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Structure of Equity**

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Income Insurance and the Equilibrium Term-Structure of Equity

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ABSTRACT

Output, wages and dividends feature term-structures of variance-ratios respectively flat, increasing and decreasing. Income insurance from shareholders to workers empirically and theoretically explains these term-structures. Risk sharing smooths wages but only concerns transitory risk and, hence, enhances the short-run dividend risk. A simple general equilibrium model, where labor rigidity affects dividend dynamics and the price of short-run risk, reconciles standard asset pricing facts with the term-structures of equity premium and volatility and those of macroeconomic variables, at odds in leading models. Consistently, actual labor-share variation largely forecasts dividend strips risk, premium and slope.

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Leading asset pricing models describe many characteristics of financial markets but fail to explain the timing of equity risk. These models have different rationale (e.g. habit formation, time-varying expected growth, disasters, prospect theory) but share an important feature: priced risk comes from variation in long-run discounted cash-flows.¹ Instead, [van Binsbergen, Brandt, and Koijen \(2012\)](#), [van Binsbergen, Hueskes, Koijen, and Vrugt \(2013\)](#) and [van Binsbergen and Koijen \(2016\)](#) document that the term-structures of equity volatility and premia are downward sloping –that is markets compensate short-run risk. Moreover, standard models usually base on assumptions concerning dividend dynamics which imply an upward-sloping term-structure of dividend risk (i.e. volatilities or variance-ratios of dividends’ growth rates which increase with the horizon). Instead, consistently with [Belo, Collin-Dufresne, and Goldstein \(2015\)](#), this paper documents that dividend risk is strongly downward-sloping, such that many models overestimate long-horizon dividend risk by an order of magnitude.

Why is dividend risk downward-sloping? Under which conditions, does downward-sloping dividend risk transmit to equity risk and premia? What macroeconomic channel explains short-term equity returns? This paper empirically and theoretically addresses these questions by providing a macroeconomic foundation of the timing of risk and by reconciling, in equilibrium, standard asset pricing facts with the new evidence about the term-structures. This is important because the term-structures of both fundamentals and equity provide information about how prices are determined in equilibrium. Hence, a term-structure perspective offers additional testable implications to asset pricing frameworks and can help us to understand the macroeconomic determinants of asset prices.

The paper argues that labor rigidity is at the heart of the timing of macroeconomic risk. [Danthine and Donaldson \(1992, 2002\)](#), among others, show that a mechanism of income insurance from shareholders to workers, which takes place within the firm, leads to volatile and pro-cyclical dividends. Hence, this mechanism explains why equity commands a high compensation.² Beyond such a *cyclicality effect* of income insurance, I show that also a *term-structure effect* takes place. Since output, wages and dividends are co-integrated ([Lettau and Ludvigson, 2005](#)), income insurance implies that the transitory component of aggregate risk is shared

asymmetrically among workers and shareholders, whereas the permanent component is faced by both. Namely, wages are partially insured with respect to transitory risk, whereas dividends load more on transitory risk as a result of operating leverage. Thus, wage and dividend risks shift respectively toward the long and the short horizon and workers and shareholders bear respectively more long-run risk and more short-run risk. I embed this mechanism of income insurance in an otherwise standard closed-form general equilibrium model and show that, under standard preferences, the *term-structure effect* of income insurance is inherited by financial markets and leads to downward sloping term-structures of equity risk and premia. Consistently, actual labor-share variation largely predicts short-term equity risk, premium and slope.

An empirical investigation supports the main model mechanism. First, I document that the timing of risk of macroeconomic variables is heterogeneous. The term-structures of risk of output, wages and dividends are respectively flat, increasing and decreasing. In accord with the model, these term-structures –and the co-integrating relationship among the levels of these variables– support the idea that both workers and shareholders are subject to permanent shocks but they share transitory shocks asymmetrically, as a result of income insurance. Consistently, [Gamber \(1988\)](#) and [Menzio \(2005\)](#) show that implicit contracts and labor market search frictions lead to wage rigidity over transitory risk only; [Guiso, Pistaferri, and Schivardi \(2005\)](#) and [Ellul, Pagano, and Schivardi \(2014\)](#) provide evidence that insurance does not concern permanent shocks; and [Ríos-Rull and Santaeulàlia-Llopis \(2010\)](#) document that the wage-share is stationary and counter-cyclical.

Second, I further support the *term-structure effect* of income insurance by investigating the model prediction that the variance ratios of dividends and the gap between the variance ratios of wages and dividends should be respectively decreasing and increasing with the labor-share. The model predicts that, after a negative transitory shock, wages are partially insured whereas dividends are hit more. This implies that, on the one hand, wages are high relative to dividends (the *cyclicality effect*) and that wages load less than dividends on transitory risk (the *term-structure effect*). Therefore, the distance between the upward-sloping variance

ratios of wages and the downward-sloping variance ratios of dividends should increase when the labor-share is high. The opposite holds after a positive transitory shock. I provide robust empirical evidence that such a dynamic relation obtains in the actual data.

Third, in accord with the model, I document an extremely strong connection between labor-share variation and short-term equity returns. The correlations between the labor-share and one-year ahead dividend strips volatility (risk), excess return over the risk-free rate (premium) and excess return over the market return (slope) are respectively 86%, 57% and 52%.

Moreover, I show that the remainder of output minus wages features a term-structure of risk which is markedly downward-sloping and essentially recovers the negative slope of dividend risk. This implies that the bulk of the gap between the approximately flat variance-ratios of output and the decreasing variance-ratios of dividends should be imputed to labor. Consistently, I document that the transitory component of dividends that should not be imputed to income insurance does not help to explain either the negative slope of dividend risk or dividend strip returns. Finally, the *term-structure effect* of income insurance implies that the labor-share positively forecasts dividend and consumption growth, which I show to be a robust feature of actual data.

The model consists of a few simple ingredients and is similar to [Greenwald, Lettau, and Ludvigson \(2014\)](#). Investment is not directly modelled and total resources are shared by workers and shareholders. The former do not invest and consume their wages ([Berk and Walden, 2013](#)), and the latter receive dividends and, thus, act as a representative agent on the financial markets. Total resources are subject to both permanent and transitory technological shocks ([Bansal, Kiku, and Yaron, 2010](#); [Lettau and Ludvigson, 2014](#)).³ Income insurance concerns transitory risk, as suggested by the empirical analysis. The insurance mechanism, on the one hand, generates counter-cyclical labor-share and downward-sloping dividend risk and, on the other hand, enhances the pricing of short-run risk. Indeed, the equilibrium state-price density equals the shareholders' marginal utility but is affected by income insurance through the levered dynamics of dividends. Differently from [Danthine and Donaldson \(2002\)](#), the model leads to a stationary equilibrium even in presence of permanent shocks (time-varying

long-run growth as in [Bansal and Yaron \(2004\)](#)) and recursive preferences. Under standard preferences (i.e. intertemporal substitution larger than wealth effect and preference for the early resolution of uncertainty), the term-structure of equity premia is non-monotone: long-run growth leads to an upward-sloping effect and transitory risk to a downward-sloping one. Indeed, transitory shocks are expected to recover and, hence, are risky in the short-run and safe in the long-run. For income insurance strong enough, operating leverage enhances the transitory risk of dividends and its equilibrium price. In turn, the negative slope of dividend risk transmits to equity returns.

The model calibration exploits the information from the term-structures of aggregate consumption, wage and dividend risk. On the one hand, they represent additional stylized facts captured by the model; on the other hand, the timing of macroeconomic risk allows to quantitatively measure the strength of income insurance and, hence, the operating leverage on dividends. Moreover, the term-structures of risk provide information about the persistence of latent factors –a main issue in asset pricing models. The baseline calibration reconciles the term-structures of both fundamentals and equity with the traditional asset pricing facts, such as the risk-free rate and equity premium puzzles as well as the the excess-volatility of equity (also at long-horizons, as in [Beeler and Campbell \(2012\)](#)). In accord with the data, the slope of equity premia is due to both the cash-flows and the discount rates channels. Moreover, the model leads to upward-sloping real interest rates. [van Binsbergen et al. \(2013\)](#) and [Aït-Sahalia, Karaman, and Mancini \(2015\)](#) refine the findings of [van Binsbergen et al. \(2012\)](#) suggesting that the negative slope of equity premia is an unconditional property of the data, whereas conditional equity premia are slightly increasing in good times and strongly decreasing in bad times. Such dynamics obtain in the model –without deteriorating other results– once fundamentals feature business cycle uncertainty. Time-varying risk premia lead to a pattern of long-horizon predictability consistent with actual data. Most of general equilibrium asset pricing models –such as the long-run risk model of [Bansal and Yaron \(2004\)](#), which obtains as a sub-case– cannot explain simultaneously all of these stylized facts. Closed-form solutions allow to decompose the equity premium and to derive an equilibrium density which captures

the relative contribution of discounted cash-flows at each horizon. In the baseline calibration, the horizon that mostly contributes to the equity premium is the immediate future, that is the density is monotone decreasing (whereas it is hump-shaped in a long-run risk model). This suggests that a “short-run” explanation of financial markets is needed to reconcile the timing of macroeconomic risk with the traditional asset pricing facts.

Related literature. A few recent papers suggest alternative and complementary channels which can contribute to explain the term-structure of equity. See [van Binsbergen and Kojen \(2016\)](#) for a recent review.⁴

The economic mechanism in [Belo et al. \(2015\)](#) differs from that of this paper: they argue that the negative slope of dividend risk comes out from rigidity in financial leverage. Namely, financial leverage switches upward-sloping EBIT risk to downward-sloping dividend risk. However, I empirically show that the term-structure of risk of EBIT is markedly downward-sloping and close to that of dividends. Thus, the financial leverage channel can only have a limited term-structure effect. Most of the change in the slope obtains earlier than financing decisions and should be imputed to wages. [Croce, Lettau, and Ludvigson \(2015\)](#) study the investors’ beliefs about fundamentals. Namely, they assume the usual long-run risk dynamics for dividends and show that bounded rationality under limited information can lead to downward-sloping dividend risk under the subjective measure of the investors. While this mechanism is complementary to that of this paper, [Croce et al. \(2015\)](#) assume that dividend risk is upward-sloping under the physical measure. Instead, dividend risk is markedly downward-sloping in actual data. Then, the beliefs formation channel can only have a limited term-structure effect relative to the bulk of the term-structure effect driven by wages. [Ai, Croce, Diercks, and Li \(2015\)](#) propose a general equilibrium model where heterogeneous investment risk due to vintage capital leads to a downward-sloping term-structure of equity premia. The investment channel is potentially complementary to the income insurance mechanism. However, on the one hand, the term-structure of risk of output minus wages almost recovers the negative slope of dividend risk; on the other hand, the term-structure of risk of output minus investments is almost identical to that of output. Thus, investments do not induce a downward-sloping

effect. Both [Belo et al. \(2015\)](#) and [Kogan and Papanikolaou \(2015\)](#) are partial equilibrium models: given dividends, a downward-sloping term-structure of equity premia obtains because of the exogenous correlations between the priced factors and dividend risk in those economies. A general equilibrium approach would produce economic restrictions on those correlations and offer additional insights into the relationship between either financial leverage or investment-specific risk and equity term-structures. [Hasler and Marfè \(2015\)](#) suggest that the negative slope of dividend risk is due to post-disaster recovery. As long as dividends recover after being hit by a disaster, dividend risk shifts towards the short horizon. While this mechanism is both alternative and complementary to that of income insurance, they interact each other since usually human capital is affected by disasters to a lower extent than physical capital.

A number of recent papers points out the importance of labor relations for asset pricing. This paper complements such a literature investigating the term-structure implications of income insurance in general equilibrium for both dividends and equity. Note that labor markets frictions –such as infrequent wage resettling in [Favilukis and Lin \(2015\)](#), search frictions in [Kuehn, Petrosky-Nadeau, and Zhang \(2012\)](#) and labor mobility in [Donangelo \(2014\)](#)– can lead to a similar *term-structure effect*. I model income insurance as an empirically motivated risk-sharing rule to capture in reduced form the combinations of labor markets mechanisms and frictions which give rise to labor rigidity. While [Danthine and Donaldson \(1992, 2002\)](#), [Favilukis and Lin \(2015\)](#) and [Kuehn et al. \(2012\)](#) propose big macro-finance models and rely on numerical solutions, I consider a simpler and more parsimonious economy and provide analytical solutions.⁵ Recently, [Greenwald et al. \(2014\)](#) investigate the asset pricing implications of low frequency swings in labor-share.

The model has also implications for the cross-section of equity returns. [Lettau and Wachter \(2007, 2011\)](#) show in partial equilibrium that a model which captures the downward-sloping term-structure of equity automatically gives rise to a value premium, when value firms are defined as shorter duration equity than growth firms. The *term-structure effect* of income insurance provides a foundation to the intuition of [Lettau and Wachter \(2007\)](#). Indeed, [Marfè \(2015a\)](#) shows that such a result obtains in an extended version of the model and provides

empirical support documenting a strong relation between variation in the labor-share and the value premium dynamics. Thus, the model is also consistent with [Koijen, Lusting, and van Nieuwerburgh \(2014\)](#), who empirically document that markets compensate short run-risk and that the value premium dynamics is related to business cycle risk.

The model emphasis on the fundamentals transitory risk is key to understand the term-structure of equity. However, the model has some limitations in the description of real interest rates. Namely, the model qualitatively captures the positive sign of the slope and the long-run real yield, but it quantitatively overestimates the curve level.⁶ This can be explained by the extreme form of limited market participation assumed in the model. Since workers do not access financial markets, the state price density inherits the large transitory risk of dividends, and bonds are essentially hedge instruments against dividend risk. This appears in contrast with the results by [Alvarez and Jermann \(2005\)](#), who infer a prominent role of permanent risk in discount rates.⁷ Such a tension of the model can be eventually relaxed in a framework that endogenizes participation in stock and bond markets, in spirit of [Berk and Walden \(2013\)](#).

The paper is organized as follows. Section I provides empirical support to the main model assumptions, mechanism and predictions. Section II describes the economy and derives the equilibrium asset pricing predictions. Asset pricing results are in Section III. A model extension is discussed in Section IV. Section V concludes.

I. Empirical Analysis

The first part of this section documents that the timing of risk is heterogeneous among macroeconomic variables. The second part argues and empirically supports the idea that a mechanism of income insurance between workers and shareholders is at the heart of the timing of risk. The third part shows that income insurance is a main driver of dividend strips risk and premia. The final part provides further robustness. The remainder of the paper shows that an otherwise standard general equilibrium model with income insurance reconciles standard asset pricing facts with the new evidence about the term-structure of equity.

I consider postwar data from the U.S. non-financial corporate sector (such as value added, labour compensations, EBIT and dividends from the Flow of Funds).

A. The Timing of Macroeconomic Risk

I define the timing of risk of a given variable as the term-structure of its variance ratios (VR's hereafter, i.e. the ratio of the growth rates variance at horizon τ relative to τ times the variance at horizon one). 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 left panel of Figure 1 provides a number of insights. We observe that the VR's of wages are markedly upward-sloping and above unity, whereas the VR's of EBIT and dividends are markedly downward-sloping and below unity. Instead, the VR's of value added lie in the middle and are approximatively flat. These results are consistent with and extend those in [Beeler and Campbell \(2012\)](#) and [Belo et al. \(2015\)](#). Note that the usual assumptions of asset pricing models about the dynamics of dividends are strongly inconsistent with the data. Indeed, time-variation in the conditional moments of a geometric process (e.g. long-run growth, stochastic volatility, time-varying disasters) induce markedly upward-sloping VR's. Thus, long-horizon dividend risk is usually overestimated by an order of magnitude or more.⁸

Figure1

B. Does Income Insurance Explain the Timing of Risk?

What explains the heterogeneity in the timing of macroeconomic risk? I argue that the main driver is an explicit or implicit mechanism of income insurance from shareholders to workers that takes place within the firm. The reasoning is the following.

On the one hand, [Danthine and Donaldson \(2002\)](#) among others suggest that risk-sharing between workers and shareholders (as well as labor markets frictions) leads to smooth wages

and, as a result of operating leverage, risky dividends. Hence, the labor-share is counter-cyclical and the dividend-share is pro-cyclical, as documented by [Ríos-Rull and Santaeulària-Llopis \(2010\)](#). I name this mechanism as the *cyclicality effect* of income insurance.

On the other hand, [Guiso et al. \(2005\)](#) document that such an income insurance exists but does not concern permanent shocks. [Menzio \(2005\)](#) theoretically shows and empirically supports the idea that labor markets frictions lead to wage rigidity with respect to transitory shocks instead of permanent shocks. Consistently, [Lettau and Ludvigson \(2014\)](#) document that macroeconomic variables are subject to both permanent and transitory shocks and [Lettau and Ludvigson \(2005\)](#) document that wages and dividends are co-integrated: i.e. they face the same permanent shocks. I extend this result and provide evidence that all quantities in Figure 1 are co-integrated (see the Online Appendix A).

