.81)
economic significance	0.30	0.30	0.33	0.36	0.28	0.29	0.29	0.31	0.29	0.30	20.36
B/V		0.95									-3.50
t-stat		(0.53)									(-1.02)
D/V			1.07								0.82
t-stat			(0.42)								(0.30)
I/A				-4.86							-5.77
t-stat				(-1.16)							(-0.86)
log P/E					-0.04						0.52**
t-stat					(-0.52)						(2.16)
log P/D						-0.02					-0.38*
t-stat						(-0.27)					(-1.97)
FL							0.07				0.11
t-stat							(0.18)				(0.19)
CS								0.15***			0.32***
t-stat								(4.02)			(3.27)
TS									-0.00		-0.01
t-stat									(-0.22)		(-0.57)
SR										0.54	0.54
t-stat										(0.93)	(0.86)
R^2	0.09	0.09	0.09	0.11	0.10	0.09	0.09	0.20	0.09	0.10	0.30
adj-R^2	0.08	0.07	0.06	0.08	0.07	0.06	0.06	0.17	0.06	0.07	0.17

Table OA.C: 3 Years Horizon Value Premium Predictability

The table reports the estimates of the regression

$$\sum_{i=1}^{3} \mathrm{HML}_{t+i} = b_0 + b_1 W/V_t + b_2' \,\text{controls} + \epsilon_t$$

where the dependent variable is the cumulative high minus low return (Fama and French (1992)) from time t over the horizon of 3 years; the independent variables are the time t wage-share (W/V_t), bondholders' remuneration (B/V_t), shareholders' remuneration (D/V_t), investments to assets (I/A_t), price-earnings, price-dividends ratios ($\mathrm{P/E}_t$ and $\mathrm{P/D}_t$), financial leverage (FL_t), credit spread (CS_t), term spread (TS_t) and one year short real rate (SR_t). Data are yearly on the sample 1946-2013. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
W/V	5.11***	5.06***	5.78***	5.63***	4.93***	5.04***	5.38***	5.23***	4.62***	5.22***	7.04***
t-stat	(3.12)	(3.29)	(3.55)	(2.92)	(2.83)	(2.86)	(3.07)	(4.14)	(2.87)	(3.07)	(3.77)
economic significance	0.40	0.40	0.46	0.45	0.39	0.40	0.43	0.41	0.37	0.41	33.74
B/V		0.93									-0.90
t-stat		(0.43)									(-0.25)
D/V			2.15								3.17
t-stat			(0.65)								(0.96)
I/A				-4.12							-9.72
t-stat				(-0.76)							(-1.33)
log P/E					-0.03						0.24
t-stat					(-0.39)						(0.87)
log P/D						-0.01					-0.27
t-stat						(-0.11)					(-1.24)
FL							-0.29				-0.98
t-stat							(-0.70)				(-1.47)
CS								0.16***			0.25***
t-stat								(3.21)			(3.07)
TS									-0.03**		-0.03**
t-stat									(-2.02)		(-2.16)
SR										0.81	0.66
t-stat										(1.38)	(0.88)
R^2	0.16	0.17	0.17	0.18	0.17	0.16	0.17	0.26	0.20	0.18	0.42
adj-R^2	0.15	0.14	0.14	0.15	0.14	0.14	0.14	0.24	0.17	0.16	0.31

Table OA.D: 5 Years Horizon Value Premium Predictability

The table reports the estimates of the regression

$$\sum_{i=1}^{5} \mathrm{HML}_{t+i} = b_0 + b_1 W/V_t + b_2' \,\text{controls} + \epsilon_t$$

