Rate Risk and Rate Insurance*

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Abstract

I decompose stock returns into a duration-matched Treasury component, identified from monetary policy surprises, and a payoff component. Risk and returns rise much less with duration for stocks than for their matched Treasuries. Stock volatility is dampened by *rate insurance*: rates fall in bad times, so the bond inside a stock provides insurance against the stock's payoff risk. Expected stock returns are dampened because the insurance works in reverse: rates rise in good times, so stocks' payoff gains hedge the losses borne by investors holding net duration, notably government bonds when Ricardian equivalence fails. This framework helps reconcile positive bond premia with negative stock-bond covariance, sheds light on equity anomalies and the collapse of the value premium, implies that fiscal and monetary policy shape bond and equity premia, and motivates a two-factor model that jointly prices stocks and bonds. Rate insurance can even turn the price of long-run risk negative, explaining why long bonds beat long stocks.

1 Introduction

Stocks are like bonds in one dimension, and the opposite of bonds in another. This paper decomposes stock returns into two components:

$$r_{j,t} = r^B_{j,t} + \delta_{j,t}, \tag{1}$$

where $r^B_{j,t}$ is the return on a duration-matched Treasury and $\delta_{j,t}$ is a residual payoff component. The first term captures rate risk. The second captures payoff risk and can be thought of as the return on a synthetic portfolio of dividend futures. I revisit risk and returns in stocks and bonds through the lens of these two components and their interaction. When the two terms comove

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negatively, the bond inside the stock provides insurance against the stock's payoff risk. But covariance is symmetric: the same negative comovement means that the payoff component insures investors' bondholdings against rate movements correlated with payoff news.

Like Treasuries, stocks are long-lived assets exposed to rate risk. Movements in rates affect a stock's price in proportion to its duration, defined as the price sensitivity to shifts in the Treasury yield curve holding payoffs fixed. Excess returns over bills thus bundle compensation for equity-specific payoff risk with generic rate windfalls. For corporate bonds, returns are routinely measured relative to duration-matched Treasuries to isolate credit risk. Yet this adjustment is not standard for stocks because they have no contractual payout schedule to start from, even though it would matter even more than for corporate bonds given stocks' longer duration. Rate movements thus blur the comparison between equities and other asset classes, and between stocks with different durations.

This bundling has mattered especially over the past several decades, as most samples used in modern empirical asset pricing overlap heavily with a secular decline in interest rates that generated enormous returns for long-duration assets. Between 1988 and 2019, the 10-year nominal rate fell from 9% to 2% and 10-year zero-coupon Treasuries earned 8.6% per year. Bond returns were not just high but also sharply increasing with maturity, by 0.3 percentage points for each additional year of duration: 30-year zero-coupon Treasuries earned 13.8% per year, comfortably above the stock market's 11.4%.

By contrast, I estimate that equity returns were flat in duration, extending findings based on dividend strips that the bond and equity term structures of returns have very different shapes. It is tempting to dismiss the secular rate decline as a long but exceptional bond rally. But even if the realized fall in rates was a unique episode, why didn't it reward stocks with longer duration? Why did stocks earn even less than duration-matched Treasuries at the long end? This is puzzling if we think of stocks as bearing the same rate risk as matched Treasuries, plus additional payoff risk. Compensation for long-run payoff risk, in particular, is often viewed as an important source of the equity premium.

Unlike Treasuries, stocks have payoffs that are not fixed but highly correlated with the very macroeconomic shocks that move rates. Suppose that rates tend to fall at the same time as expected cash flows: dividends may load on short-run recession news expected to trigger monetary easing, or on poor long-run growth news lowering the perceived "natural" rate r^*. The drop in rates induces a capital gain exactly when stocks suffer from adverse cash-flow news, which stabilizes stock prices. I call this offset *rate insurance*.[1]

[1] At the aggregate level, this offset is consistent with the standard Euler equation logic, with the natural rate r^* responding to expected growth in proportion to the inverse EIS (elasticity of intertemporal substitution). Models of

In the cross-section, some stocks are better rate-insured than others: for instance, long-term rates may correlate more strongly with payoff news in sectors driving the technological frontier, or in sectors bearing more directly on Fed decisions.[2] Holding payoff exposures fixed, the same fall in rates produces a larger capital gain for a longer-duration stock. Duration therefore has two sides: it increases exposure to rate risk, but it also magnifies rate insurance.

Rate insurance relates to the stock-bond covariance that famously turned from positive to negative around 2000, but the concepts are distinct. Stock-*bond* covariance tells us how well bonds hedge stocks in portfolios containing both. *Rate* insurance means that bad payoff news tends to come with falling rates. Even when no actual bonds are held or traded and there is thus no room for stock-bond diversification, the implicit bond inside the stock reduces the risk of the stock itself. Rate insurance can be strong even when the stock-bond covariance is positive, because that covariance also includes the variance of the matched Treasury itself. In the data, high rate risk can thus mask high rate insurance.

I denote each stock's rate insurance by χ_j (defined more precisely below). Rate insurance reduces the stock's variance in proportion to the product

$$\chi_j \, d_j,$$

because the asset's own duration d_j scales the stabilizing capital gain. However, the variance reduction from rate insurance does not, by itself, lower the required return on the stock, as priced risk depends on the stock's covariance with investors' aggregate wealth.

Pricing rate insurance requires distinguishing gross bondholdings from *net* bond wealth. Consider the standard advice of investing 60% in stocks and 40% in bonds. Standard equilibrium models either put bonds in zero net supply or impose Ricardian equivalence. Both imply that, in this 60/40 example, diversification washes out in the aggregate: investors' aggregate net position is still 100% in stocks.[3] On the rate risk side, bonds lose value when rates rise, but the representative investor is hedged as its implicit tax liability falls by the same amount. For the same reason, bonds provide no net aggregate hedge for stocks under Ricardian equivalence even when the stock-bond covariance is negative. This cancellation also underpins the theoretical irrelevance of government debt management and central bank balance sheets for asset prices (Wallace, 1981).

long-run risk usually assume that the EIS exceeds 1, so the stock market still gains from good growth news despite the accompanying rise in rates (Bansal and Yaron, 2004).

[2] I will focus on symmetric effects, so that rising rates mitigate how much good news boosts stock prices, which also stabilizes the price. There is evidence of especially strong insurance against bad payoff news, such as the "Fed put" (Cieslak and Vissing-Jorgensen, 2021).

[3] Another way to put it is that under Ricardian equivalence, investors with zero gross bondholdings are still short a long-lived stream of taxes, so buying bonds is just offsetting that short duration position. In general equilibrium, the representative investor ends up with zero net government-debt duration.

It turns out that allowing bonds as net wealth has wide-ranging implications for risk premia. For government bonds, this possibility follows most naturally from relaxing Ricardian equivalence through some form of market incompleteness, as has become standard in macroeconomics when analyzing fiscal and monetary policy. More generally, non-stock assets such as corporate bonds and housing wealth also contribute to net duration. Net bond wealth restores the intuition that stock-bond diversification benefits investors. But it also implies that bonds' covariance with stocks alone is no longer a sufficient statistic for their covariance with the market portfolio, which now includes bonds. Thus bonds' own variance matters even conditional on their covariance with stocks; this is a version of Roll's (1977) critique applied to missing duration. As a result, bonds can comove positively with the market portfolio and earn a positive premium despite a negative stock-bond covariance.

The most intriguing implication is that once bonds are net wealth (a stand-in for all sources of net duration outside stocks), the same covariance that provides rate insurance within an individual stock should also be read from the opposite side: in aggregate, *stocks hedge bonds*.[4] Rate insurance lowers expected returns in proportion to

$$\chi_j \, \mathcal{D},$$

the product of the stock's rate insurance χ_j with *aggregate* net dollar duration $\mathcal{D}$. When *good* payoff news raises rates, aggregate net duration scales the induced capital loss that the stock helps hedge. A rise in aggregate net duration increases the required compensation for rate risk (the term premium) while lowering the required return on equities relative to matched Treasuries, especially for stocks with high rate insurance χ_j.

This explains why bond and equity term structures have very different slopes: Treasury compensation rises with duration, but equity returns over matched Treasuries fall because rate insurance also rises with duration. If aggregate net duration is sufficiently large and rates comove sufficiently with equity payoff news, the rate-induced loss from good long-run news even exceeds the direct payoff gain: the price of long-run payoff risk then becomes negative, explaining why long stocks can earn less than long bonds. In the cross-section of equities, I will show that this mechanism sheds light on the beta and low-volatility anomalies, and the recent demise of the value premium.

Under this view, policy is no longer irrelevant. To the contrary, the fiscal-monetary regime becomes an essential driver of both equity and bond premia. The level of government debt and the

[4] Asset classes lie on a continuum in the rate insurance they provide. Treasuries are at one end because their payoffs are fixed. Housing is intermediate: it has long duration and uncertain rents, but news about long-run rents is less closely tied to the aggregate growth outlook that moves long rates. Stocks, especially high-duration stocks, lie toward the other end.

intergenerational timing of taxes affect aggregate net duration, while the central bank's reaction function shapes how rates respond to payoff news. This state-dependence makes it challenging to compare risk premia across eras, as the economy moved from the gold standard to an era of fiscal stimulus, forward guidance and quantitative easing.

Empirical implementation and implications. In the data, OLS Treasury betas from regressing stock returns on Treasury returns bundle rate exposure with payoff-related rate movements. To separate these two forces, I first need to measure the duration of stocks, that is, their sensitivity to rate shocks not driven by payoff news. This is harder than for bonds because stocks have no contractual payout schedule.

The standard approach is to infer equity duration by modeling the dynamics of future payouts. While the simplest Gordon constant-growth model implies that valuation (the *level* of prices) reveals duration (the *elasticity* of prices to rates), the link is sensitive to the valuation model. In the cross-section, Gordon would imply that the duration of growth stocks (with high price-dividend ratio) is an order of magnitude larger than the duration of value stocks (with low price-dividend ratio). This difference is in tension with the returns observed over the secular decline, during which the value premium was notably positive *in spite* of the huge reward for duration observed in Treasuries. It is also puzzling in light of the almost identical high-frequency responses of growth and value stocks to monetary policy surprises.

The issue is that the Gordon model is too knife-edge to infer equity durations, especially in the cross-section, because it treats any transitory growth supporting the current valuation as permanent. I show that when temporarily high expected payout growth later reverts, fitting a model with constant growth tends to overstate payout duration; temporarily weak growth followed by recovery produces the opposite bias. More elaborate measures, such as Dechow, Sloan and Soliman (2004), forecast cash flows for a finite horizon, but the remaining cash flows are still imputed from the current valuation using a terminal valuation model.

Instead, I estimate duration by comparing the responses of stock and Treasury returns to FOMC announcements. Nagel and Xu (2026) construct a Treasury portfolio from estimates of the aggregate stock market's cash-flow timing and show that it can largely explain the market's response to monetary policy surprises. I run their exercise in reverse: I match each stock portfolio to a Treasury portfolio with the same response to monetary policy shocks, using Bauer and Swanson (2023)'s orthogonalized surprises to isolate rate movements plausibly unrelated to payoff news. This provides a traded Treasury benchmark, portfolio by portfolio, without relying on a specific valuation model or cash-flow forecasts. The duration of the stock d_j is defined as the duration of that matched Treasury.

I validate the duration estimates against the contractual duration available for corporate

bonds. Moreover, equity durations estimated over 1988–2019 are good predictors of returns during the 2022 monetary tightening. The aggregate stock market has an estimated duration of 19.6 years.[5] The similar FOMC responses of value and growth stocks map into similar durations: 21.6 and 23.7 years.

With duration estimates in hand, I measure rate insurance as

$$\chi_j = d_j - \beta_j^x,$$

where β_j^x is the OLS Treasury beta obtained from regressing asset j's return on the return per duration-year of its matched Treasury. Both d_j and β_j^x are expressed in years.[6] Intuitively, I use monetary policy shocks as instrumental variables to identify duration from rate movements plausibly unrelated to payoff news, but payoff-related rate movements affect the OLS Treasury beta, so the gap χ_j captures an omitted variable bias. A positive χ_j means that rates tend to fall, and the matched Treasury tends to rise, when the residual $\delta_{j,t}$ in (1) is low.

Rate insurance rises with duration for both equities and corporate bonds. This would happen even without variation in Treasury betas, but is reinforced by the fact that stocks with longer durations tend to have *more negative* Treasury betas. This striking inversion reflects that the OLS Treasury beta is dominated by rate movements that are highly correlated with payoff news, and more so for long-duration stocks. Corporate bonds show the same pattern, with two advantages: we can observe their contractual durations and credit ratings. For a given contractual duration, lower-rated bonds have lower Treasury betas, and Treasury beta rises less with duration as ratings fall.

Rate insurance leads to a sharp contrast between stocks and bonds in cross-sectional volatility. Treasury volatility rises strongly with duration, around 0.8 percentage points per year of duration. Stock volatility rises much less, at 0.32 points per year of duration across characteristic portfolios and only 0.12 across industry portfolios. Although the variances of both the matched Treasury and the payoff component rise sharply with duration, their covariance becomes increasingly negative. The variance reduction from rate insurance scales with $d_j \chi_j$. Relative to the variance the two components in (1) would generate if uncorrelated, rate insurance cancels 16 percent in the lowest quintile of industry durations and 73 percent in the highest quintile. Equity

[5]This FOMC-implied duration estimate is much lower than what the Gordon growth model would imply. The average P/D of 43.3 years, if interpreted as duration, would imply that the market underperformed its matched bond considerably, by about 8.5% per year if the yield curve, which is already approximately flat from 20 to 30 years, continues to be flat beyond 30 years. Similarly, the secular decline should have generated incredible returns to growth stocks according to their Gordon-implied durations above 160 years.

[6]Using the same 10-year Treasury for every asset gives almost identical rate insurance measures, as $d_j - \beta_j^x$ and $d_j - \beta_j^{10Y}$ (where β_j^{10Y} is ten times the OLS coefficient on the 10-year Treasury return) have a correlation of 0.999 and differ by less than 1 year on average.

volatility falls below the volatility of matched Treasuries at durations above roughly 21 years for characteristic portfolios and 27 years for industries.

I next turn to returns. I call "stock-minus-bond wedge" or simply "wedge" the average stock return over its matched Treasury. Across both characteristics and industry portfolios, equity returns are nearly flat in duration even though matched-Treasury returns rise sharply, by about 0.3 percentage points per year of duration.[7] Therefore, the fitted wedge falls by about 0.3 points per year of duration and becomes negative above roughly 23 years. This pattern holds both before and after the stock-bond covariance turned negative. The aggregate market, with a duration of 19.6 years, happens to have a near-zero wedge: its matched Treasury earned an average 10.8% per year between 1988 and 2019, close to the market's 11.4% even though the matched Treasury is selected using only returns on 161 FOMC announcement days. van Binsbergen (2026) documents this near-zero aggregate wedge using a matched bond constructed from estimates of payout timing.

But crucially, the cross-section reveals that the market is only one point on a non-trivial term structure: its near-zero wedge reflects offsetting positive and negative wedges at different durations, rather than a general absence of equity premia over bonds. Short-duration portfolios did earn substantially more than their matched Treasuries, as in the standard equity premium logic. The puzzle is why long-duration portfolios earned much less than their matched Treasuries. The model's answer is that rate insurance rises with duration and is priced because equity payoffs hedge the rate risk in investors' net wealth, lowering the wedge and, in my point estimates, pushing it below zero at the long end.

The theory motivates two traded factors. The "Mixed Market Portfolio" (MIX) replaces the usual stock-only market portfolio (CRSP) with a mix of CRSP and Treasuries. The "Rate Insurance Portfolio" (RIP) is a duration-neutral portfolio long high-χ and short low-χ stocks. Across the 49 Fama-French industries and 30 Treasury maturities, the two-factor MIX–RIP model has a mean absolute alpha of 1.3% while regressing average returns on model-implied returns gives a slope of 0.8. Under the Fama-French 5 factors plus a Treasury TERM factor, the mean absolute alpha is 2.2% and the slope is 0.4.

Rate insurance provides a natural explanation for the beta and low-volatility anomalies. Market beta combines exposure to positively priced risks, pure rate risk and short-run payoff risk, with exposure to long-run payoff risk. The standard security market line is nearly flat, but in a joint regression on CAPM beta and RIP loading, the slope on market beta increases to 8 percentage points and the slope on RIP loading is negative. RIP loadings also rise monotonically from

[7] Of the 13.8% annualized return on the 30-year zero-coupon Treasury, 5.7 percentage points came from the average realized decline in its yield from 8.6% to 2.5%. Appendix Figure A.6 reports this contribution and the remainder across Treasury maturities.

the lowest- to the highest-volatility decile, and controlling for RIP reduces the low-minus-high volatility alpha from 11% to less than 2% per year.

The well-known recent compression in many anomaly premia, most prominently the value premium, can also be traced to a change in rate insurance. Average CAPM alphas across the anomaly endpoint spreads fell from 6.3% in 1988–2007 to 2.3% in 2010–2019. I find that characteristic spreads whose Treasury betas fell more (equivalently, whose rate insurance became stronger) also experienced larger declines in raw returns, wedges, and CAPM alphas. The cross-family relation predicts a 16.7 pp decline in the CAPM alpha of the B/M value spread based on its large decrease in Treasury beta, very close to the actual 18.9 pp decline. This period also highlights how the "value" label covers very different sorts. The D/P spread alpha did not collapse but actually *increased* over the same period. So did its Treasury beta.

Related literature

van Binsbergen (2026) documents a striking fact: in recent decades, the aggregate market was surprisingly close to a duration-matched Treasury in terms of both volatility and return (see also Polk and Vuolteenaho, 2026). I use monetary policy surprises to extend the comparison to the entire cross section, and the results motivate a framework that revolves around the interplay between rate risk and rate insurance. In surveys, expected long-term growth and long-term real rates move together (Chow et al., 2026; Gormsen and Lazarus, 2026). Gormsen and Lazarus (2026) use this relation to purify movements in rates, showing that equity yields respond weakly to rates but strongly to the pure-discounting component of rates. My focus is precisely on the implications of payoff-related rate movements for risk and expected returns, and their weak pass-through to equity yields is itself a sign of strong rate insurance at the aggregate level. At higher frequencies, Campbell et al. (2020, 2026) and Cieslak and Pang (2021) relate the sign of the stock-bond covariance to the mix of macroeconomic shocks and the stance of monetary policy. The key object here is not the sign itself, but the *gap* between direct rate exposure and ordinary stock-bond beta. Rate insurance was already present when stocks and bonds comoved positively, but strengthened as their covariance turned negative.

I take these facts as the basis for a joint theory of bond and equity risk premia, across maturities and across stocks. I read the negative stock-bond covariance from the opposite side: when good payoff news raises rates, stocks hedge the resulting losses on the rest of the market portfolio, in particular net bond wealth when Ricardian equivalence fails. The monetary regime shapes how strongly payoff news moves rates and hence the strength of this insurance, while fiscal policy affects the net duration being insured.

The same perspective applies to the cross-section of stocks: stocks with more rate insurance

(high χ) are also better hedges for the aggregate net duration book against payoff-related rate changes. My findings relate to a large empirical literature on the pricing of equity duration, with two key distinctions. The first is on the measurement side. The leading approach is to infer equity duration from cash-flow forecasts, valuations, and models of cash-flow dynamics (Dechow et al., 2004; Weber, 2018; Gonçalves, 2021; Gormsen and Lazarus, 2023).[8] While these measures can be used to sort stocks by duration, they are less suited to identify the cardinal rate exposure required to construct a matched-bond benchmark for each asset. Estimating duration independently of valuation also avoids a risk of circularity: high valuations can predict low returns for reasons unrelated to duration (e.g., low risk premia), so duration measures that are increasing in valuation can inherit the same negative relation with subsequent returns (Campbell and Shiller, 1988; Berk, 1995).

The second distinction is that duration increases both rate risk and rate insurance. Long-duration stocks are more exposed to rate risk, which raises their expected returns through the term premium, just as for bonds. But in the data they also receive more rate insurance and provide a better hedge against payoff-related rate losses on the aggregate net duration book, which lowers their expected return over matched Treasuries. The two forces can leave raw equity returns almost flat even though both components vary strongly with duration. Because the market itself has duration, CAPM alphas embed an implicit but imperfect duration adjustment and therefore closely track the stock-minus-bond wedge (Section 3.4).