Therefore, beyond the *cyclicality effect* of income insurance, also a *term-structure effect* takes place. Given co-integration, the mechanism of income insurance only concerns transitory shocks. Thus, 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 decreasing and increasing in the transitory component of output. As a consequence, wages and dividends load on transitory risk respectively less and more than output. This produces VR's of wages and dividends which are respectively increasing and decreasing and respectively above and below the VR's of output. Such a *term-structure effect* of income insurance coincides with the empirical VR's in the left panel of Figure 1.

The right panel of Figure 1 provides in a intuitive way strong empirical support to the *term-structure effect* of income insurance and its magnitude. Indeed, the VR's of the remainder of value added minus wages recover the negative slope of the term-structures of both EBIT and dividends. This means that wages explain the bulk of the distance between the flat term-structure of value added and the downward-sloping term-structure of dividends. Namely, increasing and decreasing VR's of wages and dividends represent the other side of the same coin of respectively wage rigidity and operational leverage on dividends. Instead, alternative

channels such as investment (suggested by Ai et al. (2015) and Kogan and Papanikolaou (2015)) or financial leverage (suggested by Belo et al. (2015)) have a little or negligible impact on the timing of dividend risk.⁹ In the following, I provide more formal empirical support to the *cyclicality* and *term-structure effects* of income insurance.

B.1. The Cyclicality Effect of Income Insurance

Accordingly with the above reasoning, the *cyclicality effect* of income insurance should imply that: i) changes in the labor-share are negatively correlated with changes in output; and ii) the labor-share and the dividend-share are negatively correlated.

Consistently with a number of previous works, I find empirical support for both these stylized facts. The labor-share is counter-cyclical –i.e. the correlation of changes in the labor-share and changes in log value added is -40.2%– and moves negatively with the dividend-share –i.e. the correlation between the labor- and dividend- shares is -23.5%. These results resemble the empirical findings of Boldrin and Horvath (1995), Shimer (2005) and Ríos-Rull and Santaeulàlia-Llopis (2010). The Online Appendix A documents that the labor-share Granger causes the dividend-share, whereas investment and financing decisions do not.

The smoothing effect of income insurance on wages can be easily observed. The negative covariance between labor-share and value added more than offset the contribution of the labor-share variation to wage variance:

$$\begin{aligned}
 1 &= \frac{\text{var}(\Delta \log Y)}{\text{var}(\Delta \log W)} + \frac{\text{var}(\Delta \log W/Y)}{\text{var}(\Delta \log W)} + 2 \frac{\text{cov}(\Delta \log Y, \Delta \log W/Y)}{\text{var}(\Delta \log W)} \\
 &= 149.1\% + 48.4\% - 97.5\%.
 \end{aligned}$$

Dynamically we should observe a decrease in wage volatility and an increase in dividends volatility when the labor-share is high. Then, I regress a moving-average of growth rates

conditional volatility on a moving-average of the labor-share in post-war quarterly data:

$$\begin{aligned}\overline{\sigma_{t,t+1}^W} &= a \underset{\text{(NW-t: -2.02)}}{-0.036} \overline{W/Y}_t + \epsilon_t, & \text{adj-}R^2 &= 9.32\%, \\ \overline{\sigma_{t,t+1}^D} &= a \underset{\text{(NW-t: 4.15)}}{+0.689} \overline{W/Y}_t + \epsilon_t, & \text{adj-}R^2 &= 13.61\%.\end{aligned}$$

Coefficients are statistically significant and their sign is consistent with income insurance.¹⁰

B.2. The Term-Structure Effect of Income Insurance

If income insurance only concerns transitory shocks, wages and dividends load respectively less and more than output on transitory risk. Given co-integration, this leads to a *term-structure effect*. Namely, after a negative (positive) transitory shock, workers' remuneration increases (decreases) relative to total resources, and the VR's of wages and dividends respectively increase and decrease (decrease and increase) relative to those of output.

To test this dynamic relation, I verify whether time-variation of VR's is consistent with the mechanism of income insurance. Namely, I build time-series of VR's of wages, dividends and output. Then, I regress the VR's of wages, the VR's of dividends and their difference on the labor-share:

$$\begin{aligned}\text{VR}_W|_{t,\tau} &= a + b_w \frac{W}{Y}_t + b_y \text{VR}_Y|_{t,\tau} + \epsilon_t, \\ \text{VR}_D|_{t,\tau} &= a + b_d \frac{W}{Y}_t + b_y \text{VR}_Y|_{t,\tau} + \epsilon_t, \\ \text{VR}_W - \text{VR}_D|_{t,\tau} &= a + b_{wd} \frac{W}{Y}_t + b_y \text{VR}_Y|_{t,\tau} + \epsilon_t,\end{aligned}$$

for several horizons τ ranging from 2 to 7 years. I include the VR's of output as a control to account for the variation in the VR's due to permanent shocks. Accordingly with the above reasoning, coefficients b_w and b_{wd} should be positive and the coefficient b_d should be negative. I perform these regressions using quarterly data on the sample 1951:4-2015:1 from the non-financial corporate sector. Estimation results are reported in Table I.

Table I

Sign and significance of coefficients strongly support the *term-structure effect* of income

insurance. When resources devoted to workers' remuneration are high (low) relative to total resources, dividends load more (less) on transitory risk and their VR's decrease (increase). Indeed, the coefficient b_d is negative and highly significant at all the considered horizons τ . The opposite holds for wages: the relation between their VR's and the labor-share is positive and the coefficient b_w is significant for τ large enough.¹¹ In turn, a positive and highly significant relation obtains between the labor-share and the distance between the VR's of wages and dividends (i.e. $b_{wd} > 0$). Note that sign and significance of the coefficients are preserved when controlling for financing and investment decisions. Adjusted R^2 are similar too.¹²

The left panel of Figure 2 shows the positive relationship between the labor-share and the gap between the VR's of wages and dividends. The middle and the right panels show the positive and negative relationships between the labor-share and the VR's of respectively wages and dividends. The above results strongly support the idea that income insurance within the firm is a main driver of the timing of dividend risk.

Figure2

C. Income Insurance and the Term-Structure of Equity

Now the focus turns from macroeconomic fundamentals to the term-structure of equity. As long as income insurance induces a term-structure effect, I expect that variation in the labor-share is related with risk and return on short-term assets, such as dividend strips. This could obtain by means of both the cash-flows and the discount rates channels.

In order to test whether income insurance is a driver of dividend strips returns, I build quarterly time-series of excess returns and GARCH excess return volatility. Data is monthly from van Binsbergen et al. (2012) on the sample 1996:4-2010:1 (i.e. the longest available data).¹³ To measure the slope of the term-structure of equity, I also build the time-series of dividend strips returns in excess of market returns. Then, I regress these three time-series on

the lagged labor-share and a bunch of macroeconomic and financial controls:

$$\begin{aligned}
vol_t^{\text{strip}} &= a + b_{\text{risk}} W/Y_{t-1} + b'_c \text{controls}_t + \epsilon_t \quad (\text{short-term equity risk}), \\
r_t^{\text{strip}} - r_t^{\text{risk-free}} &= a + b_{\text{premium}} W/Y_{t-1} + b'_c \text{controls}_t + \epsilon_t \quad (\text{short-term equity premium}), \\
r_t^{\text{strip}} - r_t^{\text{mkt}} &= a + b_{\text{slope}} W/Y_{t-1} + b'_c \text{controls}_t + \epsilon_t \quad (\text{short-term equity slope}).
\end{aligned}$$

Since income insurance induces a leverage effect on dividends and enhances their short-run risk, we expect a positive relation between the labor-share and the three dependent variables.

Regression results are reported in Table II. The labor-share significantly and positively predicts dividend strips volatility one-quarter, one-year ahead and two-years ahead. Newey-West t-statistics are 5.88, 6.03 and 5.37. Adjusted-R² are extremely high: 72%, 74% and 62% (without controls). Note that these variables do not share a time-trend and are not strongly persistent (the labor-share half-life is about 3.5 years).¹⁴

The left panel of Figure 3 shows how labor-share shapes dividend strips volatility: both time-series increase between 1996 and 2001, then they decrease up to 2007, increase again up to 2010. To understand how explanatory power of labor-share relates with other potential drivers of equity risk, Panel A of Table III shows horse race regressions. I consider the following controls: the three Fama and French factors (excess market return, SMB and HML returns), market return volatility, log price-earnings ratio, risk-free rate, cay as well as financial leverage and investment-share from the non-financial corporate sector.

First, labor-share coefficients remains highly significant with all of these controls. Second, horse race regressions do not change the positive sign and magnitude of the labor-share coefficients. Third, adjusted-R² do not increase substantially in any of the horse race regressions. Thus, the above results suggest that labor-share variation is a very important driver of short-term equity risk.¹⁵

Table II also shows that the labor-share significantly and positively predicts dividend strip returns in excess of respectively the risk-free rate and the market return. In the former case, Newey-West t-statistics and adjusted-R² are respectively 1.99 and 8% (one-quarter ahead), 3.02 and 31% (one-year ahead) and 6.26 and 64% (two-years ahead). In the latter case, Newey-

TableII

Figure3

West t-statistics and adjusted- R^2 are respectively 1.98 and 10% (one-quarter ahead) and 2.58, 26% (one-year ahead) and 2.43 and 28% (two-years ahead). Time-series are reported in middle and right panels of Figure 3. Similarly to the case of volatility, Panels B and C of Table III show horse race regressions with the same set of controls. Again, labor-share coefficients remain positive and significant in all of the horse race regressions and the adjusted- R^2 do not increase substantially.¹⁶

Overall, the above analysis strongly suggests that labor-share variation is an important driver not only of short-term equity risk but also of short-term equity premium and slope. Income insurance seems to be more informative about short-term equity returns than many financial indicators (e.g. valuation ratios and Fama and French factors) and alternative macroeconomic channels (e.g. financial and investment decisions).

TableIII

D. Additional Implications and Robustness

D.1. Income Insurance and Expected Growth

The previous analysis documents how income insurance affects the term structure of both dividend risk and equity returns. I now look at additional testable implications. As long as income insurance concerns transitory risk only, the labor-share should positively forecast dividend growth. This obtains because, on the one hand, the labor-share is a decreasing function of the transitory component of output and, on the other hand, dividends positively load on such a transitory shock. Therefore, I perform long-horizon predictability regressions of dividend growth rates on the labor-share. Estimation results are reported in panel A of Table IV.

The regressions support the mechanism of income insurance. Coefficients are positive and highly significant (as usual, Newey-West and Hansen-Hodrick t-statistics are used to account for autocorrelation and heteroscedasticity of residuals and overlapping samples). The explanatory power is large: the adjusted R^2 ranges from about 0% to 37%. The mechanism of income insurance also implies that the labor-share should positively forecast consumption

TableIV

growth. Panel B of Table IV provides evidence that this is the case. Coefficients are positive and significant at all the considered horizons. Adjusted R^2 ranges from about 6% to 36%. These results provide further robustness to the mechanism of income insurance, which leads to dividends and consumption predictability.¹⁷

D.2. Other Sources of Transitory Dividend Risk

This section aims to verify whether downward-sloping dividend risk as well as short-term equity risk, premium and slope could be imputed to sources of transitory dividend risk distinct from income insurance.

First, I isolate the transitory component of dividends which is not due to income insurance by looking at the dividend-share orthogonalized with respect to the labor-share. Even if the negative correlation between the dividend-share and the labor-share is highly significant, the latter only explains about 8% of variation in the former on the sample 1996:4-2010:1, for which we have dividend strip returns. Thus, a non-negligible component of transitory dividend risk should be imputed to sources different from income insurance (such as financial or investment decisions as well as the dividend policy itself).

Second, I use such an orthogonalized dividend-share as a control in the regressions of the variance-ratios of dividends at several horizons on the labor-share. If transitory risk distinct from income insurance drives the timing of dividend risk, we expect a significant coefficient of the orthogonalized dividend-share as well as an increase in the adjusted R^2 . Results are reported in Panel A of Table V. The coefficient of the orthogonalized dividend-share is never significant and its sign also changes with the horizon. This suggests that transitory risk distinct from income insurance does not help explaining the timing of dividend risk. Indeed, adjusted R^2 are almost identical to those in Panel C of Table I.

Third, I use the orthogonalized dividend-share as a control in the regressions of dividend strips return volatility, excess return over the risk-free rate and excess return over the market return on the current labor-share. Results are reported in Panel B of Table V. The coefficient of the orthogonalized dividend-share is not significant in 8 out of 9 regressions. Adjusted R^2

Table V

are almost identical to those of the univariate regressions in Table II.

This section shows that, even if transitory dividend risk distinct from income insurance is non-negligible, it does not contribute to explain either the timing of dividend risk, short-term equity risk, short-term equity premium or equity slope. This is not surprising by inspection of the right panel of Figure 1: the decreasing variance ratios of output minus wages almost recovers the negative slope of dividends. Thus, even if alternative mechanisms to income insurance could potentially affect the timing of dividend risk, it seems they do not.¹⁸ These results provide further robustness to the *term-structure effect* of income insurance.

II. Model

A. Economy

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.¹⁹

Agents 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, 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

$$J_t = \mathbb{E}_t \int_{u \geq t} f(C_u, J_u) du, \quad \text{with} \quad f(C, J) = \beta \chi J \left(\frac{C^{1-1/\psi}}{((1-\gamma)J)^{1/\chi}} - 1 \right), \quad (1)$$

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 $\psi \rightarrow 1/\gamma$. Workers' and shareholders' consumption levels are denoted by respectively $C_{w,t} = W_t$ and $C_{s,t} = D_t$.

Total resources are interpreted as a technological shock and their dynamics are modelled as the product of a permanent and a transitory shock. The former, X , features time-varying expected growth, in spirit of long-run risk literature, and induces an upward-sloping effect on the term-structure of risk. The latter, Z , 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, total resources $C = XZ$ have dynamics given by:

$$d \log X_t = dx_t = (\mu_t - \sigma_x^2/2)dt + \sigma_x dB_{x,t}, \quad (2)$$

$$d\mu_t = \lambda_\mu(\bar{\mu} - \mu_t)dt + \sigma_\mu dB_{\mu,t}, \quad (3)$$

$$d \log Z_t = dz_t = -\lambda_z z_t dt + \sigma_z dB_{z,t}, \quad (4)$$

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

B. Income Insurance, Wages and Dividends

The standard Walrasian Cobb-Douglas economy leads to a constant labor share and workers paid at their marginal productivity: $W_t = \alpha C_t$, with $\alpha \in (0, 1)$. The opposite extreme scenario would be the case where workers are promised perfect income smoothing, i.e. wages are constant (and potentially equal to the unconditional expected marginal productivity).

Here, I postulate that workers and shareholders agree in advance on a risk sharing rule \mathcal{C} . The two agent types arrange an agreement such that wages and dividends share the same long-run dynamics of total resources but the former feature an insurance to transitory shocks, implying a levered exposition of the latter. Namely, the contingent wage payments and dividend distributions are governed by the following sharing rule:

$$\mathcal{C} = \left\{ (W_t, D_t) : W_t = C_t \omega(z_t), \quad D_t = C_t \delta(z_t), \quad W_t + D_t = C_t \quad \forall t \right\}, \quad (5)$$

where the labor-share and dividend-share satisfy

$$-1 < \frac{\omega'(z_t)}{\omega(z_t)} < 0, \quad \omega''(z_t) > 0 \quad \Rightarrow \quad \frac{\delta'(z_t)}{\delta(z_t)} > 0, \quad \delta''(z_t) < 0, \quad (6)$$

such that both wages and dividends increase with z_t but are respectively concave and convex (i.e. income insurance strengthens in bad times). As it will be shown throughout the paper, these assumptions capture the mechanism of income insurance about transitory risk as well as many related empirical patterns documented in the literature and in Section I: (i) C_t , W_t and D_t are subject to both permanent and transitory shocks, (ii) C_t , W_t and D_t are co-integrated, (iii) the labor-share is counter-cyclical, (iv) short-term growth rates of wages and dividends are respectively smooth and levered, (v) VR's of wages are upward-sloping, (vi) VR's of dividends are downward-sloping, (vii) VR's of total resources are about flat, (viii) VR's of wages and dividends move respectively positively and negatively with the labor-share, (ix) the gap between the VR's of wages and dividends moves positively with the labor-share, (x) the labor-share positively forecasts dividends' growth as well as total resources' growth, (xi) the labor-share positively forecasts dividend strip return volatility, premium and slope under standard assumptions.

For the sake of exposition and tractability, I assume a simple and parsimonious functional form:

$$\omega(z_t) = \alpha e^{-\phi z_t} \quad \Rightarrow \quad \delta(z_t) = 1 - \alpha e^{-\phi z_t}, \quad (7)$$

where the curvature parameter $\phi \in (0, 1)$ represents the degree of income insurance and $\alpha \in (0, 1)$ is the steady-state labor-share (or the constant labor-share in absence of income insurance for $\phi \rightarrow 0$). Therefore, the parameter ϕ should be interpreted as the joint effect of bargaining negotiations between workers and shareholders (Danthine and Donaldson (1992, 2002)) as well as labor market frictions (Shimer (2005), Gertler and Trigari (2009), Favilukis and Lin (2015)) which lead to labor rigidity and operational leverage.