where the dependent variable is the cumulative high minus low return (Fama and French (1992)) from time t over the horizon of 5 years; the independent variables are the time t wage-share (W/V_t), bondholders' remuneration (B/V_t), shareholders' remuneration (D/V_t), investments to assets (I/A_t), price-earnings, price-dividends ratios ($\mathrm{P/E}_t$ and $\mathrm{P/D}_t$), financial leverage (FL_t), credit spread (CS_t), term spread (TS_t) and one year short real rate (SR_t). Data are yearly on the sample 1946-2013. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
W/V	7.20***	7.30***	7.18***	7.16***	7.13***	7.29***	8.22***	6.87***	6.68***	7.39***	8.88***
t-stat	(3.46)	(3.45)	(3.45)	(3.51)	(3.18)	(3.18)	(3.53)	(3.77)	(4.09)	(3.33)	(3.94)
economic significance	0.44	0.45	0.44	0.44	0.44	0.45	0.50	0.42	0.41	0.45	37.70
B/V		-0.63									-1.46
t-stat		(-0.26)									(-0.51)
D/V			-0.08								-0.64
t-stat			(-0.02)								(-0.23)
I/A				0.42							-8.40
t-stat				(0.08)							(-1.38)
log P/E					-0.01						-0.27
t-stat					(-0.10)						(-0.51)
log P/D						0.01					0.18
t-stat						(0.12)					(0.42)
FL							-0.88*				-1.88**
t-stat							(-1.88)				(-2.38)
CS								0.11			0.19
t-stat								(1.31)			(1.37)
TS									-0.06***		-0.06***
t-stat									(-3.63)		(-4.70)
SR										0.49	-0.56
t-stat										(0.74)	(-0.58)
R^2	0.20	0.20	0.20	0.20	0.20	0.20	0.25	0.23	0.33	0.20	0.51
adj-R^2	0.18	0.17	0.17	0.17	0.17	0.17	0.22	0.21	0.30	0.17	0.42

Table OA.E: 7 Years Horizon Value Premium Predictability

The table reports the estimates of the regression

$$\sum_{i=1}^{7} \text{HML}_{t+i} = b_0 + b_1 W/V_t + b_2' \text{ controls} + \epsilon_t$$

where the dependent variable is the cumulative high minus low return (Fama and French (1992)) from time t over the horizon of 7 years; the independent variables are the time t wage-share (W/V_t), bondholders' remuneration (B/V_t), shareholders' remuneration (D/V_t), investments to assets (I/A_t), price-earnings, price-dividends ratios (P/E_t and P/D_t), financial leverage (FL_t), credit spread (CS_t), term spread (TS_t) and one year short real rate (SR_t). Data are yearly on the sample 1946-2013. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
W/V	6.63***	7.45***	5.37**	6.03***	6.36**	6.28**	7.51***	5.87**	5.62**	6.82***	4.52**
t-stat	(2.83)	(3.33)	(2.16)	(2.85)	(2.65)	(2.58)	(2.91)	(2.53)	(2.59)	(2.91)	(2.28)
economic significance	0.37	0.41	0.30	0.33	0.35	0.35	0.41	0.32	0.31	0.38	18.76
B/V		-3.10									-11.79***
t-stat		(-1.24)									(-3.88)
D/V			-5.81								-5.20**
t-stat			(-1.36)								(-2.11)
I/A				8.73*							5.85
t-stat				(1.94)							(0.78)
log P/E					-0.05						0.56
t-stat					(-0.45)						(0.96)
log P/D						-0.05					-0.23
t-stat						(-0.55)					(-0.49)
FL							-0.69				0.31
t-stat							(-1.15)				(0.44)
CS								0.12			0.55***
t-stat								(1.50)			(4.10)
TS									-0.07**		-0.06**
t-stat									(-2.38)		(-2.07)
SR										0.47	-1.00
t-stat										(0.75)	(-0.95)
R^2	0.13	0.16	0.17	0.17	0.14	0.14	0.16	0.17	0.32	0.14	0.55
adj-R^2	0.12	0.13	0.14	0.15	0.11	0.11	0.14	0.14	0.29	0.11	0.46

Table OA.F: 10 Years Horizon Value Premium Predictability

The table reports the estimates of the regression

$$\sum_{i=1}^{10} \text{HML}_{t+i} = b_0 + b_1 W/V_t + b_2' \,\text{controls} + \epsilon_t$$