Dividend strips provide separate evidence across payoff horizons. Traded strips and futures reveal the equity term structure directly at short maturities (Binsbergen et al., 2012, 2013; van Binsbergen and Koijen, 2017; Bansal et al., 2021; Gormsen, 2021; Golez and Jackwerth, 2024), while Giglio et al. (2024) infer equity term structures by estimating a rich affine model of equity prices, dividends, and returns without using strip data. I extend the stock-minus-bond comparison to assets for which dividend strips or futures are not available. The short end of the relation estimated across stock portfolios lines up closely with short-strip estimates from the literature.

The model features a reversal in how the usual long-run risk logic applies to stocks. In Bansal and Yaron (2004), bad news about long-run growth raises marginal utility. Because the effect of persistent growth news on dividends compounds with horizon, this mechanism pushes equity premia up with maturity, whereas real bonds hedge the shock and carry a negative term premium. Croce et al. (2015) show that incomplete information can generate a downward-sloping equity term structure. Lettau and Wachter (2007; 2011) obtain a downward-sloping equity term structure together with an upward-sloping bond term structure through separate forces: mean reversion

[8] One exception is Chen (2022), who uses monetary policy surprises to estimate a different concept of "effective duration" defined as the sensitivity of a stock's price to its own CAPM-implied discount rate, rather than to Treasury rates. I instead reverse the logic of Nagel and Xu (2026) by matching the stock to a traded Treasury with the same FOMC response.

in dividends reduces long equity's priced risk, while long bonds are risky because short rates tend to rise when current dividends are low, which implies a positive stock-bond covariance. An upward-sloping nominal yield curve also arises in Piazzesi and Schneider (2007) and Rudebusch and Swanson (2012), where inflation is bad news for future consumption. In my model, good long-run news can instead be a high marginal utility state for current investors because the associated increase in rates lowers the value of their net bond wealth. Real bond premia can therefore rise with maturity even when stocks and real bonds covary negatively, as in the post-2000 sample.

Long-run risk does not disappear. Rather, it is distributed across assets with heterogeneous exposure to growth news. Displacement models obtain a related reversal when technological progress reduces the profits of existing firms and erodes the human capital of older workers (Gârleanu et al., 2012). Here the loss comes from the rate-induced revaluation of long-duration assets such as bonds, tying the price of long-run risk directly to bond premia.

The stock–bond literature treats the covariance with equities as the key object to assess whether bonds are risky or hedging assets (Campbell et al., 2020, 2026), while preferred-habitat and intermediary models emphasize market segmentation, with specialists pricing bonds based on their duration exposure (Greenwood and Vayanos, 2014; Haddad and Sraer, 2020; Vayanos and Vila, 2021; Kekre et al., 2024). The tight relation between Treasury yields and equity prices documented by Nagel and Xu (2026) motivates an integrated view of investors holding both stocks and bonds. In my model, the stock–bond covariance matters, but it is not a sufficient statistic for bond premia because net bond duration enters the SDF.

Related work studies how asset revaluations redistribute resources across investors and generations (Doepke and Schneider, 2006; Auclert, 2019; Gârleanu and Panageas, 2023). The departure from Ricardian equivalence is familiar from macroeconomic models with finite horizons, liquidity constraints, or incomplete markets (Blanchard, 1985; Woodford, 1990; Kaplan et al., 2018; Auclert et al., 2024; Angeletos et al., 2024). I draw implications for risk premia when government debt also has duration, so that bonds are not just net wealth, but *risky* net wealth. The same net duration that supports a positive term premium also determines how much bondholders value the insurance provided by stocks.

2 Measuring Duration and Rate Insurance

To implement decomposition (1), I need a cardinal measure of equity duration. I estimate duration using monetary policy shocks as instruments for changes in rates. This identifies the matched Treasury component, which then allows me to measure rate insurance.

2.1 Duration versus Valuation

Equities have no contractual payoff schedule so their duration (rate-sensitivity) must be estimated. There are two standard approaches. One is to use Treasury betas obtained from OLS regressions of stock returns on Treasury returns or yield changes; I return to this object in detail below.

The other is to compute duration by modeling the dynamics of cash flows. The most common example is the Gordon growth model (e.g., Greenwald et al., 2025; van Binsbergen, 2026; Polk and Vuolteenaho, 2026). With dividends growing at a constant rate and discounted at a constant rate forever, the equity yield curve is flat. It is a textbook result that, in this case, the P/D ratio recovers exactly the interest-rate sensitivity, i.e., duration equals valuation.

What happens with more general payout profiles? Consider a stock with current dividend $D_0 = 1$ and let $y_E(h)$ denote the equity yield, that is, the discount rate net of payout growth, at horizon h. Using continuous time only to avoid an inconsequential one-period shift in discrete time, the price or equivalently P/D ratio is $P = \int_0^\infty q(h)\,dh$ where $q(h) = e^{-hy_E(h)}$ is the present value of the horizon-h payout, and the Macaulay duration is given by $d^{\text{Mac}} = \frac{\int_0^\infty hq(h)\,dh}{\int_0^\infty q(h)\,dh}$.

Proposition 1. *Suppose that equity yields $y_E(h)$ are monotone in horizon h. Then:*

- *$d^{\text{Mac}} = P$ if and only if $y_E(h)$ is constant almost everywhere.*
- *If $y_E(h)$ is weakly increasing in h, then $d^{\text{Mac}} \leq P$; if $y_E(h)$ is weakly decreasing, then $d^{\text{Mac}} \geq P$.*

The Gordon model treats the transitory growth regime reflected in current valuations as permanent. The resulting bias has a clear structure. If a high P/D reflects temporarily high expected payout growth that later slows, $y_E(h)$ tends to rise with h, so P/D overstates duration for stocks with high transitory growth (e.g., growth stocks). If expected payout growth is initially weak and later recovers, $y_E(h)$ can fall, so P/D understates duration for stocks with low transitory growth (e.g., value stocks).

The gap between duration and valuation can be quite large in practice. Appendix Figure B.1 shows a simple two-stage dividend discount model, in which P/D overestimates duration for growth stocks by a factor of two to three, and underestimates it for value stocks by a factor of two. In the data, across dividend-yield deciles, P/D falls nearly tenfold, from 164.3 for the low-D/P growth portfolio to 16.6 for the high-D/P value portfolio, yet their estimated durations below are almost identical at 23.7 and 21.6 years. P/D is thus 6.9 times the estimated duration of growth, while the estimated duration of value is 1.3 times P/D. [9] A literal Gordon reading is also difficult

[9] van Binsbergen (2026) constructs a duration-matched Treasury for the aggregate stock market using an implementation of the Gordon growth model that assigns all payout weight beyond a cutoff T to date T, using $T = 30$

to reconcile with the secular decline: it would assign growth stocks a vastly larger windfall from falling rates, yet value stocks outperformed them over the sample.

The same concern applies to the influential duration measure of Dechow, Sloan and Soliman (2004). They forecast cash flows for 10 years and model the terminal value beyond 10 years as a perpetuity whose value is given by the current market capitalization minus the present value of the first-stage forecasts. Hence the current valuation directly determines the terminal component of estimated duration. This matters especially when valuation-based duration estimates are used to analyze subsequent returns: because high valuation ratios predict low returns, a duration estimate that rises with valuation can inherit the same relation (Campbell and Shiller, 1988; Berk, 1995).

2.2 Equity Duration from Monetary Policy Shocks

Instead of inferring rate sensitivity from a valuation model, I measure it directly using monetary policy surprises that provide rate variation that is plausibly unrelated to payoff news. I focus on this narrow source of variation for identification, but the goal is to then use the resulting duration estimates to study the impact of *all* rate movements, including those associated with payoff news.

If rates moved only with payoff news, duration could not be separated from payoff exposure. Suppose, then, that there exists some rate variation orthogonal to payoff news. Let x_t^R denote minus a parallel shift in Treasury yields that is orthogonal to payoff news, so that a positive realization of x_t^R corresponds to a positive Treasury return. We can then define an asset j's duration d_j, in years, as its loading on x_t^R, i.e., the return response to rates holding payoff news fixed.[10]

For asset j, let $r_{j,t}^B$ be the return on a traded Treasury portfolio with the same response to x_t^R and define this matched Treasury's return per duration-year as $x_{j,t} \equiv r_{j,t}^B/d_j$, which over short holding periods is approximately minus the change in the Treasury yield at maturity d_j.

Throughout, lower-case r denotes a simple holding-period return in excess of the one-period safe rate, $r_{j,t} = R_{j,t} - R_t^f$, while tildes denote deviations from unconditional means, $\widetilde{r}_{j,t} = r_{j,t} - \mathbf{E}r_{j,t}$.

years in the baseline because this is the longest traded Treasury maturity. As he notes, this truncation lowers the duration of the matched Treasury relative to the raw P/D ratio. In my sample, the 30-year cutoff lowers the market's Gordon-implied duration from 43.3 to 22.4 years, slightly above the 19.6-year FOMC-based estimate reported below. However, translating this approach to the cross-section is difficult because the common cutoff imposes the same upper bound T on every asset's estimated duration, even those with a raw P/D ratio much higher than T. For instance, the same truncation maps growth stocks' raw P/D ratio of 164.3 to a duration of 27.5 years.

[10]The parallel-shift benchmark summarizes rate exposure with a scalar duration. In the empirical implementation, FOMC announcements need not move the curve in parallel; the observed Treasury response curve maps each asset's response into a response-equivalent duration.

We can decompose the return $\widetilde{r}_{j,t}$ as

$$\widetilde{r}_{j,t} = \underbrace{\widetilde{r}^{B}_{j,t}}_{= d_j \widetilde{x}_{j,t}} + \widetilde{\delta}_{j,t}. \tag{2}$$

The matched-bond component $\widetilde{r}^{B}_{j,t}$ captures all gains and losses from rate movements, including those associated with payoff news. The residual $\widetilde{\delta}_{j,t}$ captures what the asset earns above and beyond what a Treasury with duration d_j would already earn. It is a synthetic version of dividend futures that are traded at the index-level at short maturities (Binsbergen et al., 2013). By construction, the residual $\widetilde{\delta}_{j,t}$ is orthogonal to $\widetilde{x}^{R}_{t}$ and hence it has zero duration, yet it can still comove with the matched bond because rates can move with payoff news. Below I will define rate insurance based on the covariance between the two components $\widetilde{r}^{B}_{j,t}$ and $\widetilde{\delta}_{j,t}$.

To identify duration, consider a variable z_t that moves Treasury yields. Equation (2) implies

$$\frac{\mathrm{Cov}(r_{j,t}, z_t)}{\mathrm{Var}(z_t)} = \frac{\mathrm{Cov}(r^{B}_{j,t}, z_t)}{\mathrm{Var}(z_t)} + \frac{\mathrm{Cov}(\delta_{j,t}, z_t)}{\mathrm{Var}(z_t)}. \tag{3}$$

If Treasury responses are monotone in duration, the asset's response to z_t maps into a response-equivalent Treasury duration. Under the exclusion restriction $\mathrm{Cov}(\delta_{j,t}, z_t) = 0$, this also equals the asset's Treasury-rate sensitivity holding its non-Treasury return component fixed.

I implement this mapping with the monetary policy surprise z_t. A large literature analyzes how asset prices respond to these surprises (Bernanke and Kuttner, 2005; Piazzesi, 2005; Hanson and Stein, 2015; Nakamura and Steinsson, 2018). I build most directly on Nagel and Xu (2026), who show that movements in the Treasury yield curve account for most of the aggregate stock-market response around FOMC announcements. I invert their logic asset by asset, using Treasury responses to convert each asset's FOMC response into duration units. This design requires neither accounting data, cash-flow forecasts, nor a model of payout timing. In principle, it can be applied to any asset with daily returns on FOMC announcement days. In practice, I estimate durations for the aggregate stock market, industry and characteristic portfolios, and portfolios of corporate bonds by rating and maturity. The usual downside of using FOMC announcements is that power is limited by the short sample. Estimating durations for portfolios is useful to reduce idiosyncratic noise and keep the asset definitions stable across events.

Data. The baseline sample is 1988–2019. The monetary policy surprises series from Bauer and Swanson (2023) starts in 1988. I use daily returns on FOMC announcement days to estimate duration and monthly returns to measure Treasury betas, volatilities, and average returns, except when using daily returns to compare FOMC and non-FOMC days. Average returns are reported

as annualized simple total returns.

The main equity sample contains 510 value-weighted decile portfolios from 55 characteristic families from Haddad et al. (2020) available until the end of 2019. I also obtain the Fama-French 49 value-weighted industry portfolios, the CRSP value-weighted market, and the book-to-market and dividend-yield deciles from Ken French's website.

FOMC-day Treasury returns are constructed from the daily zero-coupon nominal curves of Gürkaynak et al. (2007). Monthly Treasury returns are one-month holding returns on the same nominal bonds and on TIPS from Gürkaynak et al. (2010). For corporate bonds, I estimate durations using TRACE prices from 2002 to 2019 and compare them with modified duration from WRDS. For corporate bond Treasury betas, I use the longer sample of monthly corporate bond portfolio returns from Binsbergen et al. (2025) combining Lehman/Warga and Bank of America Merrill Lynch quotes from 1988 to 2019.

FOMC betas. I start by estimating, for each asset j, its FOMC beta β_j^{FOMC} from

$$r_{j,e} = a_j + \beta_j^{FOMC} z_e + \eta_{j,e}, \tag{4}$$

where e indexes announcement days and z_e is the orthogonalized monetary policy surprise ($-\text{MPS}_e$), with the sign convention that more positive FOMC betas mean stronger price increases following easing surprises. I estimate FOMC betas for equity portfolios, corporate bonds, and Treasuries of different maturities.

Treasury betas, often called "empirical duration," are obtained using OLS regressions of asset returns on Treasury returns or yield changes (e.g., Schaefer and Strebulaev, 2008; Choi et al., 2022).[11] The standard specification is to estimate the beta of different assets j with respect to a common Treasury maturity, for instance the 10-year Treasury

$$\beta_j^{10Y} \equiv \frac{\text{Cov}(r_{j,t}, x_t^{10})}{\text{Var}(x_t^{10})}.$$

The OLS estimate is based on the full variation in interest rates.[12] An alternative IV estimate is to use only the rate variation coming from monetary policy surprises:

$$\beta_j^{10Y,\text{MPS}} \equiv \frac{\text{Cov}(r_{j,t}, z_t)}{\text{Cov}(x_t^{10}, z_t)},$$

[11] Baker and Wurgler (2012) use loadings on bond returns not to estimate duration but to characterize "bond-like" stocks.

[12] I use the normalized return $x_t^{10} \equiv r_{10Y,t}^B/10$ to express β_j^{10Y} in duration-years; equivalently β_j^{10Y} is equal to 10 times $\text{Cov}(r_{j,t}, r_{10Y,t}^B)/\text{Var}(r_{10Y,t}^B)$.

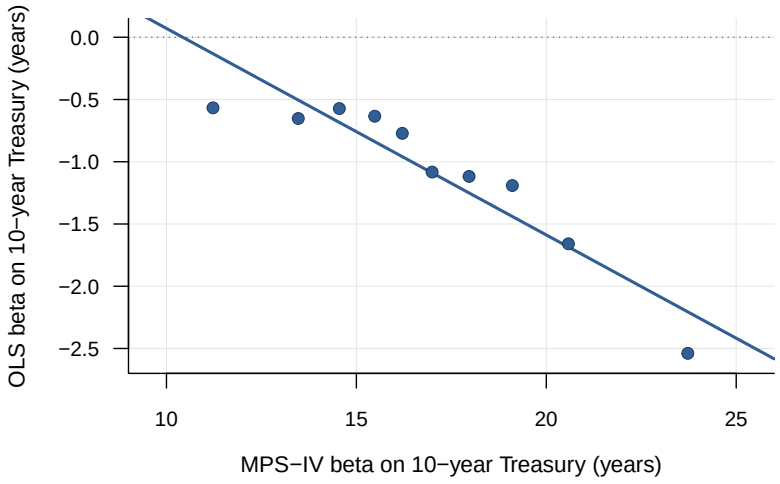


Figure 1: MPS-IV and OLS estimates of Treasury beta. Both use the 10-year Treasury return divided by ten and are expressed in years. The MPS-IV estimate uses 311 FOMC announcements from 1988 to 2019. Points are ten bins with equal numbers of portfolios, formed by MPS-IV beta. The line is fitted to all 510 characteristic portfolios.

where z_t denotes monetary policy surprises. Equivalently, $\beta_j^{10Y,\text{MPS}} = 10\beta_j^{FOMC}/\beta_{10Y}^{FOMC}$, where β_{10Y}^{FOMC} is the FOMC beta in (4) of the 10-year Treasury, estimated using all 311 FOMC announcements from Bauer and Swanson (2023) between 1988 and 2019.

Figure 1 compares the IV estimate $\beta_j^{10Y,\text{MPS}}$ with the OLS estimate β_j^{10Y}. Across 510 characteristic portfolios, every MPS-IV Treasury beta is positive, whereas 445 OLS Treasury betas are negative. Thus every portfolio has a negative estimated response to a surprise rate increase, even though most tend to rise when rates rise in monthly data.

The MPS-IV and OLS Treasury betas are even *negatively correlated*, with a correlation of −0.52. Payoff-related rate movements outside FOMC windows therefore generate a strong negative omitted variable bias that becomes more negative at higher durations.

Duration estimates. Mapping FOMC betas to durations raises two implementation issues. First, the Treasury response curve needs to preserve maturity rankings. If, for example, an easing surprise lowers the 1-year rate but raises the 30-year rate, a larger FOMC beta need not correspond to a longer maturity. I therefore retain FOMC days on which the 1-year through 30-year zero-coupon yields all move in the same direction. This leaves 161 of 311 announcements in 1988–2019 and makes the Treasury response curve increasing in maturity and thus invertible. I estimate (4) on these dates to map asset responses into durations.

Second, Treasury FOMC betas are not linear but concave in maturity, so a claim's response depends on the distribution of its payouts, not only on its duration. I therefore combine two

extremes. Matching an asset's FOMC beta to the zero-coupon response curve identifies duration exactly for a single payment, but understates it when payouts are more dispersed. At the other extreme, portfolios combining 1-year and 30-year zeros have the highest duration for a given FOMC beta. This 1–30 chord recovers duration exactly for "barbell" payouts concentrated in years 1 and 30, but overstates it for smoother payout profiles such as equities.

I use weights of 2/3 on the zero-coupon curve and 1/3 on the 1–30 chord. I use the same weights to construct the matched-Treasury return. These weights recover the known durations of synthetic Treasury portfolios with constant or geometrically declining payouts substantially better than either map alone, as Appendix Figure A.2 shows. Shifting weight to the zero-coupon curve would preserve rankings but lower all duration estimates, while more weight on the chord would raise all duration estimates.

Each asset j's FOMC beta can then be mapped to a unique duration estimate d_j. Henceforth I refer to the resulting d_j simply as duration. Appendix Figure A.1 illustrates the construction using the aggregate market as an example. The market's FOMC beta is 0.068, implying a duration of 19.6 years, around half-way between the estimate from direct zero-coupon matching (17.3 years) and the estimate from the 1–30 chord (22.4 years).[13] Across 510 characteristic portfolios, the median is 18.8 years and the interquartile range 16.3–21.2. For FF49 industries, the corresponding values are 16.9 and 12.2–24.5 years. Defense and Tobacco have the shortest durations, at 3.5 and 3.7 years, while Precious Metals and Construction have the longest, at 43.7 and 33.2 years.

Corporate bond validation. Besides Treasuries, corporate bonds also have contractual durations and can thus be used as an external check. Appendix Figure A.3 applies the same mapping on a shorter sample starting in 2002, when TRACE data becomes available. I compare the estimates with the contractual duration reported in WRDS, based on the bond's promised coupons and principal. Across five duration buckets and ratings from AAA through B, the FOMC-based estimates preserve the ordering and are close in scale to reported duration (WRDS duration ignores credit risk, so the mapping need not be exact).

Durations predict responses to the 2022 monetary tightening. FOMC announcement windows are useful because, outside them, rate movements are difficult to separate from payoff news. The 2022 monetary tightening episode provides a useful out-of-sample validation: rates rose sharply as the Federal Reserve fought inflation, rather than because of good news about the future payoffs of long-duration assets.

[13] Regressing U.S. returns on three-year changes in the residual pure-discounting component of interest rates obtained from surveyed forecasts about long-run growth, Gormsen and Lazarus (2026) estimate a coefficient of −19.1 for the aggregate market, close to the 19.6-year high-frequency estimate here.