Denote with

$$d \log \mathcal{I} = \mu^{\mathcal{I}} dt + \sigma_x^{\mathcal{I}} dB_x + \sigma_z^{\mathcal{I}} dB_z, \quad \mathcal{I} = \{C, W, D\}$$

the instantaneous dynamics of total consumption, wages and dividends. Provided $\phi > 0$, a number of results is worth noting. First, long-run growth affects in the same way the drift ($\partial_{\mu} \mu^W = \partial_{\mu} \mu^C = \partial_{\mu} \mu^D = 1$) and volatility ($\sigma_x^W = \sigma_x^C = \sigma_x^D = \sigma_x$) of total consumption, wages and dividends because labor relations do not alter the impact of permanent shocks. Second, expected consumption growth depends on z_t : $|\partial_z \mu^C| = \lambda_z$. However, the *persistence* of expected growth of wages and dividends is altered by income insurance: the larger ϕ , the stronger the persistence of wages (i.e. $|\partial_z \mu^W| < \lambda_z$) and the weaker that of dividends (i.e. $|\partial_z \mu^D| > \lambda_z$). Third, the volatility of wages and dividends due to transitory shocks is affected by income insurance. Namely, $\sigma_z^W = (1 + \frac{\omega'(z_t)}{\omega(z_t)})\sigma_z = (1 - \phi)\sigma_z$ is constant, lower than σ_z^C and decreasing with ϕ . Therefore, income insurance induces a *smoothing* effect on wages at the cost of more volatile dividends. Indeed, $\sigma_z^D = (1 + \frac{\delta'(z_t)}{\delta(z_t)})\sigma_z$ is larger than σ_z^C and heteroscedastic:

$$\sigma_z = \sigma_z^C < \sigma_z^D = \left(1 + \phi \frac{\omega(z_t)}{1 - \omega(z_t)}\right) \sigma_z. \quad (8)$$

Fourth, such an excess volatility or *leverage*, $\sigma_z^D - \sigma_z$, is proportional and increasing with both ϕ and the labor-share and counter-cyclical (i.e. $\partial_z \sigma_z^D < 0$).

The focus now turns on the term structure of growth rates' volatility. Denote with $\mathbb{C}_t(\tau, u) = \mathbb{E}_t[C_{t+\tau}^u]$, $\mathbb{W}_t(\tau, u) = \mathbb{E}_t[W_{t+\tau}^u]$ and $\mathbb{D}_t(\tau, u) = \mathbb{E}_t[D_{t+\tau}^u]$ the moment generating functions of the logarithm of total consumption, wages and dividends. The term structure of dividends growth rates' volatility is computed as in [Belo et al. \(2015\)](#):

$$\sigma_D^2(t, \tau) = \frac{1}{\tau} \log \left(\frac{\mathbb{D}_t(\tau, 2)}{\mathbb{D}_t(\tau, 1)^2} \right). \quad (9)$$

Note that μ_t and z_t lead respectively to an upward-sloping ($\partial_{\sigma_{\mu, \tau}} \sigma_D(t, \tau) > 0$) and a downward-sloping effect ($\partial_{\sigma_z, \tau} \sigma_D(t, \tau) < 0$). Interestingly, the stronger income insurance, the larger

the volatility level ($\partial_\phi \sigma_D(t, \tau) > 0$) and the more pronounced the downward-sloping effect: $\partial_{\phi, \tau} \sigma_D(t, \tau) < 0$. Therefore, income insurance enhances the strength of the transitory shock and leads to an excess of short-run risk in dividends distributions with respect to total consumption. The opposite holds for wages: $\partial_\phi \sigma_W(t, \tau) < 0$ and $\partial_{\phi, \tau} \sigma_W(t, \tau) > 0$. This effect is the model counterpart of the empirical distance between the term-structures of output and those of dividend risk and wage risk, documented in Figure 1.

While the instantaneous volatility of dividends is increasing with the labor-share as in Eq. (8), the larger the horizon, the lower the sensitivity of dividend volatility because z_t is a transitory shock. Thus, the variance ratio of dividends,

$$\text{VR}_D(t, \tau) = \frac{\sigma_D^2(t, \tau)}{\sigma_D^2(t, 1)},$$

is decreasing with the labor-share, as documented in Table I. In turn, the distance between the variance ratios of wage and dividends –i.e. the *term-structure effect* of income insurance– is increasing with the labor-share, as in the actual data.

Similarly, a number of other interesting quantities obtain in closed form. Denote with $\sigma_\omega(t, \tau)$ and $\sigma_\delta(t, \tau)$ the volatilities of the labor-share and dividend-share and with $\rho_{C, \omega}(t, \tau)$ and $\rho_{C, \delta}(t, \tau)$ their correlations with total consumption. For $\phi > 0$, we obtain:

$$\begin{aligned} 0 < \sigma_\omega(t, \tau) < \sigma_\delta(t, \tau), \\ \rho_{C, \omega}(t, \tau) < 0 < \rho_{C, \delta}(t, \tau), \end{aligned}$$

such that the labor-share is smoother than the dividend-share, the former is counter-cyclical and the latter is pro-cyclical. These results are due to income insurance, and are also an important feature of the data, as shown in Section I.

For the sake of exposition and to derive analytical results for asset prices, in the following I use a log-linearized version of dividends dynamics:

$$\log D_t \approx \log X_t + \log \bar{D} + \partial_z \log D|_{z=0} z_t = x_t + d_0 + d_z z_t, \quad (10)$$

where $\log \bar{D} = d_0 = \log(e^{z_t} - \alpha e^{(1-\phi)z_t})|_{z=0}$ captures the steady-state dividend share $1 - \alpha$, and d_z satisfies:

$$d_z = 1 + \phi \frac{\omega(z_t)}{1-\omega(z_t)}|_{z=0} = 1 + \phi \frac{\alpha}{1-\alpha}. \quad (11)$$

Note that, as usual, the dividend process is still increasing in the states x_t and z_t but inherits their homoscedasticity (Section IV considers heteroscedasticity in fundamentals).

C. Asset Prices

C.1. Equilibrium State-Price Density

Preferences in Eq. (1) and the log-linearized dividend dynamics of Eq. (10) guarantee a model solution which emphasizes the role of the state-variables μ_t and z_t in the formation of prices. A first order approximation of the shareholders' consumption-wealth ratio around its endogenous steady state, e^{c^q} , provides closed form solutions for prices and return moments up to such approximation (Benzoni, Collin-Dufresne, and Goldstein (2011)).

From the shareholders' perspective, the marginal utility evaluated at optimal consumption is the valid state-price density (Duffie and Epstein (1992)):

$$\xi_{t,u} = e^{\int_t^u f_J(C_{s,\tau}, J_{s,\tau}) d\tau} \frac{f_C(C_{s,u}, J_{s,u})}{f_C(C_{s,t}, J_{s,t})}, \quad \forall u \geq t. \quad (12)$$

Hence, the price of an arbitrary payoff stream $\{F_u\}_{u \geq t}$ is given by $\mathbb{E}_t[\int_t^\infty \xi_{t,u} F_u du]$. The equilibrium state price density $\xi_{0,t}$ satisfies:

$$C_t = W_t + D_t = I_C[\xi_{0,t}] e^{-d_0 - (d_z - 1)z_t}, \quad (13)$$

where $I_C[\xi_{0,t}] = \{C_{s,t} : \xi_{0,t} = e^{\int_0^t f_J(s) ds} f_C(t) | X_t, \mu_t, z_t\}$ denotes the time t shareholders' optimal consumption implied by $\xi_{0,t}$.

Although the state price density equals the first order condition of shareholders, it depends on the risk attitudes of both agent types. The left hand side of Eq. (13) is given by the

exogenous flows of total resources produced by the firm. The right hand side is given by the product of two terms: the former is the optimality condition for market participants; the latter is a time-varying term which captures the distributional risk due to income insurance. Namely, this term equals the inverse of the dividend-share, C_t/D_t , and its variability increases with ϕ . Instead, in absence of income insurance, the labor-share is constant and the second term on the right hand side of Eq. (13) reduces to $(1 - \alpha)^{-1}$.²⁰

Note that, even if the equilibrium state-price density is an involved function of the integrated process C_t , the economy is characterized by a stationary equilibrium. This is a necessary condition to produce realistic testable implications. Many real business cycle models circumvent the problem by excluding permanent shocks (e.g. $C_t = Z_t$). Here, allowing for both permanent and transitory shocks (e.g. $C_t = X_t Z_t$) and still obtaining a stationary equilibrium is of crucial importance in order to study the equilibrium implications for the term-structure of equity.

The equilibrium state price density has dynamics given by

$$\frac{d\xi_{0,t}}{\xi_{0,t}} = \frac{df_C}{f_C} + f_J dt = -r(t)dt - \theta_x(t)dB_{x,t} - \theta_\mu(t)dB_{\mu,t} - \theta_z(t)dB_{z,t}, \quad (14)$$

where the instantaneous risk-free rate satisfies

$$r(t) = r_0 + r_\mu \mu_t + r_z z_t, \quad (15)$$

with $r_\mu = \frac{1}{\psi}$, $r_z = -\frac{\lambda_z}{\psi} d_z$ and the instantaneous prices of risk are given by

$$\theta_x(t) = -\frac{\partial_X f_C}{f_C} X_t \sigma_x = \gamma \sigma_x, \quad (16)$$

$$\theta_\mu(t) = -\frac{\partial_\mu f_C}{f_C} \sigma_\mu = \frac{\gamma - 1/\psi}{e^{c\eta} + \lambda_\mu} \sigma_\mu, \quad (17)$$

$$\theta_z(t) = -\frac{\partial_z f_C}{f_C} \sigma_z = \left(\gamma - \frac{\lambda_z(\gamma - 1/\psi)}{e^{c\eta} + \lambda_z} \right) d_z \sigma_z. \quad (18)$$

The risk-free rate is affine in μ_t and z_t . The 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 the degree of income insurance ϕ .

The permanent shock commands a price of risk $\theta_x(t)$ due to the contribution of x_t to the instantaneous volatility of shareholders' consumption. Long-run growth commands a price of risk $\theta_\mu(t)$, which has the usual form in long-run risk models. This is a price for the contribution of μ_t to the variation in the continuation utility value of shareholders. Hence, $\theta_\mu(t)$ disappears under power utility ($\psi \rightarrow \gamma^{-1}$). Such a price of risk increases with the preferences for the early resolution of uncertainty $\gamma - 1/\psi$ and decreases in magnitude with the rate of reversion λ_μ . The transitory shock leads to a price of risk $\theta_z(t)$, which has two components. The first, $\gamma d_z \sigma_z$, is a positive price for the contribution of z_t to the instantaneous volatility of shareholders' consumption. The second, $\theta_z(t) - \gamma d_z \sigma_z$, is a price for the contribution of z_t to the variation in the continuation utility value of shareholders. Namely, at the opposite of θ_μ , this term is negative and increasing in the rate of reversion λ_z under preferences for the early resolution of uncertainty. This term disappears under power utility. Interestingly, both the components of $\theta_z(t)$ are proportional to the coefficient $d_z > 1$, which is increasing in ϕ . Therefore, for $\gamma > \psi > 1$, income insurance leads to a positive price for its effect on the current dividend volatility and a negative price for its effect on the evolution of shareholders' utility.

C.2. *Equilibrium Dividend Strips*

The equilibrium price of the market dividend strip with maturity τ is exponential affine in x_t, μ_t and z_t :

$$P_{t,\tau} = \mathbb{E}_t [\xi_{t,t+\tau} D_{t+\tau}] = X_t e^{A_0(\tau) + A_\mu(\tau)\mu_t + A_z(\tau)z_t}, \quad (19)$$

Hence, the strip's price-dividend ratio is stationary. The functions $A_\mu(\tau)$ and $A_z(\tau)$ are respectively the semi-elasticity of the price with respect to μ_t and z_t :

$$A_\mu(\tau) = \partial_\mu \log P_{t,\tau} = \frac{(1 - e^{-\lambda_\mu \tau})(1 - 1/\psi)}{\lambda_\mu}, \quad (20)$$

$$A_z(\tau) = \partial_z \log P_{t,\tau} = \left(\frac{1}{\psi} (1 - e^{-\lambda_z \tau}) + e^{-\lambda_z \tau} \right) d_z. \quad (21)$$

First, $A_\mu(\tau)$ increases with ψ , whereas $A_z(\tau)$ decreases with ψ . Second, $A_z(\tau)$ increases with the degree of income insurance ϕ . Therefore, the leverage effect on dividends due to income insurance also affects prices: this effect is amplified for $\psi < 1$ and vice-versa. Finally, for $\psi \rightarrow 1$, the strip's price-dividend ratio reduces to a state-independent function of the horizon τ . The instantaneous volatility and premium on the dividend strip with maturity τ are given by

$$\sigma_P(t, \tau) = \sqrt{\sigma_x^2 + \frac{(1-e^{-\lambda_\mu\tau})^2(\psi-1)^2}{\lambda_\mu^2\psi^2}\sigma_\mu^2 + \frac{e^{-2\lambda_z\tau}(\psi+e^{\lambda_z\tau}-1)^2}{\psi^2}d_z^2\sigma_z^2}, \quad (22)$$

$$(\mu_P - r)(t, \tau) = \gamma\sigma_x^2 + \frac{(1-e^{-\lambda_\mu\tau})(1-1/\psi)(\gamma-1/\psi)}{\lambda_\mu(e^{c\tau}+\lambda_\mu)}\sigma_\mu^2 + \frac{\left(\frac{1}{\psi}(1-e^{-\lambda_z\tau})+e^{-\lambda_z\tau}\right)(\lambda_z+\psi\gamma e^{c\tau})}{\psi(e^{c\tau}+\lambda_z)}d_z^2\sigma_z^2. \quad (23)$$

The three shocks of the model contribute to the return volatility and command a premium. The permanent shock does not lead to excess volatility. Instead, the loadings on $B_{\mu,t}$ and $B_{z,t}$, are proportional to 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 loading on long-run growth is increasing with ψ and decreasing with λ_μ . Instead the loading on the transitory shock is decreasing with ψ and increasing with λ_z . The latter is also amplified by the leverage effect due to income insurance, d_z .

The premium on the dividend strip is given by the sum of the compensations to the three shocks. The compensation for the permanent shock is positive and has the usual form: $\gamma\sigma_x^2$. Instead, the compensations associated to the states μ_t and z_t depend also on the horizon τ , the elasticity of intertemporal substitution and the persistence of the states. Long-run growth commands a premium which is increasing with ψ and decreasing with λ_μ :

$$\frac{\gamma-1/\psi}{\lambda_\mu(e^{c\tau}+\lambda_\mu)}A_\mu(\tau)\sigma_\mu^2. \quad (24)$$

This term is a compensation for the contribution of μ_t to the variability of the continuation utility value of shareholders. If the intertemporal substitution effect dominates the wealth effect and shareholders have preferences for the early resolution of uncertainty –e.g. $\gamma > \psi >$

1– long-run growth leads to a positive premium on the dividend strip. The premium for the exposition to the transitory shock z_t is given by the sum of two terms:

$$\gamma A_z(\tau) d_z \sigma_z^2, \quad \text{and} \quad - \frac{\lambda_z(\gamma-1/\psi)}{e^{cq} + \lambda_z} A_z(\tau) d_z \sigma_z^2. \quad (25)$$

The first term compensates for the contribution of z_t to the instantaneous volatility of shareholders' consumption. Such a premium is always positive and decreases with ψ . Instead, the second term is an intertemporal compensation. It is decreasing with ψ and is negative (positive) under the shareholders' preference for the early (late) resolution of uncertainty. Moreover, both terms depend on the horizon τ and increase in magnitude with income insurance, d_z .

The following is a key result of the paper. The slopes of the term-structures of dividend strips' volatility and premia are given by

$$\partial_\tau \sigma_P^2(t, \tau) = \frac{2(\psi-1)}{\psi^2} (e^{-2\lambda_\mu \tau} (e^{\lambda_\mu \tau} - 1)(\psi - 1) \lambda_\mu^{-1} \sigma_\mu^2 - e^{-2\lambda_z \tau} (\psi + e^{\lambda_z \tau} - 1) \lambda_z d_z^2 \sigma_z^2), \quad (26)$$

$$\partial_\tau (\mu_P - r)(t, \tau) = \frac{\psi-1}{\psi^2} \left(\frac{(\gamma-1/\psi) e^{-\lambda_\mu \tau} \sigma_\mu^2}{e^{cq} + \lambda_\mu} - \frac{(\lambda_z + \gamma \psi e^{cq}) e^{-\lambda_z \tau} \lambda_z d_z^2 \sigma_z^2}{e^{cq} + \lambda_z} \right). \quad (27)$$

The slope of the term-structure of volatility depends on two terms, due respectively to μ_t and z_t . The first is always positive and, hence, implies an upward sloping effect. The second 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 the leverage effect due to income insurance, d_z , outweighs the upward sloping effect due to long-run growth for some horizons τ .