where the dependent variable is the cumulative high minus low return (Fama and French (1992)) from time t over the horizon of 10 years; the independent variables are the time t wage-share (W/V_t), bondholders' remuneration (B/V_t), shareholders' remuneration (D/V_t), investments to assets (I/A_t), price-earnings, price-dividends ratios (P/E$_t$ and P/D$_t$), financial leverage (FL_t), credit spread (CS_t), term spread (TS_t) and one year short real rate (SR_t). Data are yearly on the sample 1946-2013. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
W/V	3.52	5.83**	2.46	3.77	3.49	3.50	4.50**	3.56	2.34	2.93	2.27
t-stat	(1.23)	(2.34)	(0.93)	(1.57)	(1.23)	(1.20)	(2.08)	(1.34)	(0.98)	(0.91)	(1.18)
economic significance	0.17	0.28	0.12	0.18	0.17	0.17	0.21	0.17	0.11	0.14	9.50
B/V		-6.01									-17.65***
t-stat		(-1.47)									(-4.10)
D/V			-8.62								-15.65***
t-stat			(-1.44)								(-2.84)
I/A				15.69***							21.89***
t-stat				(2.84)							(3.45)
log P/E					-0.02						0.75**
t-stat					(-0.26)						(2.16)
log P/D						-0.05					-0.26
t-stat						(-0.71)					(-0.83)
FL							-0.88				1.21*
t-stat							(-1.12)				(1.74)
CS								-0.00			0.54***
t-stat								(-0.06)			(5.28)
TS									-0.06***		-0.02
t-stat									(-2.97)		(-0.97)
SR										-0.87	-2.09**
t-stat										(-0.85)	(-2.08)
R^2	0.03	0.13	0.08	0.15	0.03	0.04	0.08	0.03	0.15	0.05	0.61
adj-R^2	0.01	0.10	0.05	0.12	-0.01	0.00	0.05	-0.01	0.11	0.01	0.52

Table OA.G: Long Horizon Value Premium Predictability: Time Trend

The table reports the estimates of the regression

$$W/V_t = b_0 + b_1 t + \widehat{W/V}_t$$
$$\sum_{i=1}^{n} \text{HML}_{t+i} = b_0 + b_1 \widehat{W/V}_t + \epsilon_t$$

where the dependent variable is the cumulative high minus low return (Fama and French (1992)) from time t over the horizon of 1, 2, 3, 5, 7 and 10 years; the independent variable is the residual of the time t wage-share (W/V_t) regressed on the time index. Data are yearly on the sample 1946-2013. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	Horizon					
	1	2	3	5	7	10
W/V	1.34**	3.19***	5.16***	7.03***	6.39**	4.38*
t-stat	(2.22)	(2.87)	(3.48)	(3.37)	(2.58)	(1.70)
economic significance	0.18	0.29	0.39	0.42	0.35	0.20
R^2	0.03	0.08	0.15	0.18	0.12	0.04
adj-R^2	0.02	0.07	0.14	0.17	0.11	0.02

Table OA.H: Long Horizon Value Premium Predictability: Sub-Samples

The table reports the estimates of the regression

$$\sum_{i=1}^{n} \text{HML}_{t+i} = b_0 + b_1 W/V_t + \epsilon_t$$

where the dependent variable is the cumulative high minus low return (Fama and French (1992)) from time t over the horizon of 1, 2, 3, 5, 7 and 10 years; the independent variable is the time t wage-share (W/V_t). Data are yearly on the sample 1946-2013: Panel A and B report the estimates of the regression respectively on the first and the second half of the sample. The Newey-West corrected t-statistics are reported in parenthesis. Economic significance denotes standardized coefficients. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

Panel A	Horizon					
	1	2	3	5	7	10
sub-sample	1947-1979	1947-1979	1947-1978	1947-1977	1947-1976	1947-1975
W/V	1.67*	2.80	4.49**	5.72***	5.36**	4.99
t-stat	(1.70)	(1.48)	(2.13)	(2.93)	(1.97)	(1.65)
economic significance	0.19	0.24	0.34	0.42	0.41	0.36
R^2	0.04	0.06	0.12	0.18	0.17	0.13
adj-R^2	0.01	0.03	0.09	0.15	0.14	0.10

Panel B	Horizon					
	1	2	3	5	7	10
sub-sample	1980-2013	1980-2012	1979-2011	1978-2009	1977-2007	1976-2004
W/V	1.17*	3.23**	5.28**	7.87**	7.58**	3.38
t-stat	(1.71)	(2.28)	(2.46)	(2.38)	(2.27)	(0.66)
economic significance	0.18	0.32	0.42	0.45	0.37	0.12
R^2	0.03	0.10	0.18	0.20	0.13	0.01
adj-R^2	0.00	0.07	0.15	0.17	0.10	-0.02