The baseline durations estimated only through 2019 predict industry returns in 2022. Appendix Figure A.4 shows that across all 49 industries, returns fell by 1.37 percentage points per duration-year, nearly identical to the 1.56-point decline in their matched Treasuries. Hence the estimated durations capture stocks' exposure to rate risk well outside the FOMC windows.

2.3 Rate Insurance = Duration − Treasury Beta

Equation (2) implies that an OLS regression of the asset's return $r_{j,t}$ on the asset-specific normalized matched Treasury return $x_{j,t} = r^B_{j,t}/d_j$ estimates

$$\beta^x_j \equiv d_j + \frac{\text{Cov}(\delta_{j,t}, x_{j,t})}{\text{Var}(x_{j,t})}. \tag{5}$$

If a risky asset gains on good payoff news that also raises rates and thus lowers bond returns $x_{j,t}$, the covariance term is negative, and Treasury beta understates duration.

What is unusual here is that the resulting omitted variable bias is itself the key object of interest. After identifying duration using monetary policy shocks, we can use the gap between duration and OLS Treasury beta to define rate insurance, expressed in the same units as duration (years), as

$$\chi_j \equiv d_j - \beta^x_j, \tag{6}$$

which equals $\frac{-\text{Cov}(\delta_{j,t},x_{j,t})}{\text{Var}(x_{j,t})}$. To make definition (6) exact, β^x_j is computed against asset j's own matched Treasury rather than the common 10-year benchmark used in β^{10Y}_j. If Treasury yields move by the same amount across maturities, $x_{j,t} = x^{10}_t$ to first order, so $\beta^x_j \approx \beta^{10Y}_j$ if parallel shifts in the yield curve dominate the covariance of asset j's return with Treasuries. In general, β^x_j may differ slightly from β^{10Y}_j, but they turn out to be extremely close, hence measuring rate insurance using $d_j - \beta^x_j$ or $d_j - \beta^{10Y}_j$ makes almost no difference: the two measures have a correlation of 0.999 and differ by around 0.7 years on average.

Rate insurance across time and asset classes. The aggregate stock–bond covariance famously turned negative around 2000 (Campbell et al., 2020), but this does not mean that rate insurance appeared only in 2000: even a positive Treasury beta can still lie far below duration. Moreover, rate insurance is not specific to stocks: any risky asset can experience comovement between rates and its payoff residual δ_j. Corporate bonds provide two advantages relative to stocks: promised payments identify their duration-matched Treasury (van Binsbergen et al., 2025), while credit ratings proxy for payoff risk.

Figure 2 plots Treasury betas for equities and corporate bonds of different ratings before and after 2000. Before 2000, equity Treasury betas were positive but already far below duration: the

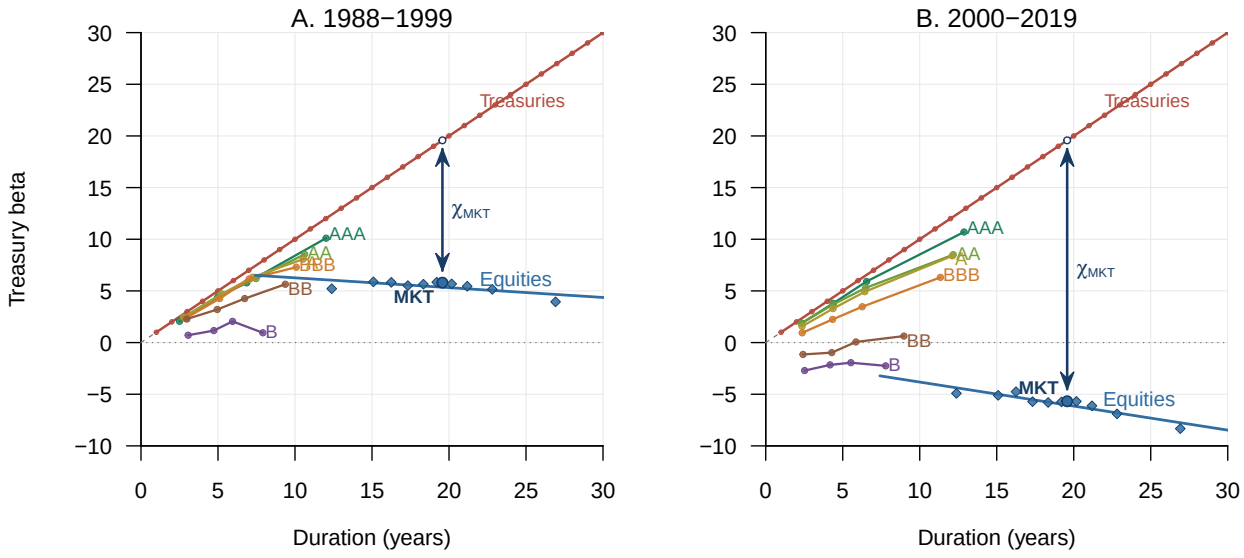


Figure 2: Rate insurance in corporate bonds and equities. The vertical axis is the monthly coefficient on each asset's matched Treasury return divided by duration. Equity duration is estimated from the full FOMC sample; corporate bond duration is the subperiod mean reported by Binsbergen et al. (2025). Corporate bond portfolios combine ratings AAA through B with four maturity groups, and their matched Treasuries follow the constituent bonds' promised payments. Equity points show ten duration bins; the line is fitted to all characteristic portfolios. The diagonal is $\beta_j^x = d_j$, and the distance below it is χ_j.

market's Treasury beta was only 5.8 years against its full-sample 19.6-year duration. Thus rate insurance was present even when stocks and Treasuries moved together. After 2000, the market's Treasury beta was -5.7 years, so covariance with payoff news more than offset the positive rate exposure.

Corporate bonds span the space between Treasuries and equities. At a given duration, corporate bonds with lower ratings have lower Treasury betas, implying that rate insurance grows with credit risk. After 2000, Treasury betas turn negative for high-yield bonds just like for stocks, and in terms of Treasury betas, equities look like an approximate continuation of B-rated corporate bonds at higher durations. Within each credit rating, Treasury beta generally rises less than one-for-one with duration, implying that rate insurance grows with duration, just like for stocks.[14]

[14]This is consistent with Schaefer and Strebulaev (2008), who document that interest-rate sensitivity is below Macaulay duration, and Longstaff and Schwartz (1995) and Duffee (1998) who document a negative relation between Treasury yields and corporate spreads. In the rate insurance interpretation, bad credit news widens spreads while Treasury yields fall, so the Treasury gain offsets part of the credit loss.

2.4 Rate Insurance and Volatility

The most immediate implication of rate insurance is for return volatility. When the matched Treasury tends to gain as the payoff component falls, its capital gain offsets part of the payoff loss. The variance of any asset return can be decomposed as

$$\text{Var}(r_{j,t}) = \text{Var}(r^B_{j,t}) + \text{Var}(\delta_{j,t}) - 2d_j\chi_j\text{Var}(x_{j,t}). \tag{7}$$

The variance reduction from rate insurance increases with $d_j\chi_j$: while χ_j measures how strongly the payoff component comoves with rates, the asset's duration d_j scales the resulting capital gain on the matched bond. For instance, a short-maturity dividend strip may have a high χ_j, but its low duration d_j means that even if rates fall upon bad news about short-maturity dividends, the value of the strip does not benefit much.

Panels A and C of Figure 3 show a systematic cross-sectional contrast between the risks of bonds and stocks as we vary duration. For the characteristic portfolios, matched-Treasury volatility rises by 0.81 percentage points per duration-year, while stock volatility only rises by 0.32. Across industries, the contrast is even starker: the corresponding slopes are 0.86 and 0.12. This cross-sectional pattern generalizes the finding in van Binsbergen (2026) that the aggregate stock market and a Treasury bond matched using valuation-based duration have comparable volatilities.

Panels B and D show the variance decomposition (7) directly across characteristic and industry portfolios, each sorted into five duration bins. In both universes, both $\text{Var}(r^B_j)$ and $\text{Var}(\delta_j)$ rise sharply with duration, but the overall stock variance rises much less. Relative to the sum $\text{Var}(r^B_j) + \text{Var}(\delta_j)$, which would be the total variance if the two components were uncorrelated, the negative covariance term cancels 55 percent in the shortest-duration characteristic quintile and 72 percent in the longest. For industries, the corresponding shares are 16 and 73 percent.

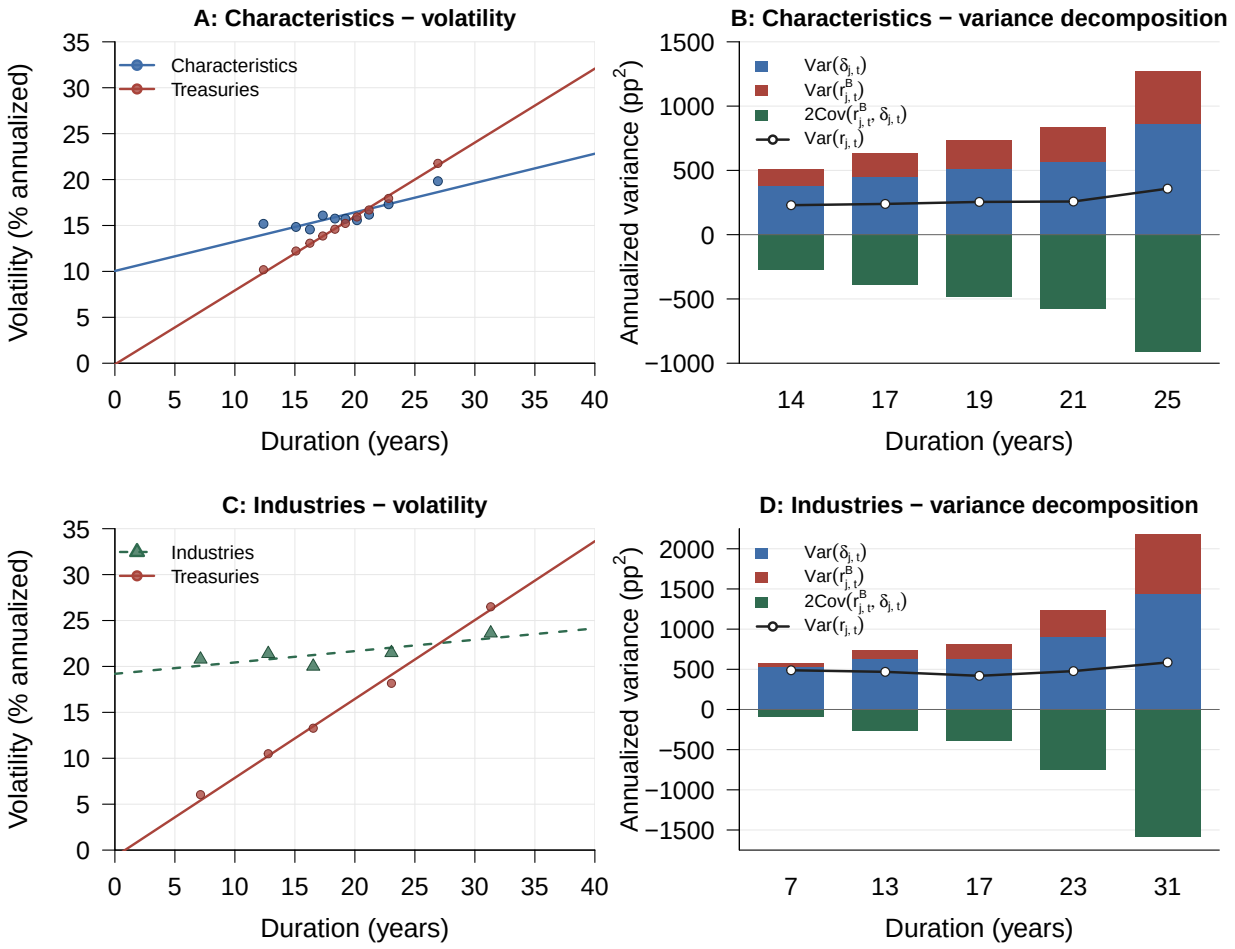


Figure 3: Volatility and its decomposition by duration. The top row uses 510 characteristic portfolios and the bottom row uses 49 industry portfolios. Panels A and C report annualized monthly volatility from 1988 to 2019. The markers show ten duration bins for characteristics and five duration bins for industries. Lines are fitted to all portfolios in each universe. Panels B and D report mean $\text{Var}(r_j^B)$, $\text{Var}(\delta_j)$, and $2\text{Cov}(r_j^B, \delta_j)$ within five duration bins for each universe. The black line is $\text{Var}(r_j)$. All variance and covariance terms are annualized and expressed in percentage points squared.

3 Benchmarking Equity Returns Against Bonds

Taking sample averages in (1) gives

$$\bar{r}_j = \bar{r}_j^B + \Delta_j, \tag{8}$$

where $\bar{r}_j^B$ is the average return on the matched Treasury selected as in Section 2. The stock-minus-bond wedge, or simply wedge, Δ_j measures asset j's excess return over the asset-specific matched Treasury, which contrasts with excess returns over T-bills that use a common zero-duration benchmark for every asset regardless of its duration.

3.1 The Term Structure of Equity Returns Over Bonds

Once we have estimates of matched-bond returns and wedges, we can study how they vary along any dimension. I first study how stock returns, matched-Treasury returns, and wedges vary with duration.

Figure 4 shows a stark contrast between stocks and bonds. Over the secular decline in interest rates, matched Treasuries earned high returns that rose sharply with duration.[15] But equity returns $\bar{r}_j$ were nearly flat in duration. As a result, wedges Δ_j fell sharply with duration, with a slope of -0.29 pp. per year of duration for characteristics and -0.32 for industries.

In fact, equities earned even less than matched Treasuries at high durations, implying *negative* fitted wedges for durations beyond 23 years. Over this 32-year sample, long-duration stocks failed to earn the same return as their matched Treasuries, let alone additional compensation for payoff risk.

Excluding FOMC-day returns. A potential concern is that the same returns on FOMC announcement days used to estimate duration also drive the relationship between returns or wedges and duration. Another is that the flat relation between raw returns and duration reflects attenuation bias from noisy duration estimates, even though Section 2 already shows that duration has strong explanatory power for other variables.

Figure 5 separates returns on FOMC days and returns on non-FOMC days. Non-FOMC returns and durations are measured on completely disjoint samples. This sample split shows that the insignificant full-sample relation between returns and duration reflects two significant slopes with opposite signs that offset almost exactly. The contribution to total returns from FOMC announcement days, which account for only 4% of trading days, is quite large, around 3 percentage

[15] The wedge Δ_j subtracts the matched Treasury whatever the source of its return, so the accounting does not depend on whether the secular decline in yields was anticipated. Figure A.6 shows that the average realized yield decline accounts for only part of long-Treasury returns. For the overlapping 2002–2023 period, Rogers (2026) uses options to separate expectations from risk premia and concludes that high average long-bond returns mainly reflect expected compensation rather than forecast errors.

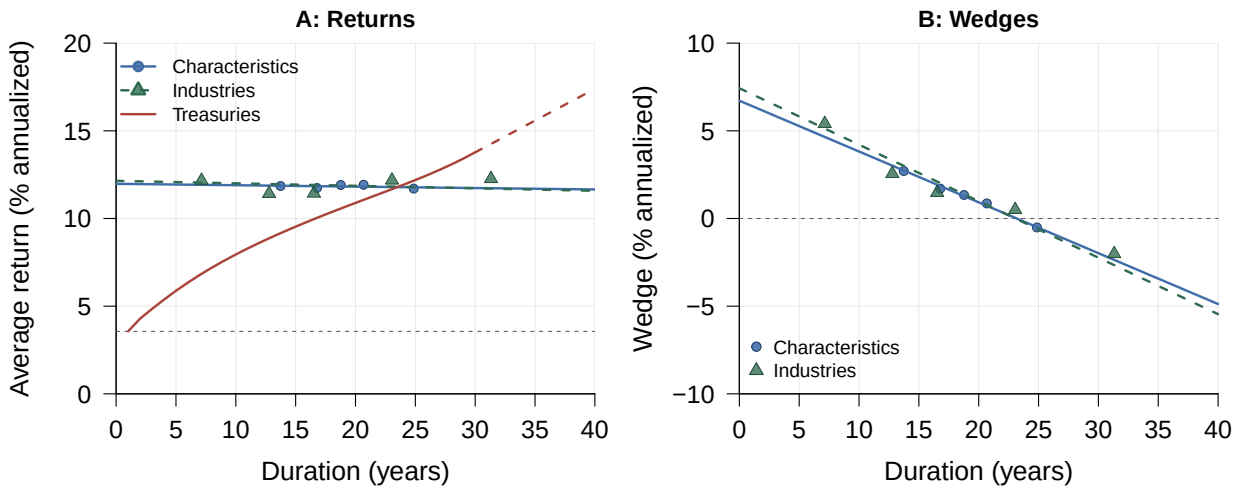


Figure 4: Returns and stock-minus-bond wedges by duration. Panel A reports average annual simple total returns on equity portfolios and their matched Treasuries. Panel B subtracts each portfolio's matched Treasury return. The markers show five duration bins for characteristic portfolios and industries; lines are fitted to all 510 characteristic portfolios and 49 industries.

points per year, and it rises by 0.064 percentage points per year of duration. Conversely, the contribution from non-FOMC days, which account for the vast majority (96%) of trading days, falls by 0.064 per duration-year.

The positive slope on FOMC days is natural: duration measures announcement-day rate sensitivity, and Hillenbrand (2025) finds that rates fell on average in narrow windows around FOMC meetings, accounting for a substantial share of the secular decline. The more surprising fact is that on non-FOMC days, the relation reverses. Most of the secular rate decline still occurred outside FOMC announcement days, and on those days Treasuries still earned high returns that increased with duration. However, once we exclude FOMC days, stock returns fall significantly with duration, hence the wedge declines even more steeply than in the full sample (Appendix Figure A.8).

Before and after 2000. I estimate the relation between wedges and duration separately before and after 2000, when the stock-bond covariance switches from positive to negative, holding the duration estimates fixed across the two periods. Appendix Table A.2 shows that the wedge already declines with duration before 2000, with slopes of −0.13 for characteristic portfolios and −0.17 for industries, and that the slopes become even more negative after 2000, respectively −0.38 and −0.41. The model below predicts lower wedges for otherwise similar assets when rate insurance is stronger. The post-2000 steepening matches Figure 2, where Treasury betas fell most among

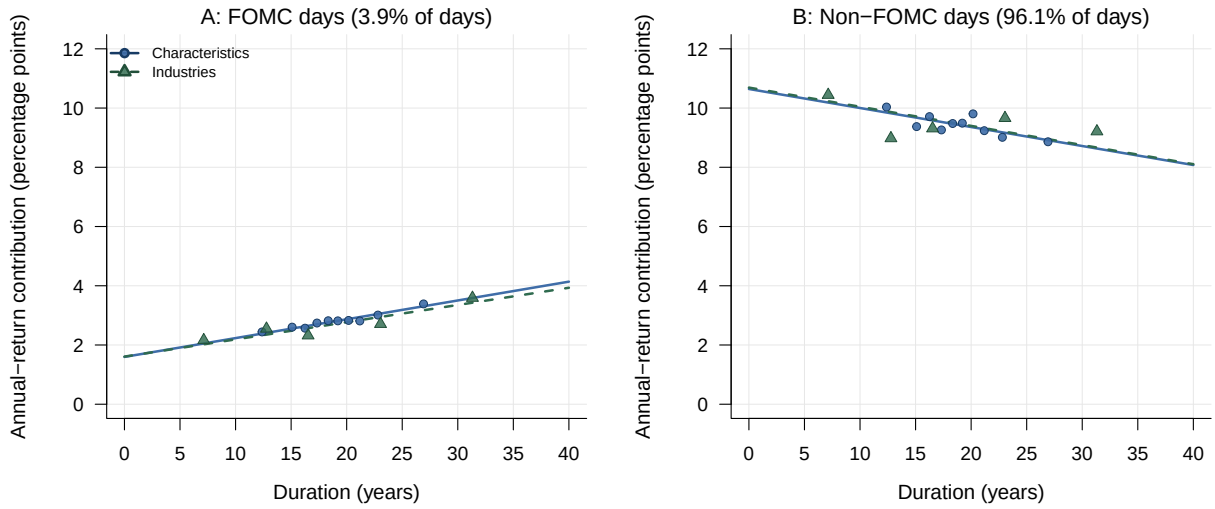


Figure 5: FOMC and non-FOMC contributions to average stock returns. The annualized contributions sum to the full-sample return. The circles show ten duration bins for characteristic portfolios and the triangles show five industry bins; lines are fitted to all portfolios.

high-duration stocks.[16]

Inflation risk. The discrepancy between stocks and bonds could reflect compensation for greater inflation risk in nominal Treasuries than in stocks, although Katz et al. (2017) show that even stocks are far from "real assets." Appendix Figure A.7 shows that over 1999–2019, when TIPS returns are available, the wedge declines as strongly with duration against TIPS as against nominal Treasuries. This similarity suggests that inflation risk is not a main driver of the difference between stocks and bonds.