Also the slope of the term-structure of premia depends on two terms, due to μ_t and z_t . The first is positive if the intertemporal substitution effect dominates the wealth effect ($\psi > 1$) and shareholders have preferences for the early resolution of uncertainty ($\gamma > 1/\psi$). The second term is negative if the intertemporal substitution effect dominates the wealth effect ($\psi > 1$) and vice-versa. Thus, the slope of equity premia can be economically interpreted as:

$$\text{slope} = \underbrace{\text{intertemporal substitution}}_{\psi-1} \times \left(\underbrace{\text{resolution of uncertainty}}_{\gamma-1/\psi} \times \underbrace{\text{long-run risk}}_{\lambda_\mu, \sigma_\mu} - \underbrace{\text{income insurance}}_{\phi} \times \underbrace{\text{short-run risk}}_{\lambda_z, \sigma_z} \right).$$

Under the usual parametrization $\gamma > \psi > 1$, variation in 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 as long as both permanent and transitory shocks enter the model. Namely, the slope is negative for income insurance strong enough.²¹

Such an analytical result clearly explains why the standard long-run risk model cannot capture the recent evidence about dividend strips. Long-run risk models (i.e. $C_t = X_t$) rule out transitory shock z_t and do a good job at matching a number of asset pricing moments as long as $\psi > 1$. Both the term-structures of volatility and premia are monotone increasing. The alternative scenarios, in which either only the transitory shock enters the model ($C_t = Z_t$) or long-run growth is constant ($C_t = X_t Z_t$ with $\mu_t = \bar{\mu}$), lead to monotone decreasing term-structures of risk and premia for $\psi > 1$. However, in such cases the equity premium is not sizeable since it decreases with ψ . Instead, when we account for both μ_t and z_t , the model can accommodate for both a high equity premium and downward sloping term-structures of equity risk and premia in the short-run. Therefore, the dynamics of dividends induced by income insurance reconciles the above stylized facts.

C.3. Equilibrium Market Asset

The market price is given by the time integral of the dividend strip price, $P_t = \int_0^\infty P_{t,\tau} d\tau$:

$$P_t = \mathbb{E}_t \left[\int_t^\infty \xi_{t,u} D_u du \right] = X_t \beta^{-1} e^{u_0 \chi^{-1} + d_0 + u_\mu \chi^{-1} \mu_t + (u_z \chi^{-1} + d_z) z_t} \quad (28)$$

where u_0, u_μ and u_z are endogenous constants. The market price dividend ratio is a stationary function of μ_t and z_t and equals the wealth-consumption ratio of shareholders. Prices increase with μ_t as long as the intertemporal substitution effect dominates the wealth effect and increase with z_t : $\partial_\mu P_t \geq 0$ if $\psi \geq 1, \forall \gamma$ and $\partial_z P_t > 0, \forall \psi, \gamma$.

The instantaneous volatility and premium on the market asset are given by

$$\sigma_P(t) = \sqrt{\sigma_x^2 + \left(\frac{1-1/\psi}{e^{cq} + \lambda_\mu}\right)^2 \sigma_\mu^2 + \left(1 - \frac{(1-1/\psi)\lambda_z}{e^{cq} + \lambda_z}\right)^2 d_z^2 \sigma_z^2}, \quad (29)$$

$$(\mu_P - r)(t) = \gamma \sigma_x^2 + \frac{(1-1/\psi)(\gamma-1/\psi)}{(e^{cq} + \lambda_\mu)^2} \sigma_\mu^2 + \frac{(\gamma\psi e^{cq} + \lambda_z)(\psi e^{cq} + \lambda_z)}{(e^{cq} + \lambda_z)^2 \psi^2} d_z^2 \sigma_z^2. \quad (30)$$

The permanent shock x_t enters the return dynamics exactly as the dividend dynamics, σ_x . Instead, the loadings on the shocks $B_{\mu,t}$ and $B_{z,t}$ depend on the preference parameters and are respectively increasing and decreasing in ψ . The loading on $B_{\mu,t}$ always leads to an excess-volatility of market returns over dividends, whereas the loading on $B_{z,t}$ generates excess-volatility for $\psi < 1$ and vice-versa.

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

Finally, provided $\gamma > \psi > 1$, the whole equity premium is increasing in γ but non-monotone in ψ . Indeed, μ_t leads to compensations increasing with the horizon, whereas short-run but persistent uncertainty due z_t leads to compensations decreasing with the horizon. Once the model is calibrated with realistic parameters, such a term-structure perspective sheds lights on which risks are priced in equilibrium. Using the definition of the market asset price as the time integral of the dividend strip prices, it is possible to write the equity premium as a time integral and, hence, to derive an equilibrium density which describes the contribution of future discounted cash-flows at each horizon (details are in the Appendix):

$$\mathcal{H}(t, \tau) = \frac{\Pi(t, \tau)}{(\mu_P - r)(t)} \quad \text{with} \quad (\mu_P - r)(t) = \int_0^\infty \Pi(t, \tau) d\tau = \int_0^\infty \frac{P_{t,\tau}}{P_t} (\mu_P - r)(t, \tau) d\tau. \quad (31)$$

The shape of the equilibrium density $\mathcal{H}(t, \tau)$ tells us whence the equity premium comes from.

The more the mass of probability concentrates on either short or long horizons, the more the riskiness associated to such horizons deserves a compensation and contributes to the whole equity premium. Therefore, $\mathcal{H}(t, \tau)$ is natural metric to understand the effect of the term-structures of equity on an important equilibrium outcome, such as the equity premium.²²

C.4. Equilibrium Bond and Equity Yields

The equilibrium price of the zero-coupon bond with maturity τ , $B_{t,\tau} = \mathbb{E}_t [\xi_{t,t+\tau}]$, is stationary and exponential affine in μ_t and z_t . Hence, the bond yield is state-dependent but its volatility inherits the homoscedasticity of the states:

$$\varepsilon(t, \tau) = -\frac{1}{\tau} \log B_{t,\tau} = \frac{1}{\tau} \left(-K_0(\tau) + (1 - e^{-\lambda_\mu \tau}) r_\mu \lambda_\mu^{-1} \mu_t + (1 - e^{-\lambda_z \tau}) r_z \lambda_z^{-1} z_t \right), \quad (32)$$

where $K_0(\tau)$ is a deterministic function of the maturity. The short- and long-run limits of the term-structure of real yields lead to the steady state term-spread:

$$\varepsilon(t, \infty) - \varepsilon(t, 0) = -\frac{r_\mu \theta_\mu \sigma_\mu}{\lambda_\mu} - \frac{r_\mu^2 \sigma_\mu^2}{2\lambda_\mu^2} - \frac{r_z \theta_z \sigma_z}{\lambda_z} - \frac{r_z^2 \sigma_z^2}{2\lambda_z^2}, \quad (33)$$

which can be either positive or negative for $\gamma > \psi > 1$: indeed, $r_\mu \theta_\mu > 0$ and $r_z \theta_z < 0$.²³

Armed with these results, the focus turns on the equity yields as introduced by [van Binsbergen et al. \(2013\)](#): $p(t, \tau) = \frac{1}{\tau} \log D_t/P_{t,\tau}$. The model equity yield is given by

$$p(t, \tau) = \frac{1}{\tau} \left(d_0 - A_0(\tau) + \frac{(1 - e^{-\lambda_\mu \tau})(1/\psi - 1)}{\lambda_\mu} \mu_t + (1 - e^{-\lambda_z \tau})(1 - 1/\psi) d_z z_t \right) \quad (34)$$

and, hence, is a stationary function of the states and the maturity. Moreover, it can be decomposed as:

$$p(t, \tau) = \varepsilon(t, \tau) - g_D(t, \tau) + \varrho(t, \tau). \quad (35)$$

The equity yield is given by the difference among the yield on the risk-less bond, $\varepsilon(t, \tau)$, and the dividend expected growth, $g_D(t, \tau) = \log(\mathbb{D}_t(\tau, 1)/D_t)/\tau$, plus a premium, $\varrho(t, \tau)$. The

latter is a state-independent function of the maturity. The transitory shock determines the level of its short-run limit, whereas long-run growth determines the level of its long-run limit. Therefore, the term-spread

$$\varrho(t, \infty) - \varrho(t, 0) = \frac{\gamma\psi\lambda_\mu + e^{cq}}{(\lambda_\mu + e^{cq})\lambda_\mu^2\psi}\sigma_\mu^2 - \frac{\lambda_z + \gamma\psi e^{cq}}{(\lambda_z + e^{cq})\psi}d_z^2\sigma_z^2,$$

can be either positive or negative depending on the model parameters. Thus, downward-sloping premia on equity yields obtain for income insurance large enough.

III. Asset Pricing Results

A. Model Calibration and the Timing of Dividend Risk

Model parameters are set by choosing cash-flows parameters in order to match key 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):

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

and three additional conditions that capture the relative error between the empirical and the model term-structures of variance ratios of consumption, wages and dividends over a 15 years horizon:

$$\begin{aligned}
m_6(\theta) &= \sum_{\tau=2}^{15} \frac{|VR_C^{\text{empirical}}(\tau) - VR_C(\tau)|}{VR_C^{\text{empirical}}(\tau)}, \\
m_7(\theta) &= \sum_{\tau=2}^{15} \frac{|VR_W^{\text{empirical}}(\tau) - VR_W(\tau)|}{VR_W^{\text{empirical}}(\tau)}, \\
m_8(\theta) &= \sum_{\tau=2}^{15} \frac{|VR_D^{\text{empirical}}(\tau) - VR_D(\tau)|}{VR_D^{\text{empirical}}(\tau)}.
\end{aligned}$$

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 income insurance.

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

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

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 17.4%, the average value of the dividend-share (i.e. the ratio of net dividends over the sum of net dividends and wages) is set to 6% and its volatility to 1.6%. These values are from the US non-financial corporate sector and 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 from the US non-financial corporate sector are computed as in Section I: wage risk increases from one to about 1.6 over a 15 years horizon, whereas dividend risk decreases from one to about 0.2. Finally, the variance-ratios of consumption (NIPA nondurable goods and services) are about flat. Table VI reports the model parameters and Table VII reports both the empirical and the model-implied moments of cash-flows.

The left panel of Figure 4 shows the model implied 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 of respectively wage and dividend risk with the horizon. Therefore, the calibration procedure does a good job at recovering the whole shape of the empirical term-structures and, hence, the timing of consumption, wages and dividend risk.

TableVI

The right panel of Figure 4 shows that empirical and model-implied autocorrelation functions of the labor-share are very similar. This is interesting because, even if autocorrelations do not enter the calibration procedure, the capability of the model to match the gap in the variance ratios of wages and dividends leads to an accurate description of the persistence of the main model state-variable (half-life is about 3.5 years).

TableVIII

The decline in the timing of dividend risk is due to the levered exposition of dividends to the transitory component of consumption, z_t . The operating leverage coefficient, $d_z = 1 + \phi \frac{\alpha}{1-\alpha} = 6.5$, allows for both i) the correct slope of the term-structure of dividends volatility, and ii) the excess volatility of dividends over consumption in yearly growth rates (i.e. 17.4% versus 2.5%). At the same time, the model leads to smooth wage growth rates (i.e. 1.7%).

Figure4

Section I empirically investigates the *term-structure effect* of income insurance by recognizing a dynamic relationship between the labor-share and, respectively, the variance ratios of dividends and the differential in the variance ratios of wages and dividends. The former relationship is negative and the latter is positive, as documented in Table I. The model leads to the same result: the left and right panels of Figure 5 show that the economic mecha-

Figure5

nism of income insurance is the driver of heterogeneity in the timing of macroeconomic risk. When wages are high (low) relative to dividends, as a result of income insurance, dividend risk becomes more (less) downward-sloping and the gap between the timing of wage risk and dividend risk increases (decreases). Similarly, income insurance leads to dividend and consumption growth predictability. Table IV documents a positive intertemporal relationship between the current labor-share and future growth. The same result holds in the model, as shown in Table VIII. Since income insurance only concerns transitory risk, both the labor-share and expected growth are decreasing in the current level of the transitory shock. Hence, dividend and consumption growth predictability obtain.

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. Thus, the calibration supports the model assumption of both permanent and transitory shocks. Second, income insurance leads to heterogeneity in the term-structures of risk of consumption, wages, and dividends. Consistently with the empirical findings of Section I, matching the positive slope of wage risk allows to quantitatively fill the gap between the approximately flat term-structure of consumption risk and the downward-sloping one of dividend risk. Thus, the calibration further supports the idea that income insurance is the main determinant of the timing of macroeconomic risk. In absence of income insurance ($\phi = 0$), the three term-structures are equal and collapse on that of consumption. 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 ($\lambda_\mu = .86$ and $\sigma_\mu = 1.8\%$). The model does not require an excessive persistence in expected consumption growth, as suggested by Constantinides and Ghosh (2011) and Beeler and Campbell (2012),

Table VIII

but accurately captures the persistence of the labor-share.

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 $\psi = 1.5$ belongs to the usual range of values. The time-discount rate β is set to 3.5%.

B. The Term Structure of Equity

In the baseline calibration ($\gamma = 10, \psi = 1.5$), the term structures of both premia and return volatility on the dividend strips are decreasing 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 approximately flat at long horizons—in which the two effects offset each other. The upper panels of Figure 6 show these term structures.

The stronger the income insurance (ϕ), the larger the operating leverage effect on dividends (d_z). This enhances the price associated to transitory risk and, for $\psi > 1$, induces a downward-sloping effect on the term-structure of equity premia. These are decreasing over a longer horizon and their slopes are larger in magnitude.

Figure6

Although the model is parsimonious and data about dividend strip returns are available on a short sample, it is instructive to compare the slope of risk premia in the model and in the data. [van Binsbergen et al. \(2012\)](#) verify that one cannot reject the hypothesis that the one-year dividend strip premium over the market is equal to zero. However, [van Binsbergen and Koijen \(2016\)](#) propose a more powerful test and verify that the average dividend strip premium up to 5 years maturity is significantly larger than the equity premium. Thus, the test provides empirical evidence of a negative slope on the sample 2002-2014. The magnitude of this premium in U.S. is relatively small, about 1.2% (i.e. 0.1% monthly). The analogous premium using dividend strip futures returns over the market return in excess of a ten year bond return is somewhat larger, about 4.1% (i.e. 0.34% monthly). I construct similar 'spot'

and ‘futures’ measures of equity slope in the model:

$$\begin{aligned} \text{(spot)} \quad & \frac{1}{5} \int_0^5 (\mu_P - r)(\tau) d\tau - (\mu_P - r) &= 1.1\%, \\ \text{(futures)} \quad & \frac{1}{5} \int_0^5 [(\mu_P - r)(\tau) - (\mu_B - r)(\tau)] d\tau - [(\mu_P - r) - (\mu_B - r)(10)] &= 3.4\%, \end{aligned}$$

where $(\mu_P - r)$ is the equity premium, $(\mu_P - r)(\tau)$ and $(\mu_B - r)(\tau)$ are the premia on the dividend strip and the risk-less bond with maturity τ . The baseline calibration produces values (1.1%, 3.4%) that are very close to their empirical counterparts. The corresponding values for $\psi = 1.25$ and $\psi = 1.75$ are respectively (0.7%, 3.7%) and (1.4%, 3.1%): a higher elasticity of intertemporal substitution leads to lower equity (higher bond) compensation but steeper equity (flatter bond) slope.

The lower left panel of Figure 6 shows the term-structure of Sharpe ratios. [van Binsbergen and Koijen \(2016\)](#) provide evidence that Sharpe ratios from dividend strip futures returns are slightly increasing with the maturity but are much larger than the Sharpe ratio of market returns in excess of the 10 year bond yield. Namely, futures Sharpe ratios from 1 to 7 years maturity range from 42% to 58% in actual data (i.e. from 12% to 17% monthly), whereas the Sharpe ratio of the market return in excess of the 10 year bond is about 12.5% (i.e. 3.7% monthly). The corresponding model quantities have similar shapes: futures Sharpe ratios from 1 to 7 years maturity range from 35% to 38.5%, whereas the Sharpe ratio of the market return in excess of a 10 year bond is about 7.7%. Thus, both empirical and model short-term Sharpe ratios are about five times larger than the market Sharpe ratio.²⁴

Dividend strip returns feature excess volatility over dividends at any horizon. Volatility approaches a value above fundamentals’ risk in the long-run, as shown in the lower right panel of Figure 6. In particular, the “long-run” excess volatility is given by:

$$\sigma_P^2(t, \infty) - \sigma_D^2(t, \infty) = \frac{(1-2\psi)\sigma_\mu^2}{\lambda_\mu^2 \psi^2} + \frac{d_z^2 \sigma_z^2}{\psi^2}.$$

Long-run excess-volatility increases with ϕ , decreases with ψ and does not depend on risk aversion. Long-run growth contributes negatively to the excess-volatility for $\psi > 1/2$ and

vice-versa. Instead, z_t always contributes positively to the excess-volatility. Thus, for ϕ large enough, a positive excess-volatility can obtain even if $\psi > 1/2$.

The model generates a long-run excess volatility of equity over dividends in line with the recent empirical evidence about the decreasing variance ratios of dividends, documented by [Belo et al. \(2015\)](#) and in Section I. Instead, long-run risk models imply payouts to shareholders riskier than equity returns, as pointed out by [Beeler and Campbell \(2012\)](#). Namely, a long-run risk model ($C_t = X_t$) produces “long-run” excess volatility only for $\psi < 1/2$ —a parametrization under which standard asset pricing implications fail to obtain.

C. The Market Asset and the Horizon Decomposition of the Equity Premium

The model reconciles the evidence about the term-structures of both equity and macroeconomic variables with standard asset pricing facts. The baseline calibration ($\gamma = 10, \psi = 1.5$) produces an unconditional equity premium, which is about 5.1%, quite close to the data. Such a result is particularly remarkable since neither stochastic volatility and disasters nor unrealistically high and time-varying risk aversion are required. The return volatility is about 13.6%, which is somewhat lower than in actual data. However, a slightly lower $\psi = 1.25$ increases return volatility to 15.8%. 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 37.2%), which accurately matches the data. Such a result is peculiar and mostly due to transitory risk, amplified by income insurance. The model leads to a risk-free rate level (about 0.9%) and volatility (about 2.8%), very close to actual data. The 20 years real bond yield is 3.6%, about 200 basis points higher than TIPs data. The model also captures quite well the level and the volatility of the price-dividend ratio (about $\exp(3.5)$ and 41.3%).

Table IX 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 also obtain for $(\gamma = 10, \psi = 1.25)$, $(\gamma = 7.5, \psi = 1)$ and $(\gamma = 5, \psi = 0.75)$. Decreasing the elasticity of intertemporal substitution leads to an increase

Table IX

in the equity premium but the price-dividend ratio and the risk-free rate are respectively too smooth and too volatile in comparison with the data. Hence, the choice $(\gamma = 10, \psi = 1.5)$ seems preferable. The operating leverage effect due to income insurance not only is crucial to the modeling of the term-structures but also helps to match the standard asset pricing moments (Danthine and Donaldson, 2002). 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 transitory risk dominates the price of long-run variations in expected growth.

The case of no income insurance ($\phi = 0$) and, hence, constant labor-share fails to describe both the risk-free rate and equity premium puzzle as well as the downward-sloping term-structure of equity.

To better understand the equilibrium equity premium, it is instructive to adopt a term-structure perspective. The equity premium is a weighted average of dividend strip premia, where the weights are given by the ratio of the dividend strip price over the equity price. From the upper left panel of Fig. 6 we observe that dividend strip premia range from about 6.9% to 4.8%. Since the slope is negative but relatively tiny, a high equity premium (5.1%) can obtain.²⁵ The equilibrium density $\mathcal{H}(t, \tau)$ of Eq. (31) represents the relative contribution of each horizon τ to the whole premium. The horizon decomposition of the equity premium does not depend only on the dynamics of the permanent and transitory shocks, but also on the equilibrium compensations for these risks. Figure 7 shows that, in the baseline calibration, the equilibrium density is monotone decreasing with the horizon. A stronger (weaker) income insurance mechanism leads to a shift of the density towards the short (long) horizon. Indeed, income insurance leads not only to riskier dividends but also to a larger compensation for the transitory risk. This horizon decomposition sheds lights on the nature of priced risk in equilibrium. A “short-run” explanation of market compensations is needed in order to simultaneously describe both the standard asset pricing moments and the term-structures of both fundamentals and equity.

Figure7

D. Bond and Equity Yields

Income insurance affects the equilibrium equity yields and their components: the yields on the risk-less bond, the expected dividend growth and the premium on the equity yields, as defined by [van Binsbergen et al. \(2013\)](#). Figure 8 plots these quantities at the steady-state as a function of the horizon both in presence and absence of income insurance.

The left upper panel shows that the equity yield is decreasing with the horizon under income insurance, whereas it is increasing in absence of income insurance ($\phi = 0$). For $\psi > 1$, the downward-sloping effect due to income insurance outweighs the upward-sloping effect due to long-run growth. The right upper panel shows the term-structure of the real bond yields. In absence of income insurance, μ_t drives the term-structure of interest rates. Similarly to long-run risk models, a downward-sloping term-structure obtains for $\psi > 1$, inconsistently with actual data from TIPs. Instead, in presence of income insurance, z_t induces a stronger upward-sloping effect, which leads to a positive slope for the bond yields. Intuitively, income insurance enhances transitory risk in equilibrium and, hence, bonds with short maturities are a better hedge than equity. Therefore, increasing bond yields obtain. Real yields (TIPs) are available for maturities of 5, 7, 10 and 20 years on the sample 2003-2015.

Figure8

	real bond yields					term spreads		
%	5y	7y	10y	20y	∞	7y - 5y	10y - 5y	20y - 5y
TIPs data	0.66	0.96	1.22	1.53	–	0.32	0.57	0.88
Model	2.20	2.54	2.92	3.65	4.37	0.34	0.71	1.35

The baseline calibration produces quite a realistic slope but overestimates the level of the curve (slightly lower β and/or higher ψ improve the fit at the cost of a lower equity premium). As commented in the Introduction, the assumption of limited market participation leads to a state-price density based on dividends. While this seems to be key to capture the short-run properties of equity, it also creates a tension concerning the quantitative predictions about real yields. Finally, the right lower panel of Figure 8 reports the term-structure of the equity yields premia. Such premia increase and decrease with horizon respectively in absence and in presence of income insurance. For maturities large enough, the equity yield is smaller than the real yield or, equivalently, the premium on the equity yield is smaller than expected dividend

growth. This case leads to negative forward equity yields:

$$f(t, \tau) = p(t, \tau) - \varepsilon(t, \tau) = \varrho(t, \tau) - g_D(t, \tau).$$

Note that negative forward equity yields are not at odds with actual data, as documented by [van Binsbergen et al. \(2013\)](#), and do not imply a low equity premium. As long as the negative slope of $\varrho(t, \tau)$ is steep enough, short-term risk is sufficient to produce a high compensation for equity. This is the case of the baseline calibration (recall that the equity premium is about 5%) and is consistent with the findings of [van Binsbergen et al. \(2012\)](#).

[van Binsbergen and Koijen \(2016\)](#) provide empirical evidence that forward equity yield volatility decreases with the horizon. Namely, in U.S. 2002-2014 data this volatility ranges from about 11% to 4% over 1 to 7 years maturities. The corresponding volatility in the baseline model calibration is also decreasing and ranges from about 15.7% to 5.2%.

In summary, the decomposition of equity yields provides two noteworthy results. First, income insurance helps to understand the term-structures of the equity yield premia, in line with the findings of [van Binsbergen et al. \(2013\)](#). Second, at the same time, income insurance helps to reconcile the term-structure of real interest rates with the equity results.

IV. Uncertainty and Time-Varying Slope of Risk Premia

While downward-sloping dividend risk is a very robust feature of the data, the empirical evidence about the term structures of equity is under debate.²⁶ On the one hand, equity volatility inherits the negative slope of dividend risk; on the other hand, the slope of equity premia depends on how and how much the sources of long-run and short-run risks are priced in equilibrium. Downward-sloping equity premia documented by [van Binsbergen et al. \(2012\)](#) appear as an unconditional property of dividend strips' returns. Indeed, [van Binsbergen et al. \(2013\)](#) and [Aït-Sahalia et al. \(2015\)](#) provide evidence that the term-structure of equity

premia is time-varying and switches from flat or slightly increasing in good times to strongly decreasing in bad times.

The model of the previous sections does not allow to study risk premia time-variation neither for dividend strips nor for the market asset. While income insurance generates endogenous heteroscedasticity (see Eq. (8)), the log-linearized dynamics of dividends used to solve for the equilibrium rules out time-variation in equity premia. This section shows that a minimal modification of the previous model accounts for the refinements by [van Binsbergen et al. \(2013\)](#). Namely, I introduce heteroscedasticity in the transitory shock z_t :

$$z_t = \bar{z} - \hat{z}_t \quad \text{with} \quad d\hat{z}_t = \lambda_z(\bar{z} - \hat{z}_t)dt + \hat{\sigma}_z \sqrt{\hat{z}_t} dB_{z,t}. \quad (36)$$

where $\hat{\sigma}_z = \sigma_z/\sqrt{\bar{z}}$ and $\bar{z} > 0$. Thus, z_t is still a zero-mean stationary process but its volatility is decreasing in z_t . This property captures larger uncertainty during business cycle downturns. Given the affine specification of the transitory shock, the model can be solved with the same methodology of the previous sections (proofs are in the Online Appendix B).

This form of heteroscedasticity in fundamentals leads to two results. First, under income insurance the wage-share is decreasing in z_t and, hence, dividends load more on the transitory shock when the latter is high volatile -i.e. operating leverage is counter-cyclical. Second, the price of risk associated to transitory risk is no more constant but is decreasing with z_t and, hence, higher compensations obtain during business cycle downturns. These two facts lead to a slope of the term-structure of equity premia which is time-varying. Long-run growth leads to an upward-sloping effect and the transitory shock leads to a downward-sloping effect, but the latter depends on the volatility of z_t . Therefore, the downward-sloping effect is counter-cyclical. As a result, the term-structure of equity premia can be flat or slightly upward-sloping in good times and strongly downward-sloping in bad times.

To provide an illustration of the equilibrium results, I calibrate the model with the same procedure of the previous section. For $\beta = 4.5\%$, $\gamma = 7.5$, $\psi = 1.5$, the model generates steady state moments in line with the data: 1.1% risk-free rate with 1.7% volatility, an equity premium

of 6.0% with return volatility of 14.5% and Sharpe ratio of 41.5% and log price-dividend ratio of 3.20 with 41.5% volatility.

The left upper panel of Figure 9 shows the term-structures of the model implied VR's (solid lines) and their empirical counterparts (dashed lines). Similarly to Figure 4, the model matches the upward- and downward-sloping shapes of wage and dividend risk and the flat term-structure of consumption risk. The right upper panel of Figure 9 shows the model implied volatility of dividends at the steady-state (solid line) and the 90% probability interval (dot-dashed and dashed lines). Dividend volatility is strongly decreasing with z_t at short horizons, whereas the effect of the transitory shock disappears in the long-run. The lower panels of Figure 9 shows the model volatility (left) and premia (right) of the dividend strip returns at the steady-state (solid line) and the 90% probability interval (dot-dashed and dashed lines). Under standard preferences ($\gamma > \psi > 1$), equity volatility inherits the negative slope of dividend risk. The transitory shock affects the level of the term-structure, which is counter-cyclical, but does not alter the sign of the slope. Instead, the transitory shock affects both the level and the slope of the term-structure of equity premia. Equity compensations are low and barely flat or slightly increasing in normal and good times. However, compensations increase in size and become markedly downward-sloping in bad times. Business cycle uncertainty helps the model to match the conditional dynamics of the term-structure of equity premia and, hence, to provide further support to the main model mechanism of income insurance. Indeed, the labor-share, which is decreasing with z_t , positively predicts dividend strips volatility and premium –consistently with the empirical results in Table II and Figure 3. Similarly to the main model, I compare the model-implied slope of dividend strips premia with actual data following van Binsbergen and Koijen (2016):

$$\begin{aligned} \text{(spot)} \quad & \frac{1}{5} \int_0^5 (\mu_P - r)(\tau) d\tau - (\mu_P - r) &= 1.4\%, \\ \text{(futures)} \quad & \frac{1}{5} \int_0^5 [(\mu_P - r)(\tau) - (\mu_B - r)(\tau)] d\tau - [(\mu_P - r) - (\mu_B - r)(10)] &= 3.7\%. \end{aligned}$$

These values closely resemble their empirical counterparts: 1.2% and 4.1%.

The model of this section leads to time-variation also in the equity premium. Namely, the

Figure9

premium on the market asset is a decreasing function of the transitory shock for $\gamma > \psi > 1$. An usual way to assess the time-varying properties of risk premia is to verify whether the model captures the pattern of predictability observed in actual data. Thus, I regress long-horizon excess returns on the log price-dividend ratio. The regression is performed on returns measured over horizons ranging from 1 to 7 years. In each simulation, the economy is simulated at the monthly frequency over a 67-year horizon. Panel A of Table X shows that the model reproduces the negative and statistically significant intertemporal relationship between the current valuation ratios and future excess returns that we observe in actual data (Cochrane (2008), Lettau and van Nieuwerburgh (2008), van Binsbergen and Koijen (2010)). Moreover, the explanatory power and statistical significance increase with the horizon. However, Panel B shows that the price dividend ratio also predicts consumption growth. The explanatory power is much smaller but inconsistent with actual data.²⁷

Overall, income insurance, combined with business cycle uncertainty, helps to jointly understand the timing of dividend risk, the dynamic slope of the term-structure of equity, the main properties of the market asset and risk-free rate, as well as long-horizon predictability of equity excess returns.

TableX

V. Conclusion

This paper documents that the timing of risk of output, wages and dividends is heterogeneous. Income insurance from shareholders to workers, which only concerns transitory risk, empirically and theoretically explains those term-structures and provides a rationale to downward-sloping dividend risk. Once the resulting dividend dynamics is embedded in an otherwise standard general equilibrium asset pricing model, the negative slope of dividend risk transmits to equity returns under standard preferences. Thus, income insurance allows to reconcile in equilibrium traditional asset pricing facts –such as the risk-free rate and equity premium puzzle, the excess volatility of equity, the increasing real yields on bonds, the long horizon equity predictability– with the new evidence about the term-structures of both fundamentals

and equity and their dynamics. Consistently, labor-share variation hugely forecasts dividend strips risk, premium and slope.

The model can be extended in a number of directions, such as interests rates and cross-sectional equity returns. Marfè (2015a, 2015b) empirically and theoretically support the idea that the term-structure effect of income insurance helps to explain respectively the joint term-structures of real and nominal interest rates and the dynamics of the value premium.

Appendix

Equilibrium State-Price Density. 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

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

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

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

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

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

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

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

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

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

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

Guess

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

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 $\psi \rightarrow 1$ 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

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

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

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

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:

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

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

and the results in the text easily follow.

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

$$\mathcal{M}_{t,\tau}(\bar{c}) = \mathbb{E}_t[e^{c_0 + c_1 \log \xi_{0,t+\tau} + c_2 x_{t+\tau} + c_3 \mu_{t+\tau} + c_4 z_{t+\tau}}] = \xi_{0,t}^{c_1} X_t^{c_2} e^{\ell_0(\tau, \bar{c}) + \ell_\mu(\tau, \bar{c})\mu_t + \ell_z(\tau, \bar{c})z_t}, \quad (\text{A4})$$

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: Consider the following conditional expectation:

$$\mathcal{M}_{t,\tau}(\bar{c}) = \mathbb{E}_t[e^{c_0 + c_1 \log \xi_{0,t+\tau} + c_2 \log X_{t+\tau} + c_3 \mu_{t+\tau} + c_4 z_{t+\tau}}] \quad (\text{A5})$$

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:

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

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

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

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 $\ell_z(\tau, \bar{c})$:

$$\begin{aligned}
0 &= \ell'_0(\tau, \bar{c}) - c_1 r_0 + \frac{1}{2}c_1(c_1 - 1)(\theta_x(t)^2 + \theta_\mu(t)^2 + \theta_z(t)^2) + \frac{1}{2}c_2(c_2 - 1)\sigma_x^2 + \ell_\mu(\tau, \bar{c})\lambda_\mu\bar{\mu} \\
&+ \frac{1}{2}\ell_\mu(\tau, \bar{c})^2\sigma_\mu^2 + \ell_z(\tau, \bar{c})\lambda_z\bar{z} + \frac{1}{2}\ell_z(\tau, \bar{c})^2\sigma_z^2 - c_1c_2\theta_x(t)\sigma_x - c_1\ell_\mu(\tau, \bar{c})\theta_\mu(t)\sigma_\mu \\
&- c_1\ell_z(\tau, \bar{c})\theta_z(t)\sigma_z \\
0 &= \ell'_\mu(\tau, \bar{c}) - c_1r_\mu + c_2 - \ell_\mu(\tau, \bar{c})\lambda_\mu \\
0 &= \ell'_z(\tau, \bar{c}) - c_1r_z - \ell_z(\tau, \bar{c})\lambda_z
\end{aligned}$$

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 available. \square

Dividends. The conditional moment generating function $\mathbb{D}_t(\tau, n)$ is a weighted sum of exponential affine functions. In particular, we have:

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

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

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

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 compute the term-structures of the growth rates' volatility $\sigma_D^2(t, \tau)$.

Under the log-linearized dynamics in Eq. (10), $\mathbb{D}_t(\tau, n)$ is exponential affine and obtains as a special

case of $\mathcal{M}_{t,\tau}(\bar{c})$ with $\bar{c} = (nd_0, 0, n, 0, nd_z)$. 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

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

The moment generating functions and the term-structures of volatility for wages and total consumption are computed in a similar way.

Dividend Strips. The equilibrium price of the market dividend strip with maturity τ of Eq. (19) 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

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

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 and premium are given by

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

The slopes of the return volatility and premium for the market dividend strip obtain by standard calculus.