3.2 Dividend Strips and the Aggregate Market

At short horizons, we can compare the stock-minus-bond wedge estimates to the returns on traded dividend strips and futures. A strip has a known maturity, so its return over a matched Treasury can be measured without estimating equity duration. Binsbergen et al. (2012) construct dividend-strip returns from index options and find that short-maturity claims earn high returns relative to the market. van Binsbergen and Koijen (2017) use dividend futures, while Golez and Jackwerth (2024) extend the option-based evidence over a longer sample.

Figure 6 compares the latter two estimates with fitted wedges over the 2002–2014 sample for

[16] Adverse realizations of growth news may also have contributed to the more negative post-2000 slopes. For instance, Gormsen and Lazarus (2026) estimate that the rate decline post-2000 is in part due to declining expected growth, based on surveyed forecasts. Yet wedges already fall with duration in the 1990s, when the same forecasts show expected growth *rising* while rates still fell and Treasury returns still rose with duration.

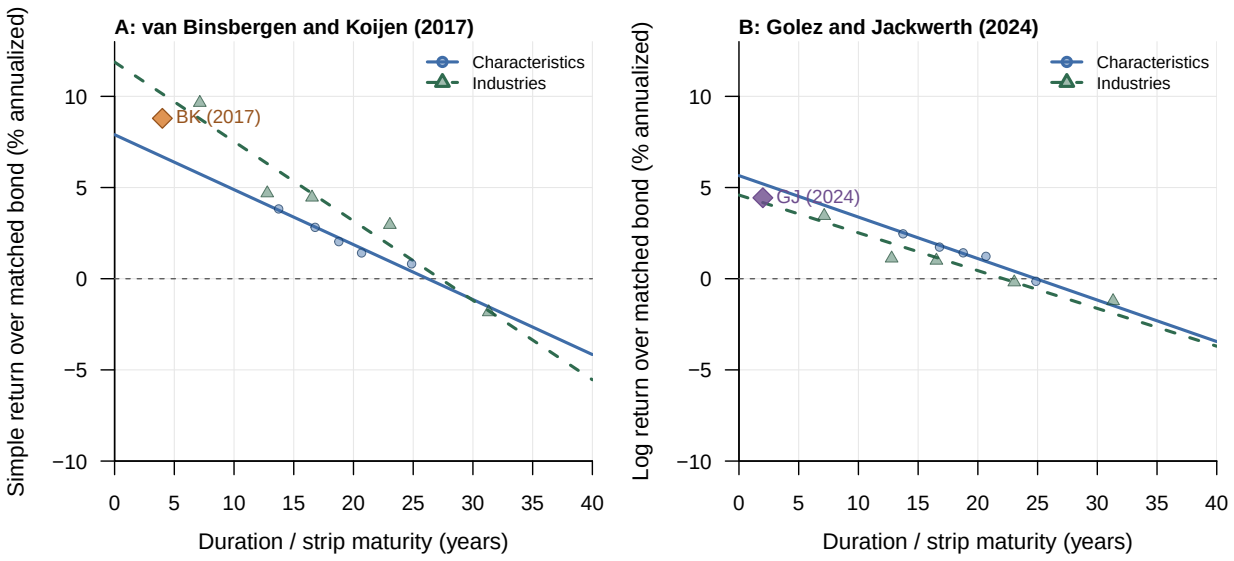


Figure 6: Dividend strips and the short end of the stock-minus-bond term structure. Panel A uses simple returns over matched bonds from van Binsbergen and Koijen (2017), November 2002–July 2014. The strip point averages maturities one through seven and is plotted at their four-year mean maturity. Panel B uses log returns over matched bonds from Golez and Jackwerth (2024), February 1996–December 2019; its point is the two-year strip return over the two-year Treasury. Equity points show five duration bins. Lines are fitted to all portfolios and exclude the strip observations.

van Binsbergen and Koijen (2017) and the overlapping 1996–2019 sample for Golez and Jackwerth (2024), using each paper's return convention.

In both panels, the strip estimate is remarkably close to the duration-based estimate, falling between the fitted values for characteristic portfolios and industries. Panel A shows the dividend-futures average of 8.8 percent in van Binsbergen and Koijen (2017) with an average maturity of four years, compared with fitted wedges of 6.7 and 10.1 percent. Panel B shows the two-year option-based estimate in Golez and Jackwerth (2024) at 4.4 percent (using their log return convention), compared with fitted wedges of 5.2 and 4.2 percent. Appendix Figure A.9 shows that my estimates are also consistent with the time-variation in the term structure of equity returns in Gormsen (2021): returns increase with duration when market D/P is high and decrease with duration when D/P is low.

Aggregate strip arithmetic. A final consistency check comes from aggregating dividend-strip returns. The aggregate stock market is the value-weighted sum of claims to dividends at all horizons. Let w_h denote the market's value weight at horizon h. Averaging the strip returns with these weights gives the market return.

Treating the horizon weights as fixed and the market's matched-Treasury return as the same

weighted average of the strips' matched-Treasury returns gives

$$\Delta_M \simeq \sum_h w_h \Delta_h.$$

The market's duration is 19.6 years and its baseline wedge is only 0.66 percent. This near-zero wedge means that applying the same portfolio weights w_h to the vastly different bond and equity term structures produces almost the same average return.

If observed short strips earn positive wedges and the aggregate wedge Δ_M is small, the remaining unobserved long strips must earn low or negative wedges. For any cutoff T, let $\Omega_{<T}$ be the share of the aggregate stock market value on strips with maturity below T, and let $\Delta_{<T}$ and $\Delta_{>T}$ denote average wedges below and above the cutoff. Under the same approximation,

$$\Delta_M \simeq \Omega_{<T}\Delta_{<T} + (1 - \Omega_{<T})\Delta_{>T}.$$

For $T = 10$ years, Knox and Vissing-Jorgensen (2022) estimate $\Omega_{<10} = 0.20$, while a 6 percent wedge $\Delta_{<10}$ gives a simple summary of the short-strip estimates. Combining these inputs with the aggregate wedge estimate $\Delta_M = 0.66\%$ gives a long-strip wedge

$$\Delta_{>10} = -0.67\%.$$

Under this approximation, the positive short-strip wedge and the near-zero market wedge imply a negative average wedge beyond ten years; Appendix Table A.4 shows that the negative sign is robust to alternative plausible values of the short-strip share $\Omega_{<10}$ and the short-strip wedge $\Delta_{<10}$.

This calculation only uses the aggregate market wedge and the two external inputs $\Omega_{<10}$ and $\Delta_{<10}$, but leads to the same conclusion as the cross-section of portfolio-level duration estimates: the wedge is negative at high durations. Ten years is still quite short relative to the market's 19.6-year duration, and the fitted wedge in Section 3.1 remains positive between 10 and 23 years. The slightly negative average beyond ten years therefore points to more negative wedges farther out in the term structure.

3.3 Decomposing Anomalies

I now use equation (8) to reexamine the returns to 55 well-known stock-market anomalies underlying the characteristic portfolios from Haddad et al. (2020). For each family f, I keep the original

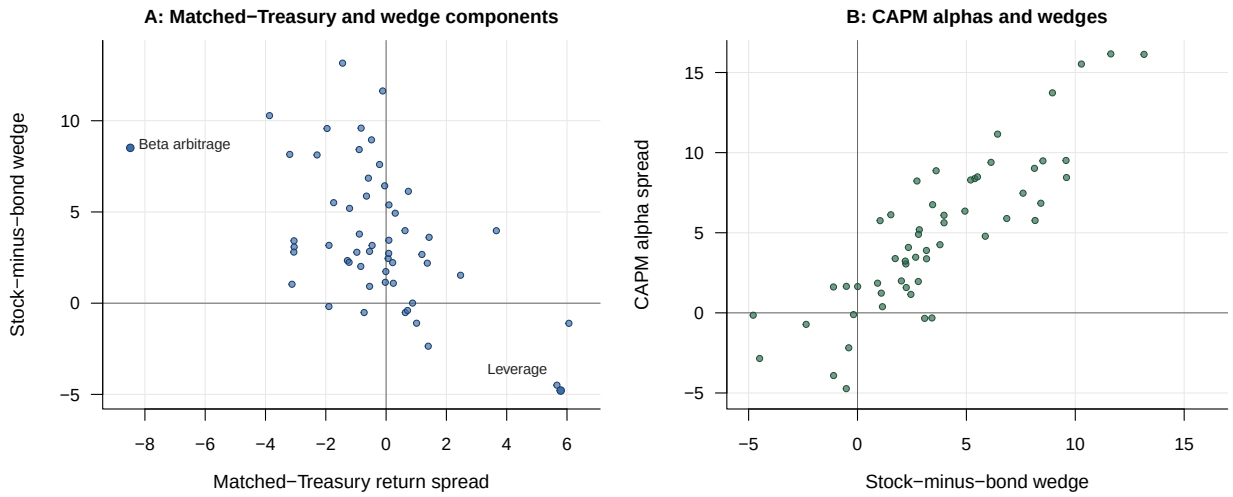


Figure 7: Decomposing anomaly premia. Each point is portfolio 10 minus portfolio 1 for one of the 55 characteristic families, retaining the original ordering. Panel A plots the matched Treasury return spread against the stock-minus-bond wedge; their sum is the raw return spread. Panel B plots CAPM alpha against the wedge. Values are annualized percentage points from January 1988 through December 2019.

ordering in Haddad et al. (2020) and form spreads that are long portfolio 10 and short portfolio 1:

$$\bar{r}_{f,10} - \bar{r}_{f,1} = \left[\bar{r}^B(d_{f,10}) - \bar{r}^B(d_{f,1})\right] + \left(\Delta_{f,10} - \Delta_{f,1}\right).$$

In my 1988–2019 sample, the raw spread is positive for 49 of the 55 families in Figure 7. The wedge spread is positive for 46 families, hence most spreads remain positive after adjusting for duration differences between the long and short legs.

Some explanations for the value premium start from growth having longer-dated cash flows. However, the FOMC responses do not show a correspondingly large difference in rate sensitivity. Growth and value have very similar FOMC betas and hence durations in both D/P and B/M portfolios. Their durations are 23.7 and 21.6 years for growth and value in D/P, and 18.8 and 22.1 years in B/M. For D/P, the matched-Treasury spread between value and growth is slightly negative at −0.5 percentage points per year, so the 2.3-pp. value premium corresponds to a 2.8-pp. wedge. A large duration gap, as implied by valuation-based durations, would have given growth a much larger windfall from falling rates, so in this respect the small differences in rate sensitivity that I find using FOMC responses help make value's outperformance over 1988–2019 less puzzling.

A small raw return spread can mask large matched-bond and wedge components offsetting each other. Figure 7 highlights two extremes, the leverage and beta arbitrage anomalies with raw spreads of only 1.00% and 0.03% per year, respectively. For leverage (high minus low total assets relative to market equity), the 18-year duration difference corresponds to a 5.79% matched-

Treasury spread and a −4.79% wedge. For beta arbitrage (low minus high market beta, estimated from daily returns over the previous five years), the −27-year duration difference corresponds to a −8.48% matched-Treasury spread and an 8.51% wedge. Despite their similarly small raw returns, the leverage and beta arbitrage CAPM alpha spreads are −0.15% and 9.5%.

3.4 The CAPM as an Implicit Duration Adjustment

The decomposition (8) provides a new perspective on CAPM alphas. The CAPM benchmarks an asset against a portfolio of the market and T-bills with the same market beta, whereas the wedge benchmarks it against a Treasury portfolio with the same duration. Because the market itself has duration exposure, subtracting the market excess return scaled by market beta removes part of the asset's duration exposure. CAPM alpha therefore embeds an implicit but imperfect duration adjustment and can approximate the stock-minus-bond wedge even when the CAPM does not hold.

To see this, let $B(d) \equiv \mathbf{E}r^B(d)$ denote the excess return on a matched Treasury with duration d. Then the CAPM alpha satisfies

$$\alpha_j^{Mkt} = \Delta_j + \left[B(d_j) - \beta_j^{Mkt} B(d_M)\right] - \beta_j^{Mkt} \Delta_M, \tag{9}$$

where β_j^{Mkt} is market beta. The market wedge is only 0.66 percent in this sample, so CAPM alpha is approximately the wedge plus the bracketed term.

The bracketed term $B(d_j) - \beta_j^{Mkt} B(d_M)$ can be viewed as a *duration benchmark error*: it compares the return on the asset's matched Treasury with the return on the market's matched Treasury scaled by β_j^{Mkt}. In Section 2.2's notation, if x^R (i.e., rate news orthogonal to payoff news) were the only common shock, market beta would equal d_j/d_M exactly. The CAPM would then scale the market return in proportion to duration. Alpha would equal the wedge if the market wedge were zero and Treasury returns were proportional to duration. Once common payoff shocks also enter market beta, market beta mixes rate exposure, which is proportional to duration, with payoff exposure, which need not be.

Figure 7, Panel B, reports a correlation of 0.86 between CAPM alphas and wedge spreads. Duration and market beta do not line up nearly as closely: their correlations are 0.49 across characteristic portfolios and 0.28 across industries. Instead, (9) explains why the correlation between alphas and wedges is so high: the duration benchmark error varies less than the wedge and is nearly uncorrelated with it.

Equation (9) also helps explain why previous work finds that the negative relation between returns and duration is more pronounced in CAPM alphas than in raw returns (Weber, 2018;

Gonçalves, 2021; Gormsen and Lazarus, 2023). Appendix Table A.3 reproduces this finding: a regression of CAPM alpha on duration gives an estimate of −0.179, while raw returns are flat in duration. Controlling for the wedge Δ_j, however, gives a coefficient close to 1 on the wedge and changes the sign of the duration coefficient, now equal to 0.156. Equation (9) sheds light on this sign reversal. The average duration mismatch $d_j - \beta_j^{Mkt} d_M$ is small (−0.4 years for characteristics and −1 year for industries) because market duration is close to the average portfolio duration and most market betas are near one. But in the cross-section, Appendix Figure A.5 shows that $\beta_j^{Mkt} d_M$ rises by only 0.40 years for each additional year of duration. The duration adjustment implicit in the CAPM is therefore too large for short-duration stocks and too small for long-duration stocks. The wedge falls with duration by more than the benchmark error rises. This is why CAPM alpha falls with duration on its own, but rises once the wedge is held fixed.

4 A Model of Rate Insurance and Risk Premia

As duration rises, both the matched Treasury and payoff components of stock returns become more volatile, but their covariance becomes increasingly negative, so equity volatility rises far less than Treasury volatility. Treasury returns also rise sharply with duration, while equity returns over matched Treasuries fall and turn negative at the long end. Interpreted as expected returns, long Treasuries require more compensation than stocks with the same duration, even though the stocks also bear payoff risk.

In this section, I develop a simple model of rate risk and rate insurance in incomplete markets. The goal is to propose a mechanism for the empirical patterns and draw implications for bond and equity premia, rather than to provide a full quantitative calibration.

4.1 Resale Value Risk in Incomplete Markets

There are overlapping generations (OLG) of investors. Each cohort lives for two periods, buys long-lived assets when young and resells them when old. Current investors are exposed to future news that affects the value at which they can sell to future investors, who will face the same risk themselves when selling to the next generation, and so on. This market structure implies that long-run news can be priced even with time-separable preferences. The same resale risk arises in richer models when investors cannot fully insure the price at which they may have to sell. Appendix B.2 details the trade between cohorts.

Return system. To simplify the rate side, I consider only parallel shifts in Treasury yields, so a Treasury with duration d earns $r^B(d) = d \cdot x$. Bond prices depend on expected short rates and

compensation for risk. Changes in those prices give the Treasury returns summarized by x. Under this approximation, dividing any Treasury return by its duration gives x, so an asset has the same Treasury beta with respect to its own matched Treasury or to a common 10-year Treasury. In the data, β_j^x and β_j^{10Y} have a correlation of 0.970 across the 510 characteristic portfolios. Denote the term premium per unit of duration $\tau_B \equiv \mathbf{E}[x]$.

Payoff news can have several dimensions, indexed by k. The duration-normalized Treasury return innovation, which corresponds to minus the parallel change in yields, is (omitting time subscripts)

$$\widetilde{x} \equiv x - \tau_B = x^R - \sum_k \phi_k \varepsilon^k. \tag{10}$$

Here x^R is the Treasury return from rate news orthogonal to payoff news, while ε^k indexes payoff-news innovations, with the convention that a positive realization captures good aggregate payoff news. The innovations are mutually orthogonal, with variances σ_R^2 and σ_k^2, hence $\mathrm{Var}(x) = \sigma_R^2 + \sum_k \phi_k^2 \sigma_k^2$.

The coefficients ϕ_k describe the equilibrium response of Treasury yields to payoff news. If $\phi_k = 0$, rates are decoupled from payoff news ε^k. A positive ϕ_k means that good news ε^k raises Treasury yields and thus lowers Treasury prices. Appendix B.3 considers a shock to expected growth in consumption and dividends and derives its effect on Treasury yields at each maturity under a Taylor rule that responds to the output gap. The yield response ϕ is larger when the shock is more persistent, the central bank is more reactive, and when the EIS is lower. In the limit of permanent shocks, ϕ converges to the inverse EIS.

Asset j's return can be decomposed as

$$r_j = d_j x + \delta_j, \tag{11}$$

with wedge $\Delta_j \equiv \mathbf{E}[\delta_j]$ and

$$\widetilde{\delta_j} \equiv \delta_j - \Delta_j = \sum_k \theta_{j,k} \varepsilon^k.$$

Thus δ_j is the realized return over the matched Treasury, Δ_j is its mean, and $\theta_{j,k}$ is its loading on news k. For an asset sold before maturity, this loading can include the response of its resale value. Treasuries correspond to the special case $\delta_j = 0$. As in Section 2, define the Treasury beta $\beta_j^x \equiv \frac{\mathrm{Cov}(r_j,x)}{\mathrm{Var}(x)}$ and rate insurance $\chi_j \equiv d_j - \beta_j^x = -\frac{\mathrm{Cov}(\delta_j,x)}{\mathrm{Var}(x)}$.

Combining (10) and (11) gives the asset's response to each shock:

$$\widetilde{r_j} \equiv r_j - \mathbf{E}r_j = d_j x^R + \sum_k \underbrace{(\theta_{j,k} - d_j \phi_k)}_{\equiv \Theta_{j,k}} \varepsilon^k. \tag{12}$$

The net loading $\Theta_{j,k}$ combines asset j's direct exposure to payoff news k with the revaluation $-d_j\phi_k$ from the accompanying rate movement. The product $d_j\phi_k$ gives the magnitude of the rate-induced response: ϕ_k measures how payoff news moves rates, while d_j scales the resulting capital gain or loss. When bad payoff news and lower rates occur together, the Treasury component helps offset the direct payoff loss. For $\theta_{j,k} > 0$, the offset is partial when $0 < d_j\phi_k < \theta_{j,k}$, but a strong enough capital gain can even change the sign of the asset's return response when $d_j\phi_k > \theta_{j,k}$. A Treasury has $\theta_{j,k} = 0$ and therefore $\Theta_{j,k} = -d_j\phi_k$. For any other asset, $\theta_{j,k} = \Theta_{j,k} + d_j\phi_k$ is its loading relative to the matched Treasury.[17]

Stochastic discount factor and risk prices. Expected returns depend on how the shocks affect current investors' consumption. Let C_{t+1} denote the date-t cohort's consumption after it sells its assets to the date-$t+1$ cohort, $\bar{C}$ its deterministic component, and $\widetilde{C}_{t+1} \equiv C_{t+1} - \bar{C}$.[18] To first order,

$$\widetilde{C}_{t+1} = \mathcal{D}\widetilde{x}_{t+1} + \sum_k a_k \varepsilon^k_{t+1} \tag{13}$$

where

$$\mathcal{D} \equiv \frac{\partial C_{t+1}}{\partial x_{t+1}}, \qquad a_k \equiv \frac{\partial C_{t+1}}{\partial \varepsilon^k_{t+1}}.$$

The first derivative holds payoff news $\{\varepsilon^k_{t+1}\}$ fixed, and the second holds the Treasury return x_{t+1} fixed. $\mathcal{D}$ is the cohort's *net dollar duration*, while a_k is the direct exposure to payoff news k. Durations d_j are measured in years, while net dollar duration $\mathcal{D}$ is measured in dollar-years. The term $\mathcal{D}\widetilde{x}$ is thus the net wealth gain or loss from interest rate changes.