Market Asset and Equity Premium. 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 previous results, the market asset price can be written as

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

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

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

Using the definition of the dividend strip price $P_{t,\tau} = \mathbb{E}_t[\xi_{t,t+\tau} D_{t+\tau}]$ and market asset price $P_t = \int_0^\infty P_{t,\tau} d\tau$, we can write the instantaneous premium of the market return as follows:

$$\begin{aligned} (\mu_P - r)(t) &= \theta_x(t) \frac{\partial_x P_t}{P_t} \sigma_x + \theta_\mu(t) \frac{\partial_\mu P_t}{P_t} \sigma_\mu + \theta_z(t) \frac{\partial_z P_t}{P_t} \sigma_z \\ &= \theta_x(t) \frac{\int_0^\infty \partial_x P_{t,\tau} d\tau}{P_t} \sigma_x + \theta_\mu(t) \frac{\int_0^\infty \partial_\mu P_{t,\tau} d\tau}{P_t} \sigma_\mu + \theta_z(t) \frac{\int_0^\infty \partial_z P_{t,\tau} d\tau}{P_t} \sigma_z \\ &= \int_0^\infty P_t^{-1} P_{t,\tau} (\theta_x(t) \sigma_x + \theta_\mu(t) A_\mu(\tau) \sigma_\mu + \theta_z(t) A_z(\tau) \sigma_z) d\tau \\ &= \int_0^\infty \Pi(t, \tau) d\tau, \end{aligned}$$

and $\Pi(t, \tau)$ easily follows using the previous results.

Bond and Equity Yields. The equilibrium price of the zero-coupon bond with maturity τ obtains as a special case of $\mathcal{M}_{t,\tau}(\bar{c})$ with $\bar{c} = (0, 1, 0, 0)$. Then, it is given by $B_{t,\tau} = \xi_{0,t}^{-1} \mathcal{M}_{t,\tau}(\bar{c})$. And the premium is: $(\mu_B - r)(t, \tau) = -\frac{1}{dt} \left\langle \frac{d\xi_{0,t}}{\xi_{0,t}}, \frac{dB_{t,\tau}}{B_{t,\tau}} \right\rangle$.

Given $p(t, \tau) = \log(D_t/P_{t,\tau})/\tau$ and $g_D(t, \tau) = \log(\mathbb{D}_t(\tau, 1)/D_t)/\tau$, it is easy to verify that the premium on the equity yield, $\varrho(t, \tau) = p(t, \tau) - \varepsilon(t, \tau) + g_D(t, \tau)$ in Eq. (34), is state-independent.

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Notes

¹Examples are the seminal works by [Campbell and Cochrane \(1999\)](#), [Barberis, Huang, and Santos \(2001\)](#), [Bansal and Yaron \(2004\)](#) and [Gabaix \(2012\)](#), among others.

²The idea that the very role of the firm is that of insurance provider has a long tradition since [Knight \(1921\)](#), [Baily \(1974\)](#), [Azariadis \(1978\)](#), [Boldrin and Horvath \(1995\)](#) and [Gomme and Greenwood \(1995\)](#). 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. Recently, [Guiso et al. \(2005\)](#), [Shimer \(2005\)](#) and [Ríos-Rull and Santaaulàlia-Llopis \(2010\)](#) provide empirical support.

³Beyond the focus on the term-structures, the model differs from [Greenwald et al. \(2014\)](#) because: (i) the labor-share is not an exogenous shock but derives from income insurance and has counter-cyclical dynamics as in [Ríos-Rull and Santaaulàlia-Llopis \(2010\)](#); (ii) the model does not account for preference shocks –which help to generate a-cyclical variation in equity returns– since the scope of the paper concerns the term-structure effect of income insurance; (iii) the model state-price density is fully endogenous, whereas [Greenwald et al. \(2014\)](#) specify an exogenous and constant risk-free rate; (iv) the model calibration exploits information from the timing of macroeconomic risk, whereas it is different in [Greenwald et al. \(2014\)](#).

⁴[Marfè \(2016\)](#) considers the term-structure of equity in the context of a long-run risk model: consumption and dividends co-integration leads to decreasing equity volatility but increasing premia. [Berrada, Detemple, and Rindisbacher \(2013\)](#), [Andries, Eisenbach, and Schmalz \(2014\)](#), [Curatola \(2015\)](#), [Khapko \(2014\)](#) and [Marfè \(2014\)](#) focus on non-standard beliefs and state-dependent risk preferences. [Lopez, Lopez-Salido, and Vazquez-Grande \(2015\)](#) consider nonlinear habit and nominal rigidities. [Lopez \(2014\)](#) investigates welfare costs.

⁵Even if the model is silent on production and workers saving decisions, [Danthine, Donaldson, and Siconolfi \(2005\)](#) show that a similar form of distributional risk improves the asset pricing implications of a standard real business cycle model without deteriorating business cycle predictions.

⁶The baseline model calibration overestimates the 20-years maturity real yield from TIPs data by about 200 basis points.

⁷[Alvarez and Jermann \(2005\)](#) show that the fraction of state-price density variation driven by its martingale component is increasing in the market return in excess of the long-term real bond yield. The low historical level of the latter implies a prominent role of the martingale component. See also [Hansen and Scheinkman \(2009\)](#) and [Hansen, Heaton, and Li \(2008\)](#). Here, while the model state-price density inherits decreasing variance-ratios from dividends, its long-run volatility is still sizeable –about 32% (see the Online Appendix A). This is due to the joint effect of consumption and dividends co-integration, time-varying long-run growth, and preferences for the early resolution of uncertainty.

⁸In the Online Appendix A, I document that payout to shareholders from the aggregate economy (NIPA

tables) and from NYSE, NASDAQ, and Amex firms (CRSP) feature markedly downward-sloping VR's. Moreover, the VR's of aggregate consumption are about flat and close to those of value added (see Figure 4). This result is consistent with the recent work by Dew-Becker (2016): robust estimators of long-run consumption volatility imply an approximatively flat term-structure of consumption VR's.

⁹The Online Appendix A shows that the term-structure of risk of value added minus investments is almost identical to that of value added. Thus, investments do not induce a term-structure effect.

¹⁰Conditional volatilities are estimated with an ARMA(1,1)-Garch(1,1) model and moving averages are computed with a rolling window of ± 5 years. Estimation details are reported in the Online Appendix A.

¹¹For small τ , the effect for wages is less prominent than the effect for dividends because the wages are mainly driven by permanent shocks. This is consistent with the mechanism of income insurance. Indeed, for τ large enough, VR's are more informative about the slope of the term-structure and one can observe a highly significant positive relation with the labor-share.

¹²The Online Appendix A documents that the results of Table I are robust to a weak time-trend in the labor-share.

¹³Monthly dividend strip excess return and AR(1)-GARCH(1,1) return volatility are available from Ralph Koijen's webpage and correspond to 'Strategy 1' in van Binsbergen et al. (2012). Namely, returns represent a one-month long position in short-term dividend strips (average maturity is about 1.6 years).

¹⁴In the Online Appendix A, I find that ruling out a weak time trend from the labor-share leads to an even stronger relationship.

¹⁵Consistently with the former analysis of the term-structure effect of income insurance, I also verify that the time-series of the variance ratios of wages minus those of dividends significantly and positively predicts dividend strips volatility. Newey-West t-statistics and adjusted-R² are respectively 3.00 and 41% (one-quarter ahead), 3.99 and 51% (one-year ahead) and 5.21 and 62% (two-years ahead). The coefficient remains positive and highly significant in all of the horse race regressions and the adjusted-R² do not increase substantially. Details in the Online Appendix A.

¹⁶The Online Appendix A documents that the labor-share significantly forecasts dividend strip return volatility, excess return over the risk-free rate and over the market return 1-quarter, 1-year and 2-years ahead both in multivariate and in horse race regressions.

¹⁷I pursue additional robustness checks in the Online Appendix A. The financial leverage ratio leads to additional explanatory power for dividend growth but it does not help to predict consumption growth. Vice-versa, the investment-share does not help to forecast dividend growth but it increases consumption growth predictability.

¹⁸The Online Appendix A reports the term-structures of risk of total payout by Larrain and Yogo (2008)

(net interests, net debt issuances, net cash dividends and net equity issuances), shareholders' payout (net cash dividends and net equity issuances) and net cash dividends from the non-financial corporate sector on the sample 1927-2004. The variance ratios of all these variables are markedly downward-sloping, similar to each other and similar to the variance ratios of the remainder of output minus wages. Thus, the payout policy likely does not induce a term-structure effect.

¹⁹The 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.

²⁰Under CRRA preferences ($\psi \rightarrow 1/\gamma$), the optimality condition for the shareholders takes the usual power form: $I_C[\xi_{0,t}] = (\xi_{0,t}e^{\beta t})^{-1/\gamma}$ and the term capturing the distributional risk is unchanged. Instead, for $\phi \rightarrow 0$, the state-price density reduces to $\xi_{0,t} = e^{-\beta t}((1-\alpha)C_t)^{-\gamma}$, as in a Lucas economy.

²¹A similar result obtains measuring the slopes by means of the term-spreads $\sigma_P^2(t, \infty) - \sigma_P^2(t, 0)$ and $(\mu_P - r)(t, \infty) - (\mu_P - r)(t, 0)$. Negative spreads obtain if the leverage effect of dividends due to income insurance is large enough.

²²Standardizing $\Pi(t, \tau)$ by $(\mu_P - r)(t)$ allows to compare the timing decomposition of the equity premium among models and parameter settings even if they produce different magnitudes for the premium.

²³Monotone downward-sloping real yields obtain in most of long-run risk models. Here, for income insurance large enough, real yields are upward-sloping consistently with the slope of TIPs data.

²⁴The term-structures of premium, volatility and Sharpe ratio of dividend strip futures returns are reported in the Online Appendix A.

²⁵The model-implied equity duration, i.e. $P_t^{-1} \int_0^\infty \tau P_{t,\tau} d\tau$, is about 35.6 years which is consistent with the estimates by [Dechow, Sloan, and Soliman \(2004\)](#).

²⁶See [Boguth, Carlson, Fisher, and Simutin \(2012\)](#), [van Binsbergen and Koijen \(2012b\)](#), [Weber \(2016\)](#) and [Schulz \(2016\)](#).

²⁷Note that the model only accounts for priced shocks. Shocks to dividends orthogonal to consumption could likely reduce the huge explanatory power for excess returns and rule out consumption growth predictability. Such a shock to dividends has not been considered for the sake of simplicity and exposition and [Table V](#) documents that it is not relevant to the scope of the paper.

Table I: The Term-Structure Effect of Income Insurance

The table reports the estimates of the regressions:

$$\text{VR}_W - \text{VR}_D|_{t,\tau} = a + b_{wd} W/Y_t + b_y \text{VR}_Y|_{t,\tau} + b'_c \text{controls}_t + \epsilon_t,$$

$$\text{VR}_W|_{t,\tau} = a + b_w W/Y_t + b_y \text{VR}_Y|_{t,\tau} + b'_c \text{controls}_t + \epsilon_t,$$

$$\text{VR}_D|_{t,\tau} = a + b_d W/Y_t + b_y \text{VR}_Y|_{t,\tau} + b'_c \text{controls}_t + \epsilon_t,$$

where the dependent variables are either the variance ratios of wages, those of dividends or their difference computed at time t with horizon τ ranging from 2 to 7 years; the independent variables are the time t wages over value added, the time t variance ratios of value added with horizon τ and the time t orthogonalized investment over value added and financial leverage as controls. Data are from the non-financial corporate sector (Flow of Funds) on the sample 1951:4-2015:1 at quarterly frequency. The time-series of variance ratios are computed through a rolling window of 10 years centered at t . Newey-West corrected t-statistics are reported in parenthesis. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

Table I: Continued

Panel A – Dependent variable: $VR_W - VR_D|_{t,\tau}$

τ	2	3	4	5	6	7
W/Y	6.35***	9.08***	10.63***	11.85***	14.41***	16.98***
t-stat	(5.50)	(5.97)	(4.55)	(3.74)	(3.45)	(3.17)
adj-R ²	0.42	0.53	0.55	0.57	0.58	0.56
W/Y	6.35***	9.08***	10.63***	11.85***	14.41***	16.98***
t-stat	(5.77)	(5.83)	(4.55)	(3.91)	(3.74)	(3.66)
I/Y [⊥]	-1.50	0.54	3.85	8.72**	12.81***	17.25***
t-stat	(-0.87)	(0.23)	(1.18)	(2.17)	(2.62)	(2.94)
Fin Lev [⊥]	0.62**	0.75*	0.61	0.18	0.16	-0.07
t-stat	(2.00)	(1.86)	(1.11)	(0.26)	(0.20)	(-0.07)
adj-R ²	0.46	0.55	0.58	0.63	0.66	0.67

Panel B – Dependent variable: $VR_W|_{t,\tau}$

τ	2	3	4	5	6	7
W/Y	1.38	2.97	4.55*	6.51**	8.86**	11.43**
t-stat	(1.26)	(1.58)	(1.78)	(1.98)	(2.06)	(2.14)
adj-R ²	0.42	0.43	0.48	0.51	0.51	0.50
W/Y	1.38	2.97	4.55*	6.51**	8.86**	11.43**
t-stat	(1.30)	(1.63)	(1.80)	(2.03)	(2.15)	(2.34)
I/Y [⊥]	-1.95	-0.15	2.02	5.82	9.9**	13.76**
t-stat	(-1.46)	(-0.07)	(0.69)	(1.62)	(2.17)	(2.45)
Fin Lev [⊥]	-0.03	-0.28	-0.34	-0.58	-0.81	-1.05
t-stat	(-0.16)	(-0.78)	(-0.68)	(-0.95)	(-1.07)	(-1.16)
adj-R ²	0.46	0.43	0.49	0.54	0.56	0.58

Table I: Continued

Panel C – Dependent variable: $VR_D|_{t,\tau}$

τ	2	3	4	5	6	7
W/Y	-4.97***	-6.11***	-6.08***	-5.34***	-5.55***	-5.55***
t-stat	(-4.39)	(-5.11)	(-5.41)	(-4.67)	(-4.53)	(-4.21)
adj-R ²	0.32	0.31	0.31	0.29	0.33	0.34
W/Y	-4.97***	-6.11***	-6.08***	-5.34***	-5.55***	-5.55***
t-stat	(-5.31)	(-6.83)	(-7.22)	(-6.04)	(-6.05)	(-5.99)
I/Y [⊥]	-0.45	-0.69	-1.83	-2.9**	-2.91**	-3.49**
t-stat	(-0.37)	(-0.46)	(-1.23)	(-1.98)	(-2.21)	(-2.79)
Fin Lev [⊥]	-0.66***	-1.02***	-0.95***	-0.76***	-0.98***	-0.98***
t-stat	(-2.98)	(-4.95)	(-4.85)	(-3.50)	(-4.42)	(-3.91)
adj-R ²	0.42	0.47	0.50	0.48	0.57	0.59

Table II: Income Insurance and the Term-Structure of Equity

The table reports the coefficient, Newey-West t-statistic and adjusted-R² of the regressions:

$$\begin{aligned} \text{short-term equity risk:} \quad & vol_t^{\text{strip}} = a + b_{\text{risk}} W/Y_{t-1} + \epsilon_t, \\ \text{short-term equity premium:} \quad & r_t^{\text{strip}} - r_t^{\text{risk-free}} = a + b_{\text{premium}} W/Y_{t-1} + \epsilon_t, \\ \text{short-term equity slope:} \quad & r_t^{\text{strip}} - r_t^{\text{mkt}} = a + b_{\text{slope}} W/Y_{t-1} + \epsilon_t, \end{aligned}$$

where the dependent variables are either the time t dividend strip return volatility or the excess return over the risk-free rate or the excess return over the market return; the independent variable is the time $t - 1$ wages over value added from the non-financial corporate sector. Data are quarterly on the sample 1996:4-2010:1. Symbols *, **, and *** denote statistical significance at 10%, 5%, and 1% levels.

	Risk			Premium			Slope		
	1-quarter ahead	1-year ahead	2-years ahead	1-quarter ahead	1-year ahead	2-years ahead	1-quarter ahead	1-year ahead	2-years ahead
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
W/Y _{t-1}	1.10***	1.04***	0.88***	0.43*	0.39***	0.37***	0.58*	0.53**	0.43**
t-stat	(5.88)	(6.03)	(5.37)	(1.99)	(3.02)	(6.26)	(1.98)	(2.58)	(2.43)
adj-R ²	0.72	0.74	0.62	0.08	0.31	0.64	0.10	0.26	0.28

Table III: Income Insurance and the Term-Structure of Equity

The table reports the coefficients, Newey-West t-statistics and adjusted-R² of the regressions:

$$\begin{aligned}
 \text{short-term equity risk:} \quad & vol_t^{\text{strip}} = a + b_{\text{risk}} W/Y_{t-1} + b'_c \text{controls}_t + \epsilon_t, \\
 \text{short-term equity premium:} \quad & r_t^{\text{strip}} - r_t^{\text{risk-free}} = a + b_{\text{premium}} W/Y_{t-1} + b'_c \text{controls}_t + \epsilon_t, \\
 \text{short-term equity slope:} \quad & r_t^{\text{strip}} - r_t^{\text{mkt}} = a + b_{\text{slope}} W/Y_{t-1} + b'_c \text{controls}_t + \epsilon_t,
 \end{aligned}$$

where the dependent variables are either time t dividend strip return volatility or dividend strip excess return over the risk-free rate or over the market return; the independent variables are the time $t-1$ wages over value added and the time t controls: Fama and French factors (excess market return, SMB, HML), market volatility, price-earnings ratio, risk-free rate, cay and the financial leverage and investment over value added from the non-financial corporate sector. Data are quarterly on the sample 1996:4-2010:1. Symbols *, **, and *** denote statistical significance at 10%, 5%, and 1% levels.

Table III: Continued

Panel A – Dependent variable: 1 year ahead dividend strip return volatility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
W/Y_{t-1}	1.04***	1.01***	1.05***	1.01***	0.92***	1.03***	1.06***	1.00***	1.03***	1.04***
t-stat	(6.03)	(6.71)	(5.89)	(7.12)	(4.79)	(6.08)	(6.76)	(5.58)	(5.97)	(9.08)
MKT_t		-0.19**								
t-stat		(-2.31)								
SMB_t			-0.08							
t-stat			(-0.83)							
HML_t				0.14						
t-stat				(0.99)						
VOL_t					0.34*					
t-stat					(1.86)					
P/E_t						0.00				
t-stat						(0.15)				
Rf_t							3.42			
t-stat							(1.31)			
CAY_t								0.14		
t-stat								(0.95)		
FL_t									0.02	
t-stat									(0.36)	
I/Y_t										0.72***
t-stat										(3.84)
adj-R ²	0.74	0.78	0.74	0.75	0.76	0.73	0.77	0.74	0.74	0.84

Table III: Continued

Panel B – Dependent variable: 1 year ahead dividend strip return over risk-free rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
W/Y_{t-1}	0.39***	0.38***	0.41***	0.35***	0.38**	0.43***	0.39***	0.46***	0.38***	0.39***
t-stat	(3.02)	(3.11)	(3.18)	(3.64)	(2.65)	(3.72)	(2.94)	(3.55)	(2.85)	(2.96)
MKT_t		-0.05								
t-stat		(-0.78)								
SMB_t			-0.12							
t-stat			(-0.82)							
HML_t				0.20						
t-stat				(1.65)						
VOL_t					0.03					
t-stat					(0.26)					
P/E_t						-0.01				
t-stat						(-0.85)				
Rf_t							0.56			
t-stat							(0.29)			
CAY_t								-0.27**		
t-stat								(-2.34)		
FL_t									0.06	
t-stat									(1.40)	
I/Y_t										-0.04
t-stat										(-0.16)
adj-R ²	0.31	0.31	0.32	0.39	0.30	0.31	0.30	0.33	0.33	0.30

Table III: Continued

Panel C – Dependent variable: 1 year ahead dividend strip return over market return

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
W/Y_{t-1}	0.53**	0.49***	0.55**	0.45***	0.60**	0.58***	0.53**	0.51*	0.52**	0.53***
t-stat	(2.58)	(2.88)	(2.52)	(3.11)	(2.48)	(2.99)	(2.46)	(2.06)	(2.46)	(3.16)
MKT_t		-0.30***								
t-stat		(-3.39)								
SMB_t			-0.10							
t-stat			(-0.43)							
HML_t				0.42***						
t-stat				(2.80)						
VOL_t					-0.20					
t-stat					(-0.79)					
P/E_t						-0.01				
t-stat						(-0.56)				
Rf_t							0.14			
t-stat							(0.04)			
CAY_t								0.09		
t-stat								(0.29)		
FL_t									0.11**	
t-stat									(2.07)	
I/Y_t										0.53
t-stat										(1.42)
adj-R ²	0.26	0.40	0.25	0.43	0.25	0.25	0.24	0.24	0.30	0.32

Table IV: Income Insurance and Expected Growth.

The table reports the coefficient, Newey-West and Hansen-Hodrick t-statistics (four lags) and adjusted-R² of the regressions of cumulative dividend growth rates and consumption growth rates over the horizons of 1, 5, 10 and 15 years on the current labor-share:

$$\sum_{i=1}^n \Delta x_{t+i} = a + b W/Y_t + \epsilon_t, \quad \Delta x_t = \left\{ \log \frac{D_t}{D_{t-1}}, \log \frac{C_t}{C_{t-1}} \right\}.$$

Consumption is NIPA non-durable goods and services; dividends and labor-share are from the non-financial corporate sector on the sample 1946-2013 at yearly frequency. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels (Newey-West standard errors).

	Panel A – Dividends				Panel B – Consumption			
Horizon (years)	1	5	10	15	1	5	10	15
W/Y	-0.12	2.69**	4.57***	6.93***	0.17*	0.51**	1.01***	1.44***
NW t-stat	(-0.24)	(2.54)	(2.76)	(4.08)	(2.09)	(2.57)	(4.92)	(6.08)
HH t-stat	(-0.49)	(3.33)	(2.37)	(3.64)	(2.13)	(2.49)	(5.22)	(6.00)
adj-R ²	0.00	0.10	0.24	0.37	0.06	0.12	0.30	0.36

Table V: Income Insurance and Other Sources of Transitory Dividend Risk

The table reports coefficients, Newey-West t-statistics and adjusted-R² of the regressions:

$$\begin{aligned}
 \text{dividend slope:} \quad & \text{VR}_D|_{t,\tau} = a + b_w W/Y_t + b_d D/Y_t^\perp + b_y \text{VR}_Y|_{t,\tau} + \epsilon_t, \\
 \text{short-term equity risk:} \quad & \text{vol}_t^{\text{strip}} = a + b_w W/Y_{t-1} + b_d D/Y_{t-1}^\perp + \epsilon_t, \\
 \text{short-term equity premium:} \quad & r_t^{\text{strip}} - r_t^{\text{risk-free}} = a + b_w W/Y_{t-1} + b_d D/Y_{t-1}^\perp + \epsilon_t, \\
 \text{short-term equity slope:} \quad & r_t^{\text{strip}} - r_t^{\text{mkt}} = a + b_w W/Y_{t-1} + b_d D/Y_{t-1}^\perp + \epsilon_t.
 \end{aligned}$$

In regression (1), the time t variance ratio of dividends with horizon τ is regressed on the time t labor-share, the time t orthogonalized dividend-share and the time t variance ratio of value added with horizon τ . Data are from the non-financial corporate sector (Flow of Funds) on the sample 1951:4-2015:1 at quarterly frequency. The time-series of variance ratios are computed through a rolling window of 10 years centered at t . In regressions (2)-(3)-(4), either the time t dividend strip return volatility or dividend strip excess return over the risk-free rate or over the market return are regressed on the time $t-1$ labor-share and the time $t-1$ orthogonalized dividend-share. Data are quarterly on the sample 1996:4-2010:1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

Table V: Continued

Panel A – Dividend Variance Ratios

τ	2	3	4	5	6	7
W/Y	-4.97***	-6.11***	-6.08***	-5.34***	-5.55***	-5.55***
t-stat	(-4.42)	(-4.97)	(-5.23)	(-4.64)	(-4.58)	(-4.30)
D/Y [⊥]	2.14	2.11	1.70	0.28	-0.31	-0.88
t-stat	(1.58)	(1.07)	(0.95)	(0.17)	(-0.21)	(-0.60)
adj-R ²	0.34	0.32	0.32	0.28	0.33	0.34

Panel B – Equity Risk, Premium and Slope

	Risk			Premium			Slope		
	1-quarter	1-year	2-years	1-quarter	1-year	2-years	1-quarter	1-year	2-years
	ahead	ahead	ahead	ahead	ahead	ahead	ahead	ahead	ahead
W/Y _{t-1}	1.10***	1.04***	0.88***	0.43*	0.39***	0.37***	0.58*	0.53**	0.43**
t-stat	(5.96)	(6.14)	(5.42)	(1.98)	(3.01)	(6.42)	(2.00)	(2.66)	(2.55)
D/Y _{t-1} [⊥]	0.12	0.14	0.04	-0.02	0.02	-0.06**	0.32	0.39	0.24
t-stat	(1.15)	(1.28)	(0.31)	(-0.15)	(0.20)	(-2.45)	(-1.12)	(1.45)	(1.32)
adj-R ²	0.72	0.74	0.62	0.06	0.30	0.64	0.10	0.30	0.30

Table VI: Calibration – Model Parameters

	Symbol	Value
volatility of permanent shock	σ_x	0.005
steady-state long-run growth	$\bar{\mu}$	0.020
reversion of long-run growth	λ_μ	0.857
volatility of long-run growth	σ_μ	0.018
reversion of transitory shock	λ_z	0.198
volatility of transitory shock	σ_z	0.026
wages over wages plus dividends	α	0.942
income insurance	ϕ	0.396

Table VII: Calibration – Cash-Flows Moments

	Symbol	Data	Model
long-run growth	g_C	0.020	0.020
one year consumption volatility	$\sigma_C(1)$	0.025	0.025
one year dividends volatility	$\sigma_D(1)$	0.174	0.174
dividend-share average (D/(D+W))	δ	0.060	0.058
dividend-share volatility	σ_δ	0.016	0.015

Variance ratios of consumption $v_{R_C}(\tau)$

τ	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data	0.98	0.95	0.90	0.85	0.81	0.77	0.74	0.74	0.75	0.77	0.80	0.84	0.88	0.90
Model	0.99	0.98	0.97	0.95	0.93	0.91	0.89	0.88	0.87	0.86	0.85	0.84	0.83	0.83

Variance ratios of wages $v_{R_W}(\tau)$

τ	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data	1.20	1.33	1.42	1.47	1.51	1.54	1.55	1.57	1.58	1.59	1.60	1.60	1.58	1.54
Model	1.18	1.32	1.41	1.47	1.51	1.54	1.56	1.57	1.58	1.59	1.59	1.60	1.60	1.61

Variance ratios of dividends $v_{R_D}(\tau)$

τ	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data	0.62	0.40	0.28	0.22	0.20	0.20	0.20	0.20	0.19	0.18	0.16	0.14	0.14	0.19
Model	0.84	0.71	0.61	0.54	0.47	0.42	0.38	0.34	0.31	0.29	0.26	0.25	0.23	0.22

Table VIII: Income Insurance and Expected Growth.

The table reports the coefficient, Newey-West t-statistics and adjusted-R² of the regressions of cumulative dividend growth rates and consumption growth rates over the horizons of 1, 5, 10 and 15 years on the current labor-share:

$$\sum_{i=1}^n \Delta x_{t+i} = a + b W/Y_t + \epsilon_t, \quad \Delta x_t = \left\{ \log \frac{D_t}{D_{t-1}}, \log \frac{C_t}{C_{t-1}} \right\}.$$

One thousand simulations are run at the monthly frequency over a 67-year horizon. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	Panel A – Dividends				Panel B – Consumption			
Horizon (years)	1	5	10	15	1	5	10	15
W/Y	4.63***	15.32***	19.65***	20.58***	0.64**	2.01**	2.67*	2.93
t-stat	(2.66)	(3.43)	(4.00)	(3.89)	(2.14)	(2.09)	(1.85)	(1.50)
adj-R ²	0.10	0.37	0.47	0.49	0.09	0.22	0.26	0.26

Table IX: 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	20 years bond yield %	bond yield slope
10	1.5	3.5	0.86	2.80	5.06	13.6	37.2	3.51	41.3	< 0	3.56	> 0

Model – No income insurance ($\phi = 0$)

γ	ψ	β %	r %	σ_r %	$\mu_P - r$ %	σ_P %	SR %	$\log P/D$	$\sigma_{\log P/D}$ %	strip premium slope	20 years bond yield %	bond yield slope
10	1.5	3.5	4.68	1.24	0.24	2.0	11.8	3.54	1.0	≈ 0	4.48	< 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	20 years bond yield %	bond yield slope
10	0.75	3.5	-3.93	5.59	12.90	24.5	52.6	3.23	39.7	> 0	3.71	> 0
	1	3.5	-1.21	4.15	8.50	19.0	44.8	3.36	0.0	= 0	3.66	> 0
	1.25	3.5	0.07	3.36	6.39	15.8	40.3	3.44	24.6	< 0	3.60	> 0
	1.5	3.5	0.86	2.80	5.06	13.6	37.2	3.51	41.3	< 0	3.56	> 0
	1.75	3.5	1.37	2.40	4.19	12.0	34.9	3.56	53.5	< 0	3.52	> 0
7.5	0.75	3.5	-2.01	5.59	11.0	24.4	45.0	3.22	39.6	> 0	4.28	> 0
	1	3.5	0.15	4.15	7.14	19.0	37.6	3.36	0.0	= 0	4.10	> 0
	1.25	3.5	1.14	3.36	5.29	15.8	33.4	3.45	24.6	< 0	3.97	> 0
	1.5	3.5	1.74	2.80	4.13	13.6	30.4	3.52	41.4	< 0	3.88	> 0
	1.75	3.5	2.11	2.40	3.39	12.0	28.3	3.58	53.6	< 0	3.81	> 0
5	0.75	3.5	-0.05	5.59	9.10	24.4	37.3	3.20	39.5	> 0	4.86	> 0
	1	3.5	1.51	4.15	5.78	19.0	30.4	3.36	0.0	= 0	4.54	> 0
	1.25	3.5	2.19	3.36	4.21	15.8	26.6	3.46	24.6	< 0	4.34	> 0
	1.5	3.5	2.59	2.80	3.23	13.6	23.8	3.54	41.5	< 0	4.19	> 0
	1.75	3.5	2.83	2.40	2.61	12.0	21.8	3.60	53.8	< 0	4.09	> 0

Table X: Predictability of Excess Returns and Consumption Growth.

The table reports the coefficient, Newey-West t-statistics and adjusted-R² of the regressions of cumulative excess returns in Panel A and cumulative consumption growth rates in Panel B over the horizons of 1, 3, 5 and 7 years on the current log price-dividend ratio:

$$\sum_{i=1}^n \Delta x_{t+i} = a + b \log P/D_t + \epsilon_t, \quad \Delta x_t = \left\{ \log \frac{R_t}{R_{t-1}^f}, \log \frac{C_t}{C_{t-1}} \right\}.$$

One thousand simulations are run at the monthly frequency over a 67-year horizon. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	Panel A – Excess Returns				Panel B – Consumption			
Horizon (years)	1	3	5	7	1	3	5	7
log P/D _t	-0.98***	-2.36***	-3.20***	-3.68***	-0.10*	-0.27*	-0.37*	-0.44*
t-stat	(-3.76)	(-4.59)	(-6.31)	(-7.63)	(-2.08)	(-1.98)	(-2.04)	(-2.04)
adj-R ²	0.19	0.46	0.60	0.66	0.06	0.15	0.20	0.22

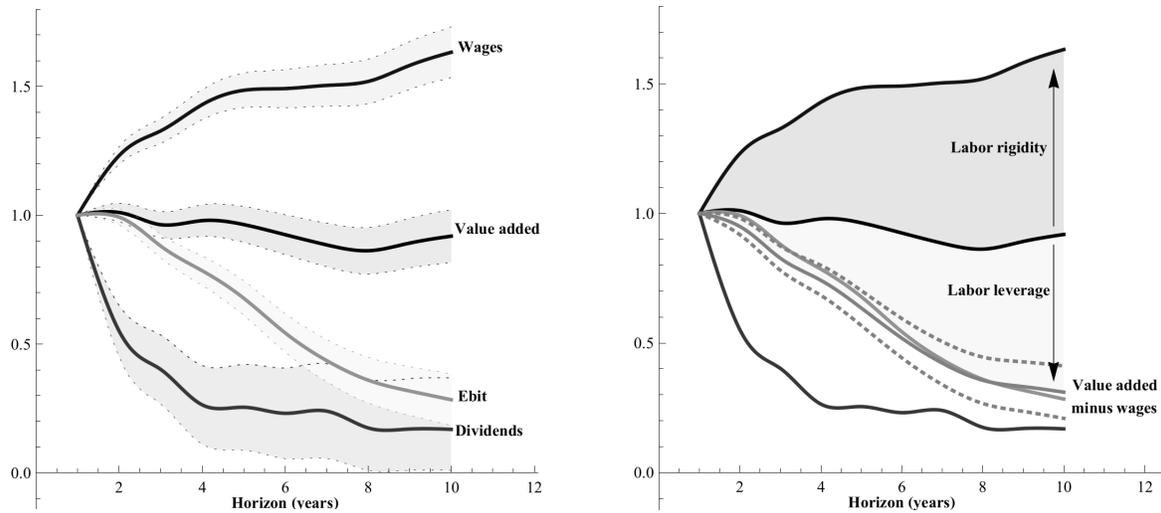


Figure 1: The Timing of Macroeconomic Risk and Income Insurance

Left panel: Variance-ratios of value added, wages, EBIT, dividends as a function of the horizon. Shadow areas denote heteroscedasticity robust 95% confidence intervals. Right panel: Variance-ratios of value added, wages, EBIT, dividends and value added minus wages (dashed lines denote heteroscedasticity robust 95% confidence interval) as a function of the horizon. Data are yearly on the sample 1946-2013.