Substituting (10) into (13) gives the response of consumption to the underlying shocks:

$$\widetilde{C}_{t+1} = \mathcal{D}x^R + \sum_k \big(a_k - \phi_k\mathcal{D}\big)\varepsilon^k. \tag{14}$$

Payoff news k changes consumption by $a_k - \phi_k\mathcal{D}$: a_k is the direct effect holding the Treasury return fixed, while $-\phi_k\mathcal{D}$ is the revaluation of net duration. $\Theta_{j,k}$ is the response of one asset to news k. Adding these responses across the cohort's positions, together with any direct effect on its consumption outside the portfolio, gives $a_k - \phi_k\mathcal{D}$.

Let γ denote relative risk aversion.[19] Since $t+1$ is the cohort's terminal consumption date,

[17] Thus the model could be rewritten in more abstract notation as starting from shock loadings d_j, $\{\Theta_{j,k}\}_k$ for each asset j (including Treasuries, whose loadings can be used to define ϕ_k). I use the more intuitive but equivalent formulation (11)-(12).

[18] The cohort also consumes at t. That consumption is known at the pricing date, so it affects the level of the SDF but not its date-$t+1$ innovation. Appendix B.2 gives the Euler equation with both consumption dates.

[19] Appendix B.2 uses Epstein-Zin preferences that separate risk aversion γ from the EIS ψ, which may enter the coefficients ϕ_k. Expected utility with CRRA is obtained when $\gamma = 1/\psi$. With recursive preferences and a remaining

its normalized one-period SDF is, to first order,

$$\frac{M_{t+1}}{\bar{M}} = 1 - \frac{\gamma}{\bar{C}}\widetilde{C}_{t+1} = 1 - \lambda_R x^R - \sum_k \lambda_k \epsilon^k.$$

Appendix B.2 gives the underlying Euler equations. We can then solve for the risk prices λ_R, λ_k as follows.

Proposition 2 (Risk premia)**.** *Risk prices are given by*

$$\lambda_R = \gamma \frac{\mathcal{D}}{\bar{C}}, \qquad \lambda_k = \gamma \frac{a_k - \phi_k \mathcal{D}}{\bar{C}}.$$

Denote $\Lambda_R = \lambda_R \sigma_R^2$ and $\Lambda_k = \lambda_k \sigma_k^2$ for each k. Expected returns are given by

$$\bar{r}_j = d_j \tau_B + \Delta_j$$

where

$$\tau_B = \Lambda_R - \sum_k \phi_k \Lambda_k$$

is the term premium per year of duration, and the stock-minus-bond wedge (equal to zero for Treasuries) is

$$\Delta_j = \sum_k \theta_{j,k} \Lambda_k$$

and satisfies

$$\Delta_j = \underbrace{\frac{\gamma}{\bar{C}} \sum_k \theta_{j,k} a_k \sigma_k^2}_{\text{direct payoff compensation}} \underbrace{- \chi_j \, \mathcal{D} \, \frac{\gamma \mathrm{Var}(x)}{\bar{C}}}_{\text{hedging value}} \tag{15}$$

The first term in (15) is the compensation for the payoff component's covariance with consumption changes holding the Treasury return fixed. These consumption changes include gains and losses on assets current investors already hold. The second term is the value of its hedge against the revaluation of net duration $\mathcal{D}$.

4.2 Stocks Hedge Bonds

When $\chi_j > 0$, the Treasury component of a positive-duration asset hedges its payoff component, even if its owner holds no separate bonds. If current investors bear positive net duration $\mathcal{D} > 0$,

horizon beyond $t + 1$, continuation-value news would also enter the SDF directly. Here, resale value risk already allows long-run news to enter the SDF even with separable preferences.

the roles reverse: the payoff component δ_j hedges their net duration exposure. The corresponding covariance offsets thus scale with $d_j \chi_j \text{Var}(x)$ and $\mathcal{D}\chi_j \text{Var}(x)$, respectively. The asset's own duration d_j scales the hedge within the asset, while $\mathcal{D}$ scales the payoff component's value as a hedge against investors' net duration.

Risk-parity strategies, which set leverage using the variance of the whole portfolio, give one practical example of this symmetry. With a negative covariance, stocks reduce the risk of the bond position just as bonds reduce the risk of the stock position.

When do long stocks earn even less than long bonds? To interpret the term structure evidence in Section 3, let us specialize payoff news to two shocks with different horizons: news about short-run S and long-run L payoffs. Long-run (e.g., growth) news L has a negative price if and only if the loss on net duration, $\phi_L \mathcal{D}$, exceeds the direct gain a_L holding the Treasury return fixed:

$$\lambda_L < 0 \quad \Longleftrightarrow \quad \phi_L \mathcal{D} > a_L.$$

The evidence on returns points to different prices across horizons: wedges are positive at the short end and negative at the long end. I represent these point estimates with $\lambda_S > 0 > \lambda_L$. When $\phi_S, \phi_L > 0$, this sign pattern obtains if and only if

$$\frac{a_L}{\phi_L} < \mathcal{D} < \frac{a_S}{\phi_S}. \tag{16}$$

Within the interval (16), the two prices have opposite signs. In that case, good long-run news can raise future equity payoffs yet lower the current holder's consumption. This reverses the usual long-run-risk logic, in which bad long-run news raises marginal utility and bond prices, so bonds provide a hedge (Bansal and Yaron, 2004; Campbell, 2018).[20]

When $a_S, a_L > 0$, the ordering $a_L/\phi_L < a_S/\phi_S$ matters even when both risk prices are positive. For $\mathcal{D} > 0$, we have

$$\frac{\lambda_L}{a_L} - \frac{\lambda_S}{a_S} = -\frac{\gamma \mathcal{D}}{\bar{C}} \left(\frac{\phi_L}{a_L} - \frac{\phi_S}{a_S} \right) < 0.$$

Thus long-run news has a lower price per unit of its direct effect on consumption and is the first to become negatively priced as $\mathcal{D}$ rises. The same ordering then implies $\lambda_L/\phi_L < \lambda_S/\phi_S$, so that for a fixed amount of rate insurance, replacing short-run with long-run exposure therefore lowers the wedge even when $\lambda_L > 0$.

Appendix B.3 shows how the ordering $a_L/\phi_L < a_S/\phi_S$ arises naturally when the central bank sets the short rate according to a Taylor rule that responds to the output gap. A more persistent

[20] Displacement provides a complementary route: innovation can erode older workers' human capital and the value of assets in place enough to make $a_L < 0$, while growth opportunities hedge the loss (Gârleanu et al., 2012). The duration channel can make the price negative even when $a_L > 0$.

shock raises expected future short rates for longer, so the resulting increase in long rates offsets a larger share of the direct gain. This makes the ratio a/ϕ decreasing in shock persistence, which generalizes the distinction between short-run and long-run news.

With $\phi_L > 0$ and $\lambda_L < 0$, good long-run news contributes positively (by $-\phi_L \Lambda_L > 0$) to the bond premium. The payoff component rises in the same state, so its marginal effect on the wedge at fixed duration and risk prices is

$$\frac{\partial \Delta_j}{\partial \theta_{j,L}} = \Lambda_L < 0. \tag{17}$$

Thus greater long-run payoff exposure lowers the return over the matched bond.[21]

Holding an asset's payoff exposure fixed, a one-year increase in duration raises its expected return by the term premium τ_B. But across assets, average payoff exposures and therefore wedges Δ also vary with duration, and the total effect of a marginal increase in duration is $\tau_B + \Delta'(d)$. Section 3 shows that the two terms τ_B and Δ' offset each other in the data: the matched-Treasury and Δ slopes are around 0.3 and -0.3 percentage points per duration-year, leaving raw returns approximately flat in duration.

Long-run payoff exposure enters both the variance decomposition and expected returns: with $\phi_L, \theta_{j,L} > 0$, the matched Treasury and payoff component respond in opposite directions, while with $\Lambda_L < 0$, greater exposure lowers the expected wedge. If exposure to long-run news rises with duration, as it would across dividend strips, this connects the growing covariance offset in Figure 3 to the declining wedge in Figure 4.

Ricardian non-equivalence and net duration. So far I have left the sources of a_L and $\mathcal{D}$ implicit, so that Proposition 2 can apply to a broad range of environments. In the specialization below, equity contributes to both, but government debt can add to $\mathcal{D}$ without adding to a_L. When current holders do not fully internalize the future taxes backing their bondholdings and bonds have duration, bonds become not just net wealth, but *risky net wealth.*

Let V_M and V_G denote the market values of equity and government bonds held by the cohort, and let d_M and d_G denote their durations. Let η denote the share of government-bond dollar duration not offset by taxes borne by the current cohort. In this specialization, net dollar duration is

$$\mathcal{D} = d_M V_M + \eta d_G V_G. \tag{18}$$

Under Ricardian equivalence, $\eta = 0$: when rates rise, the capital loss on the bonds is offset by a

[21] Lettau and Wachter (2007; 2011) obtain these opposing slopes through separate forces. The equity term structure slopes down because of mean reversion: negative shocks to current dividends come with higher dividend growth going forward, which reduces long equity's exposure to the priced current-dividend risk. The bond term structure slopes up because rate and inflation shocks make long bonds risky, also implying a positive stock-bond covariance.

fall in the present value of the taxes backing them.

A positive η can arise from liquidity constraints, weak bequest motives, or beliefs about future taxes. Even under rational expectations, current bondholders may correctly expect future generations to pay some of the taxes backing the debt they hold. Recent empirical work finds direct evidence of "non-Ricardian" household behavior. Adams and Matthes (2026) estimate that households internalize only one-fifth of future taxes, consistent with incomplete fiscal consolidation, while Eichenbaum et al. (2026) find that households largely ignore the future taxes implied by aggregate transfers when planning their spending.

The condition $\phi_L \mathcal{D} > a_L$ compares the loss on the cohort's duration holdings with its direct gain from the same news. The two sides need not be independent: the timing of dividends can affect both d_M and equity's contribution to a_L. For instance, consider the permanent limit of the persistent expected-growth process in Bansal and Yaron (2004), normalized so that expected log dividend growth rises by one percentage point in every future year. The definition of a_L holds the Treasury return fixed; here I also hold other components of strip discount rates fixed. The expected dividend h years ahead, and the value of that strip, then rise by approximately h percent. Its duration under a parallel shift in Treasury yields is also h, so its exposure to the growth shock per dollar of value equals its duration. If equity is the cohort's only direct exposure, aggregating across strips gives

$$a_L = d_M V_M. \tag{19}$$

This special case leads to a transparent characterization of the price of long-run risk:

Proposition 3 (Government debt and long-run risk)**.** *Suppose* (19) *holds and* $d_M V_M > 0$*. The price of long-run payoff risk is*

$$\lambda_L = \frac{\gamma}{\bar{C}} \left[(1 - \phi_L) d_M V_M - \phi_L \eta d_G V_G \right].$$

It is negative if and only if

$$\phi_L \left(1 + \frac{\eta d_G V_G}{d_M V_M} \right) > 1. \tag{20}$$

If $\phi_L = 1$*, then Ricardian equivalence* $\eta = 0$ *implies* $\lambda_L = 0$*, whereas any positive net duration from government bonds,* $\eta d_G V_G > 0$*, gives*

$$\lambda_L = -\gamma \frac{\eta d_G V_G}{\bar{C}} < 0.$$

Under (19), Ricardian consolidation gives $\lambda_L > 0$ when $\phi_L < 1$ and $\lambda_L < 0$ when $\phi_L > 1$. When $0 < \phi_L < 1$, sufficiently large net government-bond duration implies $\lambda_L < 0$ even though good news raises equity value.

More generally, $\mathcal{D}$ sums dollar-duration exposure across all assets and liabilities. The key

variation across asset classes is that loadings $\Theta_{j,L} = \theta_{j,L} - d_j\phi_L$ vary from clearly negative for bonds ($\Theta_{j,L} = -d_j\phi_L$) to positive for stocks (under the usual assumption that good growth news is good). Corporate bonds and housing have payoff exposure as well as duration, and lie somewhere between bonds and stocks.

Positive bond premia despite negative stock-bond covariance. Once some duration lies outside the stock market, a bond that hedges stocks need not hedge marginal utility. Recall that

$$\tau_B = \Lambda_R - \phi_S\Lambda_S - \phi_L\Lambda_L.$$

The short-run term is the familiar hedging force: when $\phi_S, \Lambda_S > 0$, bonds rise after bad short-run news and $-\phi_S\Lambda_S < 0$. Pure rate news contributes $\Lambda_R > 0$ when $\mathcal{D} > 0$. Long-run news also contributes positively when $\phi_L > 0 > \Lambda_L$, because bonds lose when marginal utility is high.

Let r_M denote the stock-market return (using $j = M$ for the aggregate stock market). The term premium is governed by $-\mathrm{Cov}(M, x)$. The stock-bond covariance, or equivalently

$$\mathrm{Cov}(x, r_M) = d_M\sigma_R^2 - \sum_k \phi_k\Theta_{M,k}\sigma_k^2, \tag{21}$$

contains the same information only if the stock market spans the SDF. If pure rate news were the only shock, stocks and bonds would move together and the bond premium would be positive when $\mathcal{D} > 0$. If a payoff shock with $\phi_k, \Theta_{M,k} > 0$ dominated instead, stocks and bonds would move in opposite directions; but whether that shock raises or lowers the bond premium depends on the sign of Λ_k.

Proposition 4 (Stock–bond covariance and the term premium)**.** *Under* (18)*, suppose the cohort's exposure to each payoff shock comes through the stock market, so that $a_k = \theta_{M,k}V_M$ for every k. Then the term premium is*

$$\tau_B = \frac{\gamma}{C}\left[V_M\mathrm{Cov}(x, r_M) + \eta d_G V_G \mathrm{Var}(x)\right].$$

Under Ricardian equivalence ($\eta = 0$), the term premium and the stock-bond covariance $\mathrm{Cov}(x, r_M)$ *always have the same sign. Otherwise, the term premium τ_B can be positive in spite of a negative stock-bond covariance if*

$$\eta d_G V_G > \frac{-\mathrm{Cov}(x, r_M)}{\mathrm{Var}(x)} V_M.$$

Between 2000 and 2019, long Treasuries had negative betas to CRSP but positive average excess returns that rose with maturity. The maturity slope was at least as large as between 1988 and 1999, when the stock-bond covariance was positive.[22] In the model, a negative stock-bond

[22] In 2000–2019, the 10-year Treasury's beta to CRSP was −0.18 and its average annualized excess return was 5.99

covariance and a positive bond premium can coexist if the stock market is not the entire wealth portfolio. This is an example of Roll's (1977) critique where duration is the missing risk exposure: using CRSP as a proxy for the market portfolio already excludes traded bonds and other non-stock assets whose net duration matters for marginal utility. Long bonds can comove negatively with stocks and still be risky for investors whose broader portfolios lose when rates rise, because the bonds also lose when marginal utility is high. Long-duration equities can then earn less than matched Treasuries because their payoffs hedge the Treasury losses associated with long-run news. Expected Treasury excess returns can therefore be positive and increasing in maturity even when Treasuries hedge stocks.

4.3 Fiscal and Monetary Policy

Fiscal policy changes the net duration investors bear, while monetary policy changes how rates respond to payoff news. Both therefore affect bond and equity premia.

Government debt. When Ricardian equivalence does not hold, debt that will be repaid partly by future generations is net wealth for current investors. Issuing more debt or extending its maturity therefore raises $\mathcal{D}$. Purchases of long Treasuries by the central bank can reduce $\mathcal{D}$ when reserves replace those bonds in investors' portfolios.

Suppose, for instance, the government issues a perpetuity that pays one unit each period. Each cohort buys the entire outstanding perpetuity from the previous cohort, but pays only the tax financing the current coupon. Each cohort therefore bears the rate risk on the entire resale value. In this sense, interest rate risk is not a fixed quantity shared across generations: moving to a regime with permanently higher government debt increases the risk borne by *every* generation rather than shifting a given amount of risk from one generation to another.

Holding the other terms in Proposition 2 fixed, the effect of net dollar duration is:

$$\frac{\partial}{\partial \mathcal{D}} \begin{pmatrix} \tau_B \\ \Delta_j \\ \mathbf{E}r_j \end{pmatrix} = \frac{\gamma \mathrm{Var}(x)}{\bar{C}} \begin{pmatrix} 1 \\ -\chi_j \\ d_j - \chi_j \end{pmatrix}. \tag{22}$$

The relevant scale is $\mathcal{D}/\bar{C}$, net dollar duration relative to baseline consumption. More net duration raises the bond premium and lowers the wedge for assets with $\chi_j > 0$. Its effect on the raw premium has the sign of $\beta_j^x = d_j - \chi_j$.

percent; in 1988–1999, they were 0.23 and 4.94 percent. Across maturities 1 through 10 years, average excess returns in the two periods rose by 0.61 and 0.43 percentage points per year of maturity, respectively.

Using complementary measures of fiscal news, Wiegand (2026) and Gomez Cram et al. (2024) find that larger expected deficits lower Treasury prices. Wiegand (2026) further finds that the estimated term-premium response rises with maturity and that, at ten years, about two-thirds of the nominal-yield response appears in TIPS rates.

Besides government debt issuance, the level of interest rates and payout policies can also change net dollar duration. Lower rates raise the value and, when payouts are dispersed, the duration of a fixed positive cash-flow stream. Corporate financial policy can move equity duration independently of rates. For instance, Golez and Koudijs (2025) document a post-1945 increase in plowback ratios that lengthened equity duration.

Central bank reaction function. The monetary regime affects the ϕ_k coefficients, which govern how rates respond to payoff news. I focus here on ϕ_S, the response of long rates to short-run payoff news, because it is most directly tied to the central bank's reaction to current conditions. Clarida et al. (2000) estimate that after 1979 the Fed responded much more strongly to expected inflation and the output gap. Cieslak and Vissing-Jorgensen (2021) show that, since the mid-1990s, the Fed has eased after declines in the stock market as its growth outlook deteriorated. Bernanke (2013) described this as an "*automatic stabilizer*," stating that "*interest rates should fall and asset prices should rise*." Bauer and Swanson (2023) estimate that the Fed became more responsive to both inflation and real activity over the past three decades.

An increase in ϕ_S affects bond and equity risk premia through

$$\frac{\partial \lambda_S}{\partial \phi_S} = -\frac{\gamma \mathcal{D}}{\bar{C}}, \qquad \frac{\partial \tau_B}{\partial \phi_S} = \frac{\gamma \sigma_S^2}{\bar{C}} \left(2\phi_S \mathcal{D} - a_S\right).$$

A higher ϕ_S has two opposing effects on τ_B. When $\lambda_S > 0$, Treasuries fall more after good short-run news, strengthening their hedge against bad news and lowering the premium. But when $\mathcal{D} > 0$, the same increase in ϕ_S lowers λ_S, reducing the value of that hedge and raising the premium. The bond premium rises when $2\phi_S \mathcal{D} > a_S$ and falls when the inequality is reversed.

With $\mathcal{D} > 0$, a larger ϕ_S lowers the wedge Δ_j for stocks with $\theta_{j,S} > 0$. The expected return over bills also includes the term premium on the stock's Treasury component $d_j \tau_B$, whose response can have either sign. A larger ϕ_S therefore lowers the equity premium over a duration-matched Treasury, while its effect on the premium over bills is ambiguous.

5 Rate Insurance and the Cross-Section of Returns

In this section, I study the framework's implications for the cross section of stock and bond returns. Rate insurance and the negative price of long-run risk provide a new interpretation of

well-known equity anomalies and help explain the evolution of anomaly premia, in particular the sharp reversal in the value premium after the GFC.

5.1 The MIX-RIP Factor Model

The model suggests two traded factors.

Since bonds and other non-stock positions, omitted from a stock-only market portfolio such as CRSP, enter net duration $\mathcal{D}$, I replace the usual CRSP market portfolio with a "Mixed Market Portfolio" (MIX), an equal-weighted portfolio of CRSP and the 10-year Treasury. This serves as a simple proxy for the net positions outside the stock market, including government bonds, corporate bonds, and mortgage-backed securities.

The second factor is the "Rate Insurance Portfolio" (RIP), which compares high- and low-χ portfolios with similar durations, motivated by the relation between rate insurance and the wedge. In the model, both depend on the same payoff exposures $\theta_{j,k}$, only weighted differently:

$$\chi_j = \sum_k \theta_{j,k}\, \phi_k\, \sigma_k^2 / \mathrm{Var}(x), \tag{23}$$

$$\Delta_j = \sum_k \theta_{j,k}\, \lambda_k\, \sigma_k^2. \tag{24}$$

Rate insurance χ_j weights exposures $\theta_{j,k}$ by the responses of rates to payoff news ϕ_k, whereas Δ_j weights exposures by the risk prices λ_k.

I construct RIP from the 510 characteristic portfolios. To disentangle duration from rate insurance, I assign each portfolio to one of ten duration bins. Given the short FOMC sample, I use durations estimated over the full sample rather than on a rolling basis, so RIP is not implementable in real time. Each June, I estimate the Treasury beta β_j^x from the preceding five years of daily returns and set $\chi_j = d_j - \beta_j^x$. Within each duration bin, I sort portfolios on χ_j, subtract each portfolio's own matched Treasury, and form the high-minus-low spread, which I then average across bins. This construction keeps the sort from simply buying long-duration stocks. RIP is designed to have zero duration and positive rate insurance, hence a negative Treasury beta.

In the two-shock model, (23) implies that high χ_j can reflect greater exposure to S, to L, or both. RIP has positive χ by construction and earns a negative average return. Given $\phi_S, \phi_L > 0$ and $\lambda_L < 0 < \lambda_S$, this is consistent with the high-χ leg having greater exposure to L, whereas RIP would earn a positive premium if the variation in χ came from exposure to S instead.[23]

[23] RIP could have a negative expected premium even when $\lambda_L > 0$, if $\lambda_L/\phi_L < \lambda_S/\phi_S$ and the high-χ portfolio has more L exposure but sufficiently less S exposure than the low-χ portfolio.

Exposure to long-run growth news. Long-run growth forecasts from the Survey of Professional Forecasters (SPF) suggest that the high-χ portfolios used to construct RIP indeed capture stronger exposure to long-run news. Each year, the first-quarter SPF reports the mean forecast of real GDP and labor productivity growth averaged over the current year and the next nine years. I define a long-run growth revision as the change from the preceding first-quarter survey and sum daily simple excess returns from the preceding survey deadline to the current one. Within each of the ten duration bins used to construct RIP, I subtract each portfolio's own matched Treasury and sort on χ. Appendix Figure A.10 shows that across five buckets with increasing χ, the return response becomes more positive for both forecasts.

RIP loadings. For equities, I use as test assets the Fama-French 49 industry portfolios, which do not enter the construction of the RIP factor. In daily regressions on MIX and RIP, Chips, Coal, Hardware, and Steel have the largest RIP loadings, while negative loadings are concentrated in Beer, Smoke, Food, Household Products, Soda, Utilities, and Drugs.

Duration alone cannot account for this pattern. Across the 49 industries, duration and the RIP loading have a correlation of only 0.23. Food and Chips have almost identical durations, 12.06 and 12.42 years, but RIP loadings of -0.84 and 3.88. Gold has by far the longest duration among the 49 industries, 43.75 years, yet its RIP loading is only 0.81, below the industry median of 1.37.

Pricing stocks and bonds. We can now ask how well MIX and RIP account for average returns across industries and the Treasury term structure. I estimate each asset's factor loadings using daily returns and multiply them by the factors' sample average excess returns. The left panel of Figure 8 plots average excess returns against their model-implied values for 49 Fama-French industries and 30 Treasury maturities. The middle panel shows the Fama-French 5-factor model, and the right panel adds the TERM bond factor in Fama and French (1993), using the 10-year zero-coupon Treasury excess return.

On the FF49 industries, the MIX + RIP model has a mean absolute alpha of 1.62%, around half of the 3.16% value under the FF5 model. Regressing average excess returns on model-implied excess returns gives a slope of 0.75, compared with -0.21 under FF5. Table 1 reports the same three specifications together with the CAPM (i.e., a single CRSP factor), MIX, and CRSP + RIP.

Adding TERM to FF5 mechanically improves the bond fit since Treasuries of different maturities can load on the 10-year Treasury and returns are approximately linear in maturity. However, the industry cross-section is essentially unchanged. The mean absolute alpha and slope across industries remain at 3.10 and -0.20.

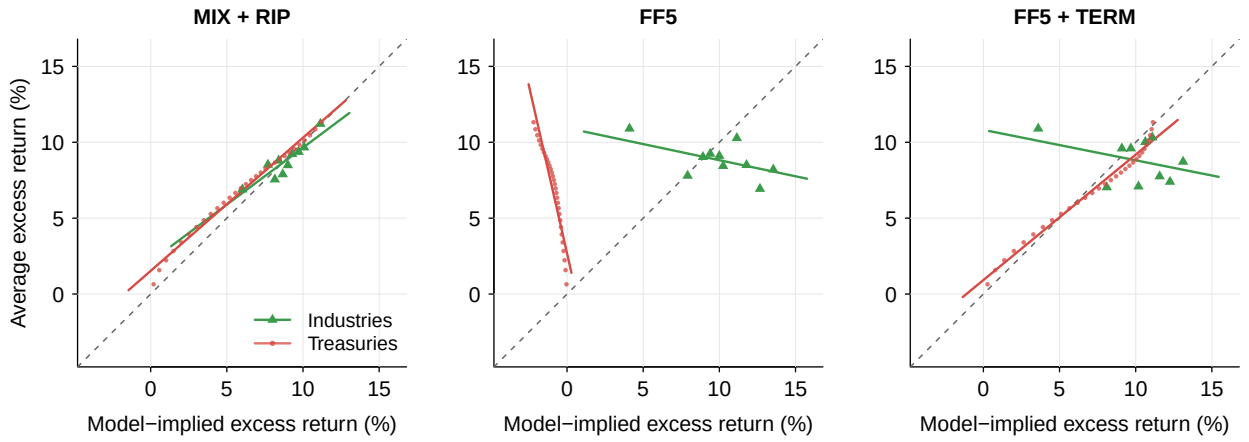


Figure 8: Factor pricing with MIX and RIP. The panels use MIX + RIP, FF5, and FF5 + TERM. Green triangles are ten bins of the 49 industries formed by fitted excess return; red circles are the 30 Treasury maturities. Solid lines are fitted to the individual assets, and the dashed line is the 45-degree line. RIP is constructed from characteristic portfolios, which are not among the test assets.

This closely reproduces the cross-sectional result in Fama and French (1993). Conventional TERM exposure contains little cross-sectional information about stocks, with or without the stock factors: the standard deviation of TERM loadings is 0.077 both when TERM and DEF are used alone (their Table 3) and when the stock factors are included (their Table 7a), and is 0.081 across the 49 industries here. By contrast, adding RIP to either CRSP or MIX raises the cross-sectional R^2 for average industry returns from 1–3% to 20%. TERM loadings, like Treasury betas, capture only the reduced-form exposure to rates and do not separate direct duration exposure from rate insurance.

Pooling all 79 assets together, the two-factor MIX + RIP model has a mean absolute alpha of 1.30 percent and slope of 0.81, compared with 2.18 percent and 0.42 under the six-factor FF5 + TERM model.

Table 1: Pricing performance for FF49 industries and Treasuries

		FF49		Treasuries		Pooled (79 assets)	
Model	K	Mean $\lvert\alpha\rvert$	Slope	Mean $\lvert\alpha\rvert$	Slope	Mean $\lvert\alpha\rvert$	Slope
CAPM	1	2.39	0.13	7.86	-5.52	4.46	0.18
MIX	1	2.86	0.16	3.55	1.74	3.12	0.33
FF5	5	3.16	-0.21	7.82	-4.41	4.93	0.11
FF5 + TERM	6	3.10	-0.20	0.69	0.83	2.18	0.42
CRSP + RIP	2	1.96	0.86	5.30	2.25	3.23	0.46
MIX + RIP	**2**	**1.62**	**0.75**	**0.78**	**0.88**	**1.30**	**0.81**

Notes: Daily excess-return regressions, 1988–2019. Test assets are the 49 Fama-French industries and zero-coupon Treasuries maturing in 1 to 30 years; pooled statistics use all 79 assets. K is the number of factors. Mean $\lvert\alpha\rvert$ is the mean absolute annualized pricing error in percentage points. Slope is from a regression across assets of average excess returns on model-implied excess returns. Statistics use individual assets.

5.2 Reinterpreting Low-Risk Anomalies

The negative price of long-run risk that reconciles the bond and equity term structures in Section 3 also provides a natural resolution for well-known low-risk anomalies within equities: long-run payoff exposure $\theta_{j,L}$ can raise market beta or volatility, while also lowering expected returns.

The beta anomaly. Average stock returns are flat or decreasing in market beta (Black, 1972; Baker et al., 2011; Frazzini and Pedersen, 2014; Hong and Sraer, 2016). In the model, market beta takes a simple form:

$$\beta_j^{Mkt} = A_M d_j + \frac{\sum_k \theta_{j,k}\Theta_{M,k}\sigma_k^2}{\mathrm{Var}(r_M)},$$

where $A_M d_j = \frac{\mathrm{Cov}(x, r_M)}{\mathrm{Var}(r_M)} d_j$ is the beta of asset j's matched Treasury on the aggregate stock market. In the full sample, A_M is negative because market returns covary negatively with Treasury returns. Yet market beta rises with duration, so the payoff term $\sum_k \theta_{j,k}\Theta_{M,k}\sigma_k^2/\mathrm{Var}(r_M)$ must rise with duration fast enough to more than offset the decline in $A_M d_j$.

Holding duration fixed, greater $\theta_{j,L}$ raises market beta when good long-run news raises the market return ($\Theta_{M,L} > 0$). If that news also raises Treasury yields ($\phi_L > 0$), the larger exposure raises χ_j and lowers OLS Treasury beta through equation (6). At the same time, a negative price λ_L implies that expected returns over the matched Treasury fall with $\theta_{j,L}$.

I test whether RIP exposure accounts for the flat relation between returns and market beta using the 49 industry portfolios, which do not enter RIP construction (Appendix Figure A.11). For this exercise and the low-volatility test below, I rebuild the factor after excluding four of

the 55 characteristic families whose definitions use volatility or market beta.[24] I estimate CAPM beta from monthly excess returns and RIP loadings from a monthly regression on MIX and RIP. Industries with higher CAPM betas are more exposed to RIP, which earns a negative return. Subtracting each industry's RIP loading times RIP's average return raises the slope of returns on market beta from 0.67 to 3.65. In a joint regression with market beta and the RIP loading, the coefficients are 8.05 and −1.61, respectively.

Therefore, the positive relation between market beta and RIP exposure implies that RIP's negative return flattens the usual security market line.

The low-volatility anomaly. Stocks with low past volatility earn higher risk-adjusted returns than stocks with high past volatility (Ang et al., 2006; Baker et al., 2011).[25] As with market beta, long-run payoff exposure can raise volatility and lower expected returns at the same time. The contribution of shock L to stock j's variance is $(\theta_{j,L} - d_j\phi_L)^2\sigma_L^2$. Therefore, holding duration fixed, greater $\theta_{j,L}$ raises volatility when $\Theta_{j,L} = \theta_{j,L} - d_j\phi_L > 0$ (i.e., good long-run growth news is on net good for stocks), while it lowers the wedge Δ_j when $\lambda_L < 0$.

To test this link, I form ten value-weighted portfolios of CRSP common stocks each June using total volatility over the preceding year. The test portfolios do not enter RIP construction. Appendix Table A.5 reports RIP loadings for all ten volatility deciles. RIP loadings rise at every step from the lowest- to the highest-volatility decile. Since RIP responds positively to long-run growth revisions, the rising loadings are consistent with greater $\theta_{j,L}$ in higher-volatility portfolios. The low-minus-high alpha is 11% per year under the CAPM and less than 2% under both CRSP-RIP and MIX-RIP.

5.3 Changes in Rate Insurance and Anomaly Premia

The realized book-to-market value premium has been much weaker in recent decades (Fama and French, 2021). My sample shows an especially sharp collapse around the GFC: value's CAPM alpha fell from 7.1% per year in 1988–2007 to −11.8% in 2010–2019. I now show that changes in rate insurance help account for this collapse. They also help explain why other anomaly premia changed so differently over the same period.

I estimate 10-year Treasury beta separately in 1988–2007 and in 2010–2019. If the payoff exposures reflected in χ carry negative premia, larger falls in Treasury beta (which under stable

[24] Using the labels in Haddad et al. (2020), these are "Beta Arbitrage", "Idiosyncratic Volatility", "Industry Relative Reversals (Low Volatility)", and "Industry Momentum-Reversal".

[25] Baker and Wurgler (2012) show that OLS loadings on long-term government bonds fall sharply from low- to high-volatility stocks, controlling for the market. Variables that predict bond returns also predict returns on low-volatility stocks relative to high-volatility stocks. I estimate duration separately and measure rate insurance as the gap between duration and OLS Treasury beta.

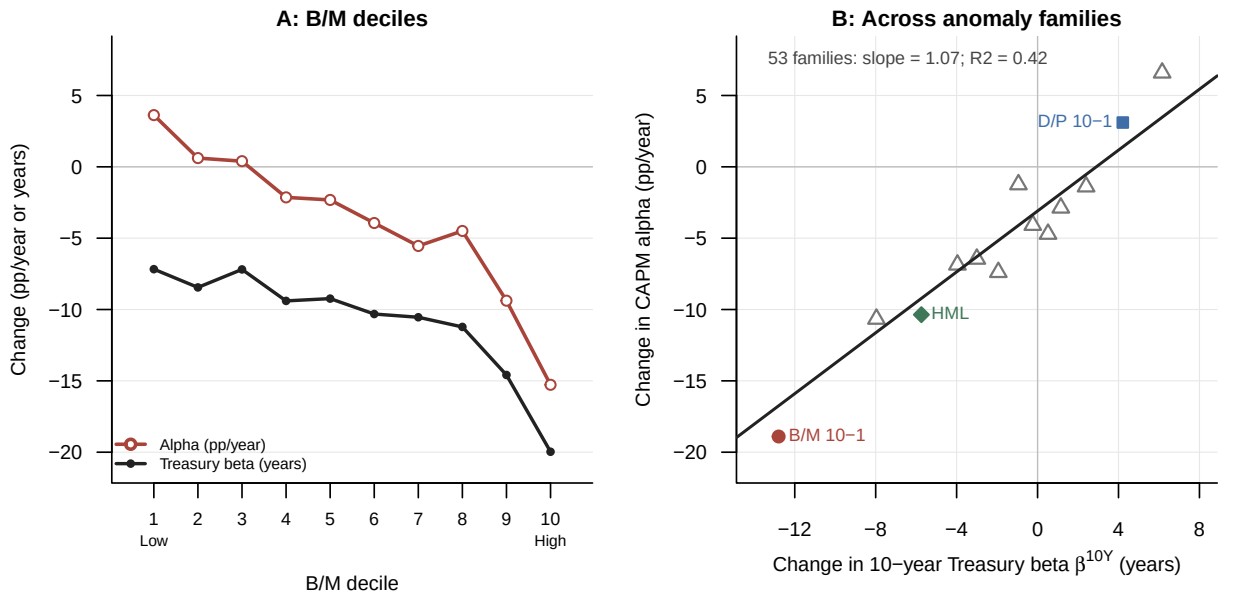


Figure 9: Changes in Treasury beta and anomaly premia. Changes are 2010–2019 minus 1988–2007. Panel A reports CAPM alpha and 10-year Treasury beta for the ten value-weighted B/M portfolios. Panel B uses portfolio 10 minus portfolio 1 spreads from 53 characteristic families, excluding B/M and D/P. Points are ten bins; the line and statistics use all 53 families. The labeled B/M, D/P, and HML points are excluded from the fit. Treasury beta uses the exact holding return on the 10-year zero-coupon Treasury divided by ten.

durations correspond to increases in rate insurance) should be associated with larger declines in CAPM alpha.

The Value Premium. Figure 9, Panel A, shows that across B/M deciles, larger falls in Treasury beta line up almost perfectly with larger falls in CAPM alpha. For the B/M high-minus-low spread, Treasury beta fell by 12.8 years and CAPM alpha fell by 18.9 percentage points. Regressing the change in CAPM alpha on the change in Treasury beta gives a slope of 1.36 with $R^2 = 0.94$: a one-year larger fall in Treasury beta is associated with a 1.36 percentage-point larger fall in CAPM alpha.

Across Anomalies. Across the 55 characteristic families, the mean CAPM alpha of the high-minus-low portfolio spreads fell from 6.3% per year in 1988–2007 to 2.3% per year in 2010–2019. The changes varied widely across families. If changes in rate insurance help explain this variation, the alpha decline should be larger where Treasury beta falls more.

Figure 9, Panel B, shows the estimated relation across the other 53 families, leaving B/M and D/P out. Across these families, larger falls in Treasury beta are associated with larger declines

in CAPM alpha. The cross-family slope is 1.07 ($R^2 = 0.42$), close to the 1.36 slope within B/M deciles.

The cross-family relation predicts a 16.7 percentage-point decline in the B/M alpha, compared with 18.9 points in the data. The Fama-French HML factor behaves similarly: its 10-year Treasury beta fell by 5.7 years and the CAPM alpha by 10.4 percentage points, while the fitted relation predicts a 9.2 percentage-point decline.

Value portfolios based on different valuation ratios evolved quite differently after the GFC. While the reversal of the B/M value spread has received most of the attention, the CAPM alpha of the D/P spread did not follow the same path and instead *rose* by 3.1 percentage points. This difference is consistent with its Treasury beta also rising by 4.2 years.

6 Conclusion

Rate risk and rate insurance can both have large effects on stock returns, but they work in opposite directions and are difficult to disentangle. Monetary policy shocks provide a new tool to separate these forces. Comparing stock and Treasury responses identifies a Treasury with the same rate exposure as each stock. While the market earned almost exactly the return on its duration-matched Treasury, the cross section reveals a stark contrast between stocks and bonds. Treasury returns rise sharply with duration, while equity returns are flat and eventually fall below matched Treasuries. Equity volatility also rises much less with duration than bond volatility.

I explain these patterns and draw further implications by modeling the two roles of rate insurance. A stock's matched Treasury component hedges its payoff component, lowering the stock's variance in proportion to $d_j \chi_j$. Conversely, the payoff component hedges investors' aggregate net duration, lowering the stock's expected return in proportion to $\mathcal{D} \chi_j$. When long-run news moves rates more strongly relative to its direct effect, its normalized price is lower than that of short-run news. For a fixed amount of rate insurance, shifting exposure from short-run to long-run news can therefore lower the wedge even when both prices are positive. When aggregate net duration is large enough, the rate loss generated by good long-run news exceeds the direct payoff gain. Long-run payoff risk then has a negative price, and long bonds can earn more than long stocks, even when the stock-bond covariance is negative. Rate risk and rate insurance motivate a simple two-factor model for stocks and bonds. In the cross-section of stocks, rate insurance also helps explain low-risk anomalies and the recent compression in value and other anomaly premia.

Interpreting historical stock-minus-bond wedges as expected premia requires weaker stationarity assumptions than interpreting realized excess returns over bills, because wedges remove the rate windfall associated with each stock's duration. But the model highlights that wedges need not be stable even with stable preferences. Corporate payout policies, industry mix, and the level

of interest rates all affect aggregate duration and change over time, sometimes without mean reversion. The amount and maturity of government debt affect how much duration each generation of investors needs to absorb, while monetary policy determines how strongly payoff news moves rates. In 1915, the gold standard prevailed and U.S. government debt was less than 10% of GDP. By 2015, debt exceeded 100% of GDP, and the Federal Reserve operated under an inflation target while using quantitative easing and forward guidance. Very long samples may therefore average risk premia that have no reason to be the same across these regimes.