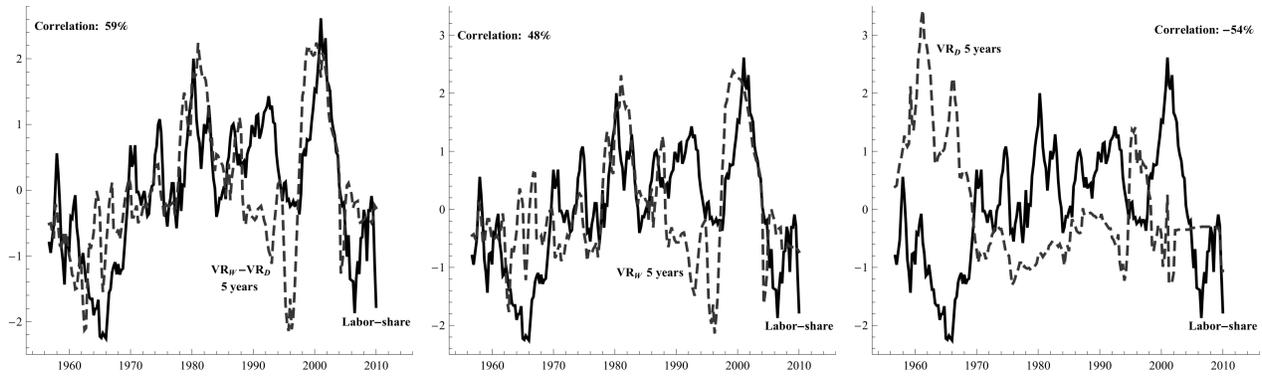


Figure 2: The Term-Structure Effect of Income Insurance

The standardized labor-share (solid line) is plotted together with the standardized 5 years variance ratios of wages minus the variance ratios of dividends (dashed line, left panel), the 5 years variance ratios of wages (middle), and the 5 years variance ratios of dividends (right). Data are from the non-financial corporate sector (Flow of Funds) on the sample 1951:4-2015:1 at quarterly frequency. The time-series of variance ratios are computed through a rolling window of 10 years.



Figure 3: Income Insurance and the Term-Structure of Equity

The standardized labor-share from the non-financial corporate sector (solid line) is plotted together with the standardized one-year ahead dividend strip return volatility (dashed line, left panel), the standardized one-year ahead excess return over the risk-free rate (middle), the standardized one-year ahead excess return over the market return (right). Data are quarterly on the sample 1996:4-2010:1.

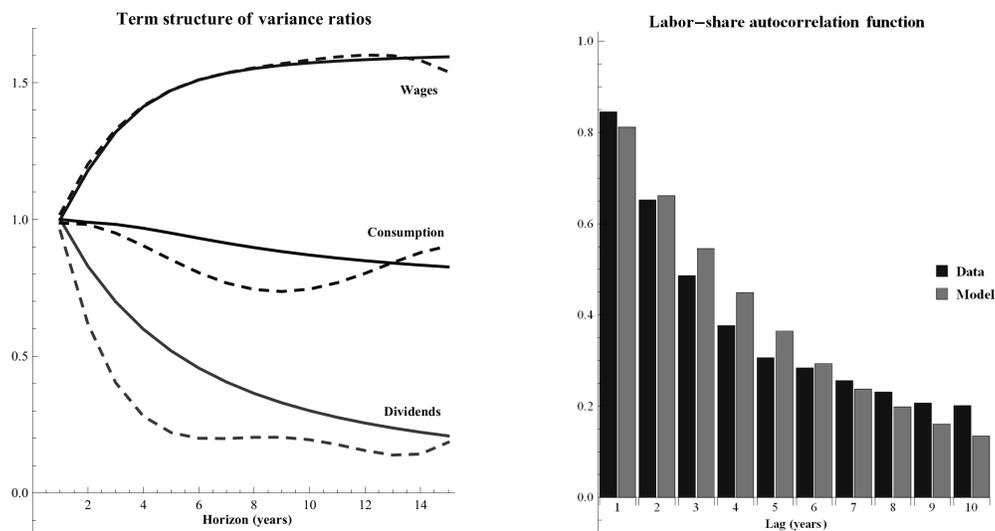


Figure 4: Variance Ratios and Persistence

Left panel: Variance-ratios of wages, consumption, and dividends as a function of the horizon. Dashed lines denote empirical data. Right panel: Autocorrelation function of the empirical and model-implied labor-share. Cash-flows parameters are from Table VI.

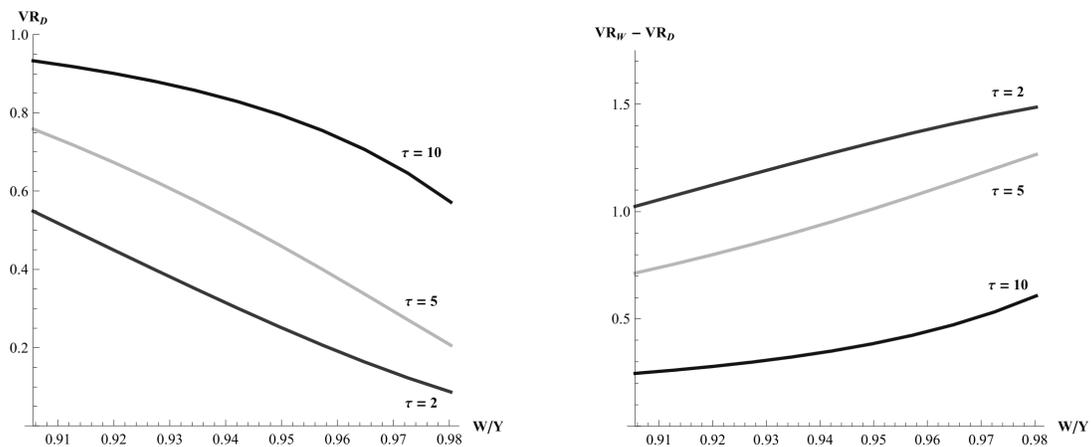


Figure 5: The Term-Structure Effect of Income Insurance

The left and right panels show respectively the variance ratios of dividends and the difference between the variance ratios of wages and dividends as a function of the labor-share for several horizons ($\tau = 2, 5$ and 10 years). Cash-flows parameters are from Table VI.

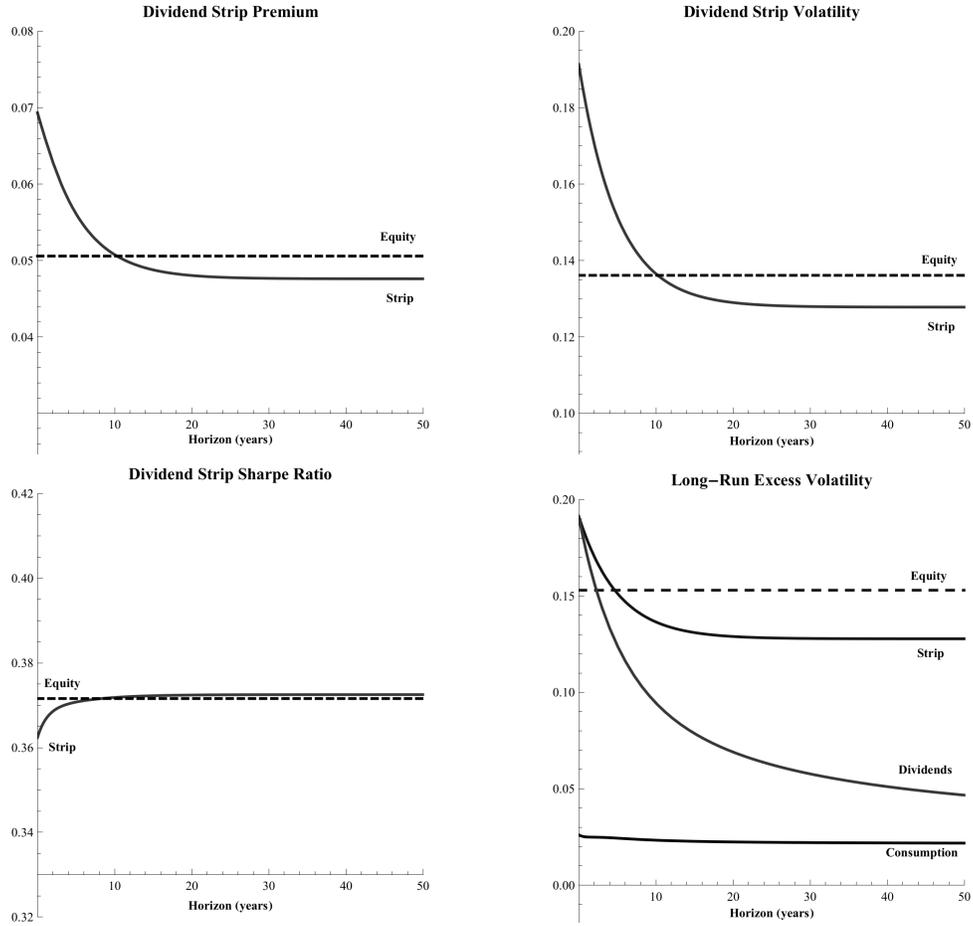


Figure 6: Term-Structures of Dividend Strips

The term-structures of dividend strip return premium, volatility and Sharpe ratio are reported respectively in the upper left, upper right and lower left panels. The horizontal dashed line denotes the corresponding moment for equity. The lower right panel shows the dividend strip return volatility, the equity return volatility, the dividend volatility, and the consumption volatility. Cash-flows parameters are from Table VI and $\gamma = 10$, $\psi = 1.5$ and $\beta = 3.5\%$.

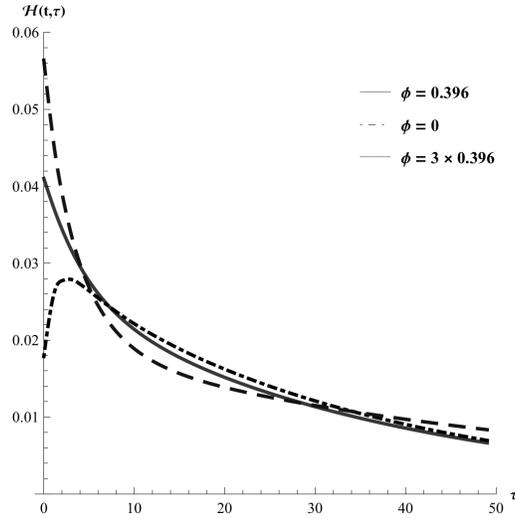


Figure 7: The Horizon Decomposition of the Equity Premium

Equilibrium density $\mathcal{H}(t, \tau)$ as a function of the horizon τ (i.e. the relative contribution of each horizon τ to the equity premium). Solid, dot-dashed and dashed lines denote respectively the baseline calibration of Table VI ($\phi = 0.396$) and the cases of no income insurance ($\phi = 0$) and augmented insurance ($\phi = 3 \times 0.396$).

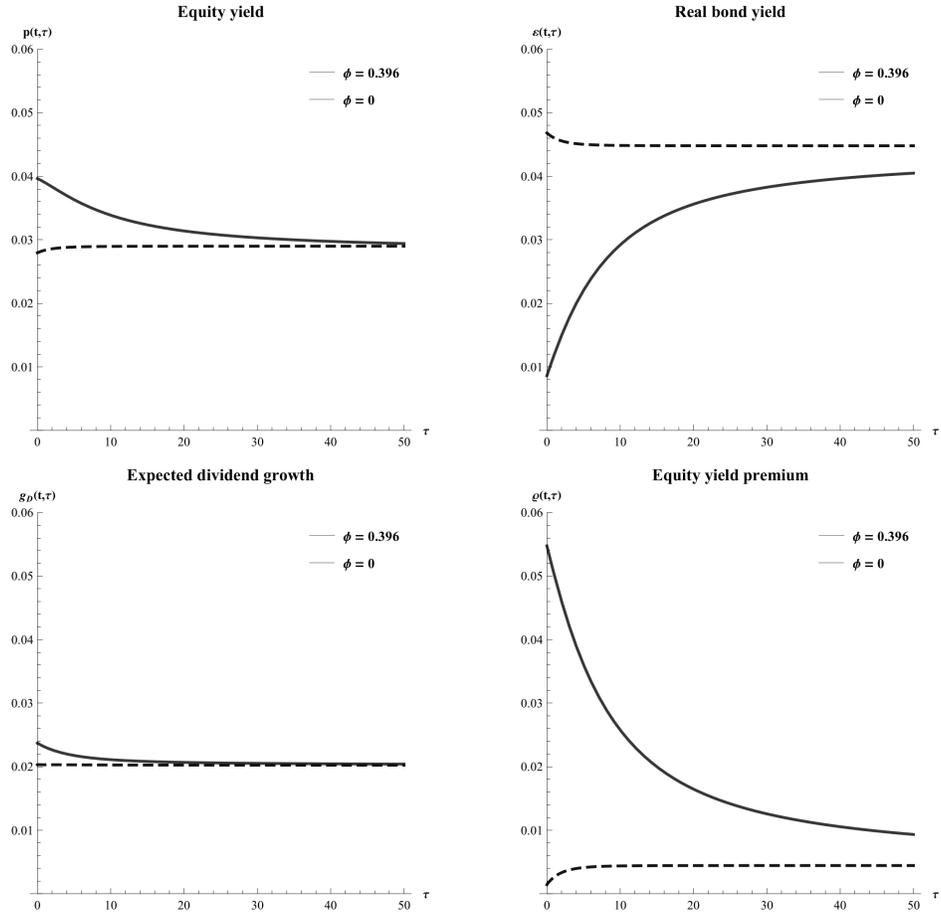


Figure 8: Bond and Equity Yields

Term-structures of equity yields (left upper panel), real bond yields (right upper panel), expected dividend growth (left lower panel) and premium on equity yields (right lower panel) at the steady-state as a function of the horizon. Solid and dashed lines denote respectively the baseline calibration of Table VI and the case of no income insurance ($\phi = 0$).

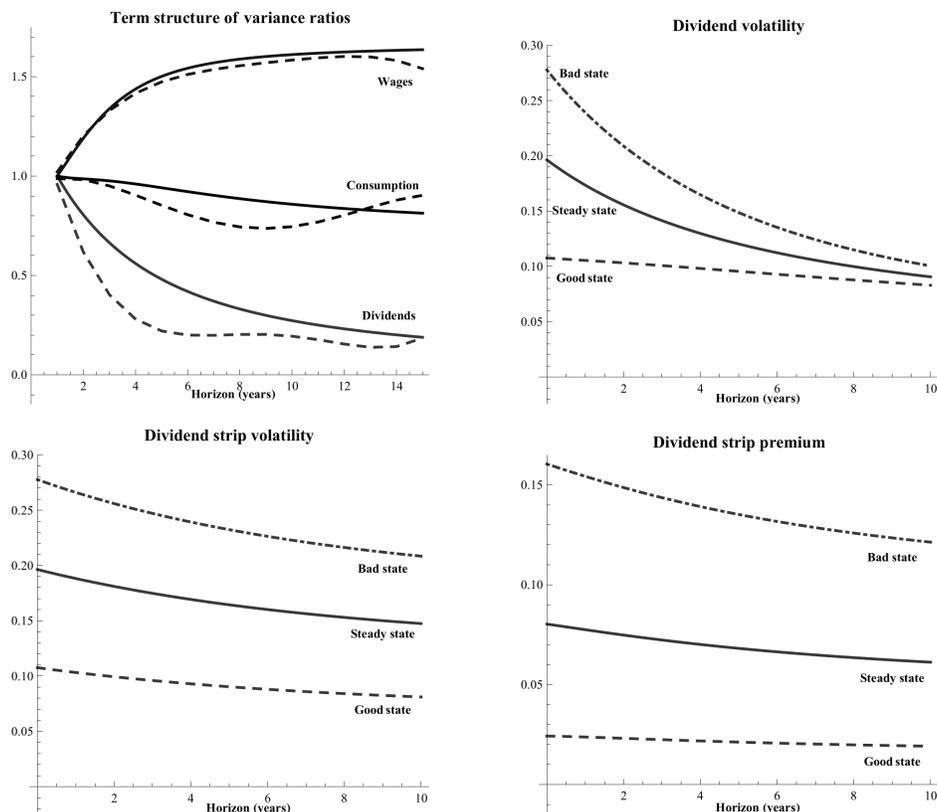


Figure 9: Business Cycle Uncertainty and Term-Structures

Left upper panel: Term-structures of variance ratios of consumption, wages and dividends as a function of the horizon. Dashed lines denote empirical data. Other panels: Term structures of dividend volatility (right upper panel), dividend strip return volatility (left lower panel) and dividend strip premium (right lower panel) as a function of the horizon. Solid lines denote the steady state ($z_t = \bar{z}$), dashed and dot-dashed lines denote respectively good and bad states. Cash-flows parameters: $\sigma_x = .005$, $\bar{\mu} = 0.02$, $\lambda_\mu = 0.86$, $\sigma_\mu = 0.018$, $\bar{z} = 0.1$, $\lambda_z = 0.19$, $\sigma_z = 0.026$, $\alpha = 0.94$, $\phi = 0.418$. Preference parameters: $\gamma_s = 7.5$, $\psi = 1.5$, $\beta = 4.5\%$.