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Online Appendix

A Empirical Appendix

A.1 Duration measurement and validation

Let $\beta_{ZC}^{FOMC}(d)$ denote the FOMC response obtained by linearly interpolating the 1–30-year zero-coupon response curve and extending it beyond 30 years with its terminal slope. The response of the 1–30 chord is

$$\beta_{1-30}^{FOMC}(d) = \beta_{ZC}^{FOMC}(1) + (d-1)\frac{\beta_{ZC}^{FOMC}(30) - \beta_{ZC}^{FOMC}(1)}{29}.$$

The baseline Treasury response map is

$$\beta_{\text{Treas}}^{FOMC}(d) = \frac{2}{3}\beta_{ZC}^{FOMC}(d) + \frac{1}{3}\beta_{1-30}^{FOMC}(d). \tag{A.1}$$

Duration is the unique value satisfying

$$\beta_{j}^{FOMC} = \beta_{\text{Treas}}^{FOMC}(d_j).$$

Let $r_{d,t}^{ZC}$ follow the same interpolation and extrapolation convention as the response map. I use the same weights to construct the corresponding realized matched-bond excess return:

$$r_{d,t}^{B} = \frac{2}{3}r_{d,t}^{ZC} + \frac{1}{3}\left[r_{1,t}^{ZC} + (d-1)\frac{r_{30,t}^{ZC} - r_{1,t}^{ZC}}{29}\right].$$

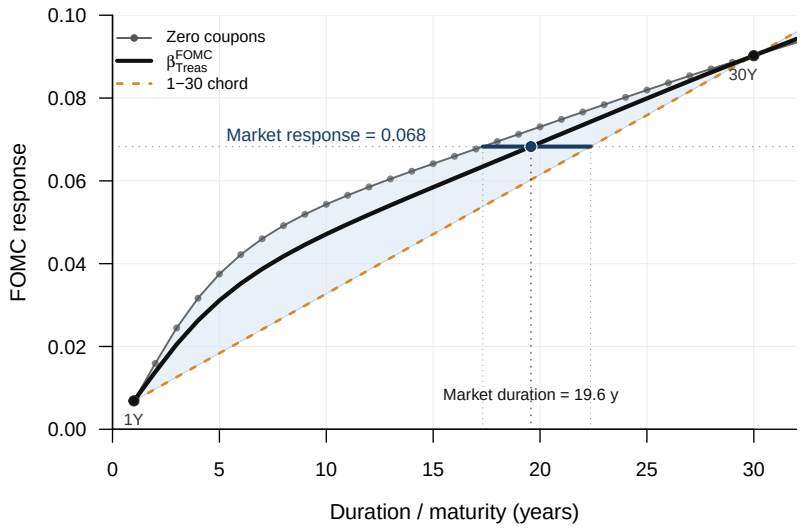


Figure A.1: Mapping FOMC beta to duration. The solid line mapping β^{FOMC}_{Treas} puts weight 2/3 to direct zero-coupon matching and 1/3 to the 1–30 chord. The market FOMC beta of 0.068 maps to a duration of 19.6 years.

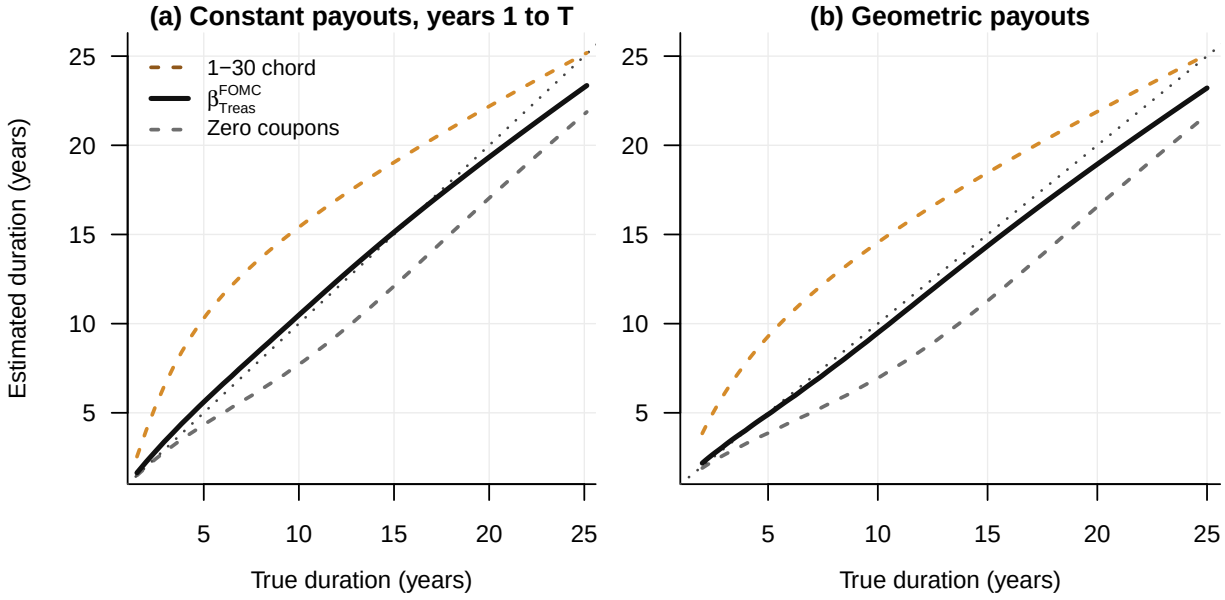


Figure A.2: Treasury placebos. The panels show duration estimates against the true known duration for Treasury portfolios with constant or geometric payouts. The dashed line shows the 45-degree line.

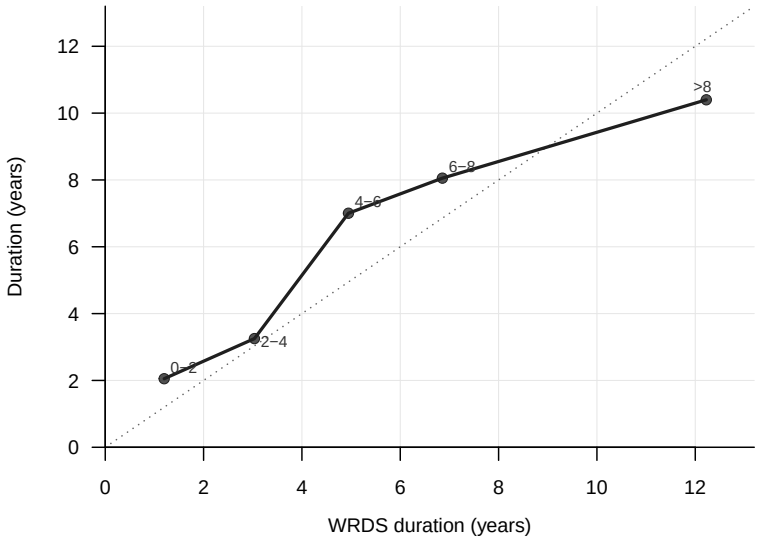


Figure A.3: Corporate bond validation: Estimated duration versus WRDS duration. Portfolios are weighted by amount outstanding within five WRDS duration buckets for bonds rated AAA through B. The sample contains 77 FOMC announcements from 2002 to 2019. The reported WRDS duration is computed from promised coupons and principal at each bond's yield. Event returns use the last TRACE price after 2 p.m. on the FOMC announcement day relative to the previous trading day's last TRACE price. The Treasury response curve is re-estimated on the same announcements.

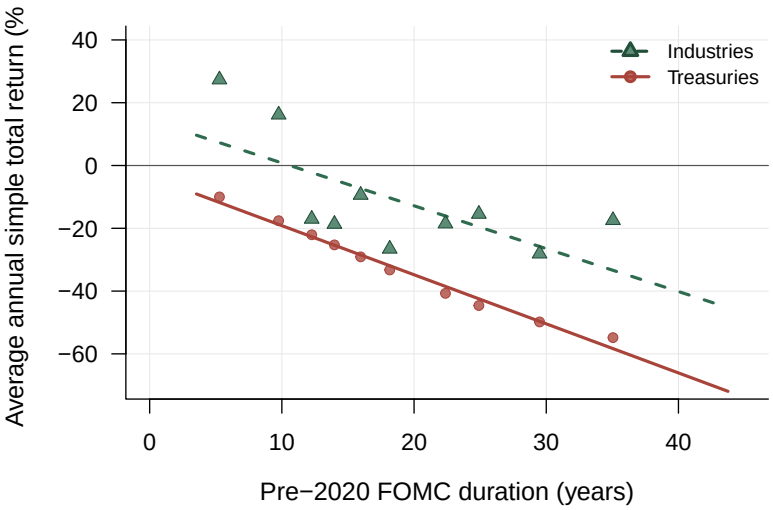


Figure A.4: Industry returns in 2022. Simple total returns for the 49 industries and their matched Treasuries, plotted against duration estimated from 1988–2019 FOMC announcements. Markers show ten duration bins. Each line uses all 49 observations.

Table A.1: Valuation, duration, and returns across D/P deciles

	D/P decile									
	1	2	3	4	5	6	7	8	9	10
P/D	164.3	84.3	64.5	51.8	40.4	36.7	32.3	27.5	21.2	16.6
FOMC beta	.077	.078	.066	.062	.068	.054	.069	.067	.070	.073
FOMC-implied duration (years)	23.7	24.2	18.4	16.8	19.4	13.1	19.8	19.2	20.6	21.6
Average return	10.2%	11.3%	11.9%	12.0%	12.1%	14.0%	12.3%	11.9%	11.2%	12.5%

Notes: FOMC betas are absolute response coefficients from the same sign sample, and durations use the baseline Treasury map. Returns are annualized simple total returns, 1988–2019. The 30-year zero-coupon response is 0.090.

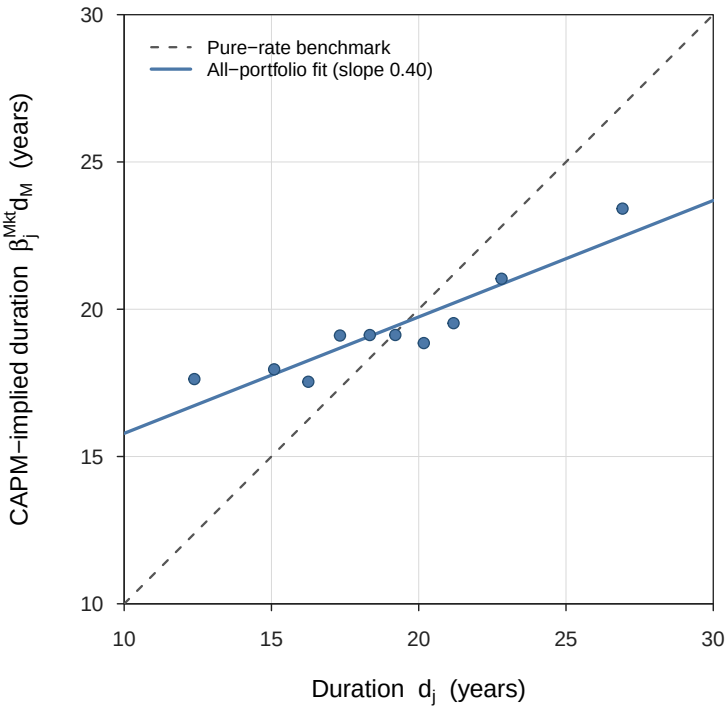


Figure A.5: Market beta and duration. Horizontal axis: duration d_j estimated from FOMC responses. Vertical axis: $\beta_j^{Mkt} d_M$, with $d_M = 19.6$. Markers are ten bins containing equal numbers of portfolios. The fitted line uses all portfolios. The diagonal corresponds to $\beta_j^{Mkt} = d_j / d_M$.

A.2 Return and wedge robustness

Table A.2: Return slopes before and after 2000.

	Characteristics			FF49 industries		
Period	Equity	Treasury	Wedge	Equity	Treasury	Wedge
1988–99	0.15	0.29	-0.13	0.15	0.32	-0.17
2000–19	-0.10	0.28	-0.38	-0.11	0.30	-0.41

Notes: Entries are slopes in annual percentage points per year of duration. Durations and the Treasury map are estimated over 1988–2019 and held fixed across periods. Regressions use 510 characteristic portfolios and 49 industries.

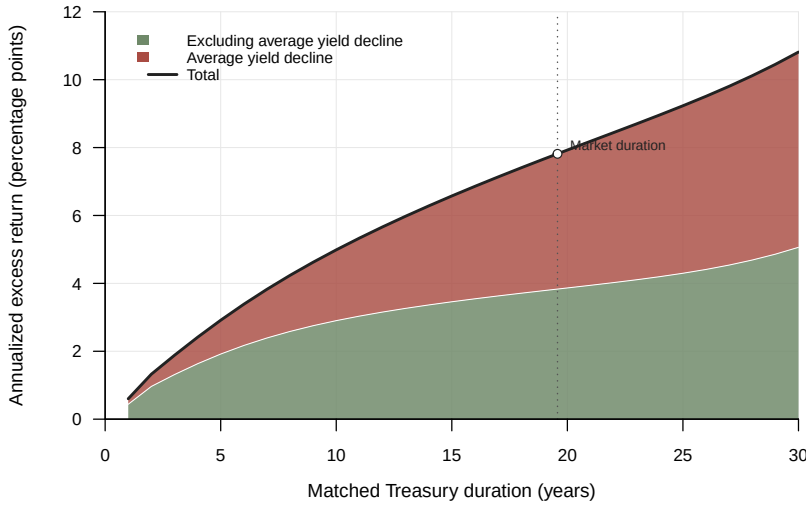


Figure A.6: Realized matched Treasury returns, 1988–2019. At each duration, the simple excess return is split into the contribution of the average monthly yield change and the remainder. The vertical line marks market duration (19.6 years).

Table A.3: CAPM alphas and wedges.

	Dependent variable			
	CAPM alpha	Wedge	CAPM alpha − wedge	CAPM alpha
	(1)	(2)	(3)	(4)
Duration d_j	-0.179***	-0.290***	0.111***	0.156***
	(0.030)	(0.020)	(0.017)	(0.020)
Wedge Δ_j				1.154***
				(0.049)
N	510	510	510	510
R^2	0.094	0.337	0.117	0.740

Notes: Columns (1)–(3) use duration as the sole regressor; column (4) includes duration and the wedge. Returns and alphas are annualized percentage points. Robust standard errors are in parentheses.

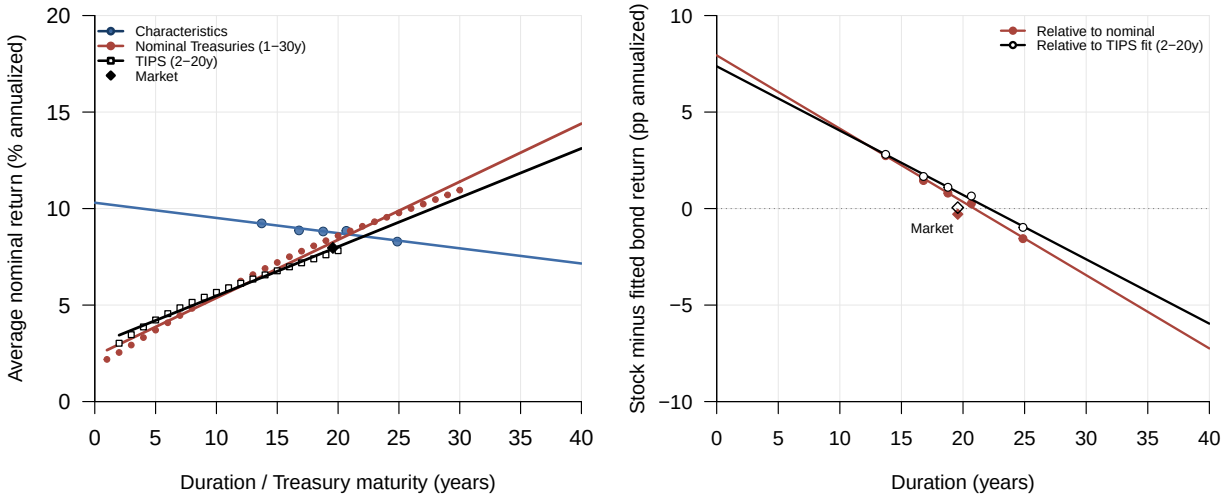


Figure A.7: Nominal Treasury and TIPS benchmarks, February 1999–December 2019. Panel A reports nominal returns for 509 characteristic portfolios against duration and Treasury returns against maturity. Markers are five bins containing equal numbers of stock portfolios; the stock line uses all 509 portfolios. TIPS holding returns are converted to nominal terms using CPI-U NSA and Treasury rules for the reference index. Panel B subtracts the fitted nominal Treasury or TIPS schedule at each portfolio's duration. Fits use maturities from 1 to 30 years for nominal Treasuries and 2 to 20 years for TIPS and are extended to 40 years.

Table A.4: Implied wedge beyond ten years

	Short-strip wedge $\Delta_{<10}$		
First-decade value share $\Omega_{<10}$	5.0	6.0	7.0
0.15	-0.10	-0.28	-0.46
0.20	-0.42	**-0.67**	-0.92
0.25	-0.78	-1.12	-1.45

Notes: Entries are annualized percentage points and equal $\Delta_{>10} = (\Delta_M - \Omega_{<10}\Delta_{<10})/(1 - \Omega_{<10})$, with $\Delta_M = 0.663\%$ at $d_M = 19.6$. Bold indicates the baseline.

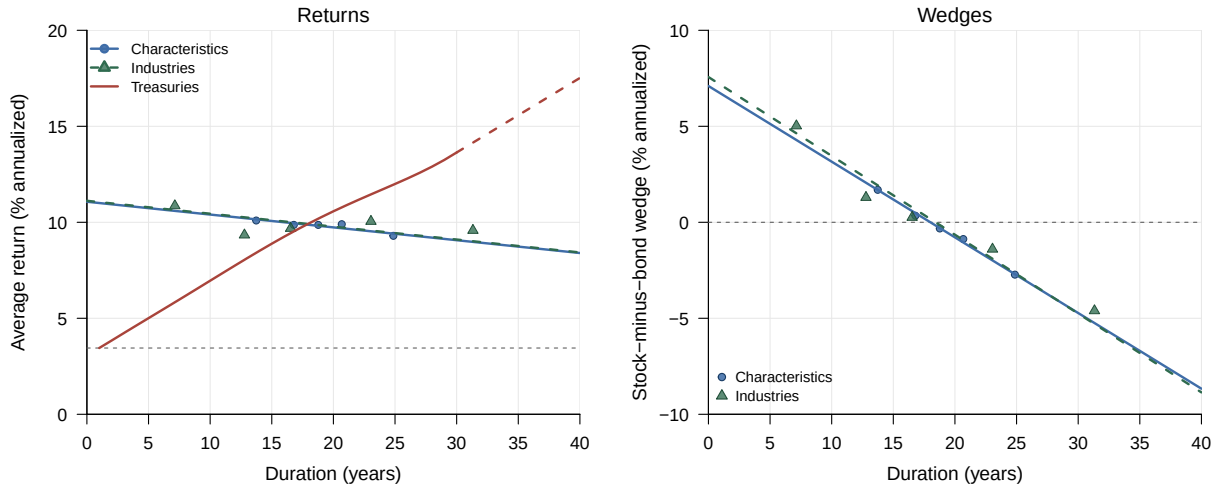


Figure A.8: Returns after excluding FOMC days. Equity and Treasury returns omit all FOMC announcement days. Duration estimates and Treasury matches are unchanged. Markers are five duration bins, and lines use all portfolios.

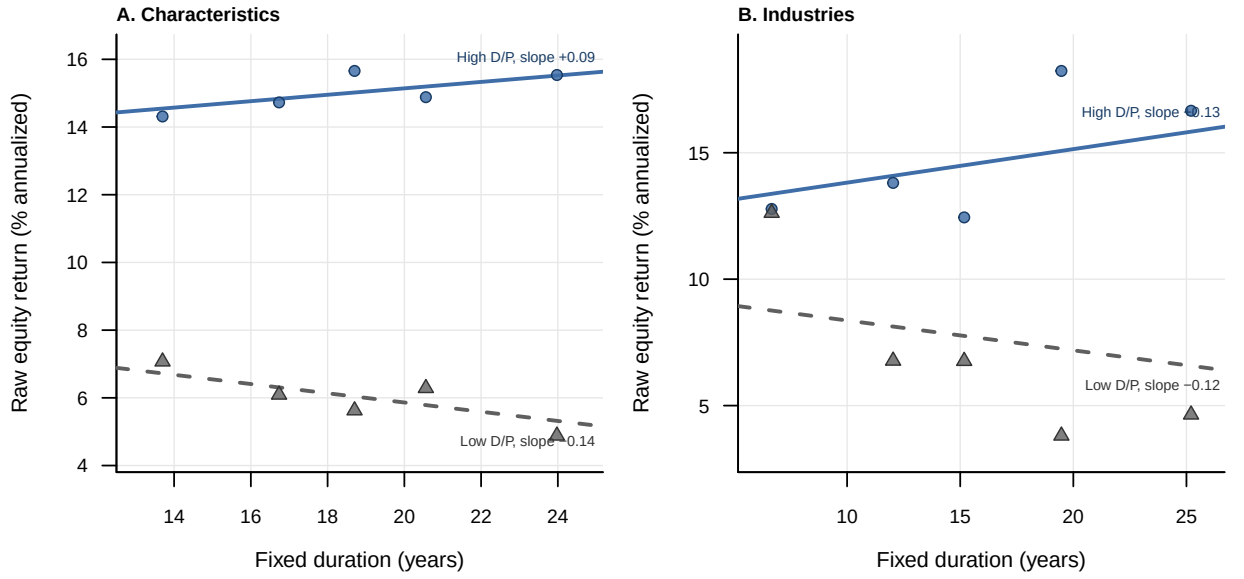


Figure A.9: Equity returns in high and low D/P states. Duration quintiles are formed once using the full sample. Returns are computed in the highest and lowest 20 percent of months by market D/P. Lines are fitted separately to all characteristic portfolios and all 49 industries.

A.3 Factor pricing and anomaly premia

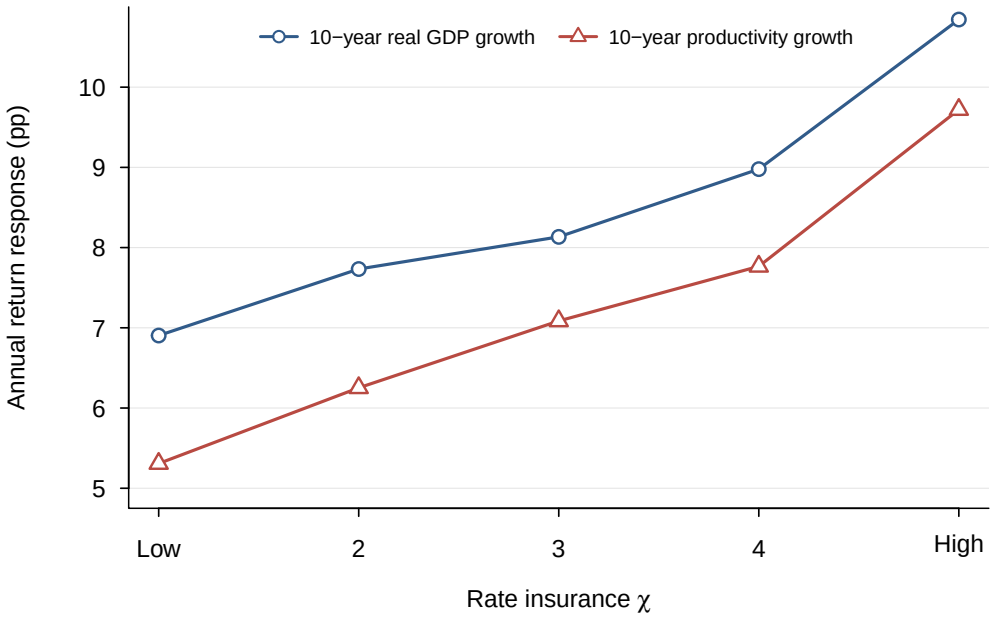


Figure A.10: Long-run growth forecasts across χ quintiles. RGDP10 and PROD10 are the first-quarter SPF mean forecasts of the average annual growth rate of real GDP and output per hour over the current year and the next nine years. Within each of ten fixed duration bins, the characteristic portfolios used to construct RIP are sorted into five χ groups. Each June, χ is computed from matched Treasury betas estimated over the preceding five years of daily returns. Each portfolio's own matched Treasury return is subtracted before returns are averaged across duration bins. The point estimates show coefficients from separate regressions of annual returns on standardized forecast revisions, estimated over the full sample from 1993 through 2019. Annual returns sum daily simple excess returns between first-quarter survey deadlines.

Table A.5: RIP loadings across volatility deciles

Volatility decile	CRSP + RIP	MIX + RIP
1 (Low)	-1.60	-0.46
2	-1.36	0.08
3	-0.87	0.71
4	-0.48	1.10
5	-0.04	1.67
6	0.31	1.99
7	0.92	2.69
8	1.54	3.30
9	2.65	4.38
10 (High)	4.13	6.02
High minus low	5.73	6.48
Newey–West t	(12.09)	(17.03)
Rank correlation	0.97	0.98

Notes: Ten value-weighted portfolios of CRSP common stocks are formed each June using NYSE breakpoints for volatility over the preceding twelve months and held from July through June, 1988–2019. Entries are RIP coefficients from monthly excess-return regressions on the factors named in each column. Daily MIX and RIP returns are compounded within month; Newey–West t-statistics use six lags. RIP excludes characteristic portfolios formed on idiosyncratic volatility or market beta and the two industry-reversal signals that use a low-volatility screen. The test portfolios do not enter RIP.

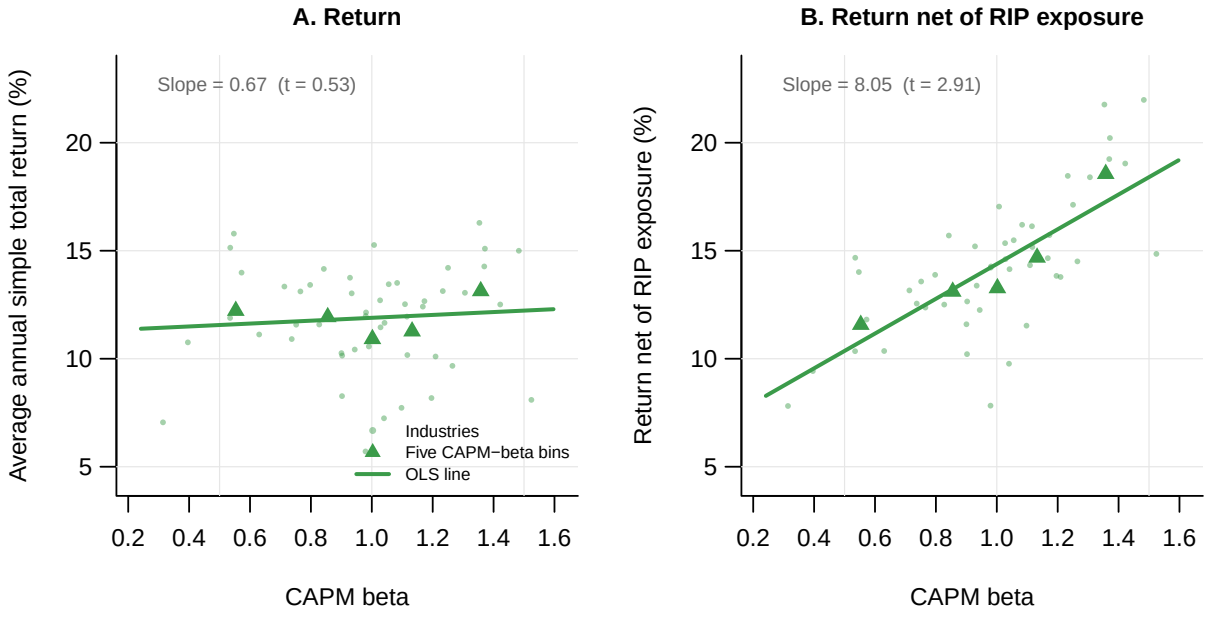


Figure A.11: Rate insurance and the beta anomaly. Panel A reports annualized average simple total returns against CAPM beta for 49 value-weighted industries, 1988–2019. Panel B subtracts $\hat{\lambda}_{\text{RIP}}\hat{\beta}_j^{\text{RIP}}$ from each return. The RIP loading comes from a monthly regression on MIX and RIP; $\hat{\lambda}_{\text{RIP}}$ comes from a regression across industries of average returns on CAPM beta and the RIP loading. Small points are industries; triangles are five bins formed on CAPM beta and held fixed across panels. Lines use all 49 industries. RIP excludes the four characteristic families defined using volatility or market beta.

Table A.6: Changes in Treasury beta and anomaly premia. Regressions use changes from 1988–2007 to 2010–2019 across 53 characteristic families. Each spread is portfolio 10 minus portfolio 1; B/M and D/P are excluded. Outcomes are annualized average returns, wedges, and CAPM alphas. $\Delta\beta^x$ is the change in matched Treasury beta, $\Delta\beta^{Mkt}$ is the change in CAPM beta, and $\Delta\text{vol}(r)$ is the change in annualized monthly volatility. Standard errors are in parentheses.

	Average return			Wedge			CAPM alpha		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta\beta^x$	0.43**	0.29	0.41**	0.50***	0.39**	0.49***	1.02***	0.70***	1.00***
	(0.17)	(0.18)	(0.17)	(0.16)	(0.18)	(0.16)	(0.19)	(0.18)	(0.19)
$\Delta\beta^{Mkt}$		−4.98*			−3.98			−11.21***	
		(2.77)			(2.73)			(2.82)	
$\Delta\,\text{vol}(r)$			0.19			0.14			0.19
			(0.19)			(0.19)			(0.22)
R^2	0.12	0.17	0.13	0.16	0.19	0.17	0.37	0.52	0.38
Families	53	53	53	53	53	53	53	53	53

B Theoretical Appendix

B.1 Proofs and derivations

Proof of Proposition 1. Write $A(h) \equiv h y_E(h)$, so $q(h) = e^{-A(h)}$. If $y_E(h)$ is weakly increasing, then for any $s, u \geq 0$,

$$y_E(s+u) \geq y_E(s), \qquad y_E(s+u) \geq y_E(u),$$

and therefore

$$A(s+u) = (s+u) y_E(s+u) \geq s y_E(s) + u y_E(u) = A(s) + A(u).$$

It follows that $q(s+u) \leq q(s) q(u)$. Using

$$\int_0^\infty h q(h)\, dh = \int_0^\infty \int_0^\infty q(s+u)\, ds\, du,$$

we obtain

$$\int_0^\infty h q(h)\, dh \leq \left(\int_0^\infty q(h)\, dh \right)^2 = P^2.$$

Dividing by P gives $d^{\text{Mac}} \leq P$. If $y_E(h)$ is weakly decreasing, every inequality reverses and $d^{\text{Mac}} \geq P$.

If $y_E(h) \equiv \kappa$, then

$$q(h) = e^{-\kappa h}, \qquad P = \frac{1}{\kappa}, \qquad d^{\text{Mac}} = \frac{\int_0^\infty h e^{-\kappa h}\, dh}{\int_0^\infty e^{-\kappa h}\, dh} = \frac{1}{\kappa}.$$

Strict monotonicity of $h \mapsto y_E(h)$ gives a strict inequality. Under weak monotonicity, $d^{\text{Mac}} = P$ requires $y_E(h)$ to be constant almost everywhere. □

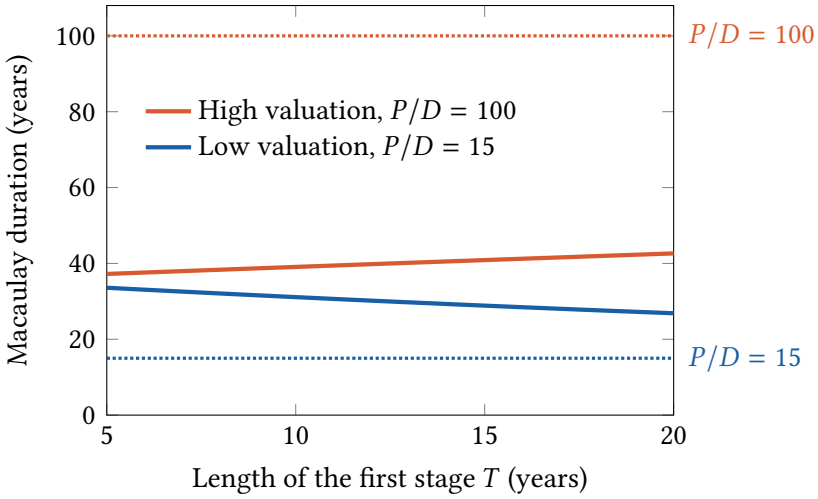


Figure B.1: Duration in a DDM with two growth stages. The discount rate is 7 percent and terminal growth is 4 percent. For each length T of the first stage, its growth rate is chosen to hold P/D at 100 or 15. Dotted lines set duration equal to P/D.

Proof of Proposition 2. Let $\widetilde{C} \equiv C_{t+1} - \bar{C}$. Because $t+1$ is the cohort's terminal date, Epstein-Zin preferences with relative risk aversion γ imply $M_{t+1} \propto C_{t+1}^{-\gamma}$ across states and

$$\frac{M_{t+1}}{\bar{M}} = 1 - \gamma \frac{\widetilde{C}}{\bar{C}} + o(\widetilde{C}).$$

Substituting the consumption equation (14) for $\widetilde{C}$ and collecting the coefficient on x^R and on each ε^k yields kernel loadings $-\lambda_R$ on x^R and $-\lambda_k$ on ε^k, with $\lambda_R = \gamma \mathcal{D}/\bar{C}$ and $\lambda_k = \gamma(a_k - \phi_k \mathcal{D})/\bar{C}$ for each k.

Equation (10) and the first-order pricing condition give $\mathbf{E}[r^B(d)] = d(\Lambda_R - \sum_k \phi_k \Lambda_k)$; (11) gives $\Delta_j = \sum_k \theta_{j,k} \Lambda_k$. □

Proof of Proposition 3. Substituting $\mathcal{D} = d_M V_M + \eta d_G V_G$ into $\lambda_L = \gamma(d_M V_M - \phi_L \mathcal{D})/\bar{C}$ gives the expression in the proposition. With $\phi_L = 1$, $\lambda_L = -\gamma \eta d_G V_G / \bar{C}$. □

Proof of Proposition 4. The risk prices in Proposition 2 imply

$$\tau_B = \frac{\gamma}{\bar{C}} \left[\mathcal{D} \mathrm{Var}(x) - \sum_k \phi_k a_k \sigma_k^2 \right].$$

Equation (21) can be written as

$$\mathrm{Cov}(x, r_M) = d_M \mathrm{Var}(x) - \sum_k \phi_k \theta_{M,k} \sigma_k^2.$$

Combining these expressions gives the general identity

$$\tau_B = \frac{\gamma}{\bar{C}}\left[V_M \mathrm{Cov}(x, r_M) + (\mathcal{D} - d_M V_M)\mathrm{Var}(x) - \sum_k \phi_k (a_k - \theta_{M,k} V_M)\sigma_k^2\right].$$

Under the assumptions in the proposition, the second term inside the brackets is $\eta d_G V_G \mathrm{Var}(x)$ and the final sum is zero. This gives the displayed identity. Setting $\eta = 0$ and rearranging when the covariance is negative give the remaining statements. □

Equation (22). For (22), $\partial\lambda_R/\partial\mathcal{D} = \gamma/\bar{C}$ and $\partial\lambda_k/\partial\mathcal{D} = -\gamma\phi_k/\bar{C}$, so $\partial\tau_B/\partial\mathcal{D} = (\gamma/\bar{C})(\sigma_R^2 + \phi_S^2\sigma_S^2 + \phi_L^2\sigma_L^2) = (\gamma/\bar{C})\mathrm{Var}(x)$ and $\partial\Delta_j/\partial\mathcal{D} = -(\gamma/\bar{C})\sum_k \theta_{j,k}\phi_k\sigma_k^2 = -(\gamma/\bar{C})\mathrm{Var}(x)\chi_j$. Then $\partial \mathbf{E} r_j/\partial\mathcal{D} = d_j \partial\tau_B/\partial\mathcal{D} + \partial\Delta_j/\partial\mathcal{D}$. □

B.2 Overlapping generations

This appendix details the OLG structure underlying Section 4. The variable C_{t+1} in that section is the cohort's old-age consumption c_{t+1}^o.

A new cohort enters each period, consuming once when young and once when old. Cohort t has two-period Epstein-Zin utility

$$\mathcal{U}_t = \left[(1-\beta)(c_t^y)^{1-1/\psi} + \beta(C_t^o)^{1-1/\psi}\right]^{1/(1-1/\psi)},$$

where

$$C_t^o \equiv \left(\mathbf{E}_t\left[(c_{t+1}^o)^{1-\gamma}\right]\right)^{1/(1-\gamma)}$$

is the certainty equivalent of old-age consumption, $\gamma > 0$ is relative risk aversion, $\psi > 0$ is the EIS, and $\beta \in (0,1)$ is the discount factor.

At date t, the young cohort buys q_t units of an asset with future random payoffs $X_{t+1}, X_{t+2}, \ldots$ at price P_t, and saves s_t at the gross risk-free rate R_t. At date $t+1$, when old, the cohort receives X_{t+1} and sells the asset for P_{t+1}. The flow budget constraints are

$$c_t^y + P_t q_t + s_t = Y_t^y, \tag{B.1}$$

$$c_{t+1}^o = Y_{t+1}^o + q_t\,(P_{t+1} + X_{t+1}) + R_t s_t. \tag{B.2}$$

The Euler equations are

$$P_t = \mathbf{E}_t[M_{t+1}\,(P_{t+1} + X_{t+1})], \tag{B.3}$$

$$1 = R_t \mathbf{E}_t[M_{t+1}], \tag{B.4}$$

where the SDF is

$$M_{t+1} = \frac{\beta}{1-\beta}(c_t^y)^{1/\psi}(C_t^o)^{\gamma-1/\psi}(c_{t+1}^o)^{-\gamma}.$$

Everything multiplying $(c_{t+1}^o)^{-\gamma}$ is known at date t, so M_{t+1} is proportional to $(c_{t+1}^o)^{-\gamma}$ across states at date $t+1$. Around deterministic old-age consumption $\bar{c}^o$, we have, to first order,

$$\frac{\widetilde{M}_{t+1}}{\bar{M}} = -\gamma\frac{\widetilde{c}_{t+1}^o}{\bar{c}^o}.$$

This is the SDF used in Proposition 2. The EIS does not enter its variation across terminal states, although it can affect the coefficients ϕ_k through rate responses.

The next cohort's demand determines the resale price P_{t+1}. Cohort $t+1$ buys q_{t+1} units of the asset when young and, when old, receives X_{t+2} and sells the asset at $t+2$:

$$c_{t+1}^y + P_{t+1}q_{t+1} + s_{t+1} = Y_{t+1}^y, \tag{B.5}$$

$$c_{t+2}^o = Y_{t+2}^o + q_{t+1}\left(P_{t+2} + X_{t+2}\right) + R_{t+1}s_{t+1}. \tag{B.6}$$

The current cohort receives q_tP_{t+1} when old, while cohort $t+1$ pays $q_{t+1}P_{t+1}$ when young. With a fixed supply of the asset, market clearing sets $q_{t+1} = q_t$. These terms would cancel if the two cohorts shared one budget. With separate cohort budgets, the direct effect a_k in equation (13) includes the response of the resale price to payoff news holding the Treasury return fixed.

In this environment, news about payoffs beyond the current cohort's horizon matters even if each cohort has time-separable utility. Suppose the asset pays only X_{t+2} at $t+2$ and then expires, so that $P_{t+2} = 0$. If X_{t+2} is known at $t+1$, $P_{t+1} = X_{t+2}/R_{t+1}$. News about X_{t+2} affects the stochastic discount factor M_{t+1} through the resale price P_{t+1}.

B.3 Taylor rule and rate responses

This subsection describes a simple economy where the central bank sets short-term rates according to a Taylor rule. It shows how the coefficients ϕ_k depend on the persistence of payoff shocks, the EIS, and the policy reaction function.

Consider a shock z_t that raises the expected growth rates of consumption and dividends s periods ahead by $\rho^s z_t$, where $0 \le \rho < 1$. Therefore, the natural real rate follows

$$r_t^n = \frac{z_t}{\psi}, \qquad E_t z_{t+s} = \rho^s z_t,$$

and a dividend strip maturing at T has payoff loading

$$G_T(\rho) \equiv 1 + \rho + \cdots + \rho^{T-1}. \tag{B.7}$$

If the strip has value V_T and duration $d_T = T$, its exposure holding rates fixed is

$$a_T(\rho) = V_T G_T(\rho) = d_T V_T \frac{G_T(\rho)}{T}. \tag{B.8}$$

Consider the following linearized IS equation and Taylor rule (abstracting from inflation):

$$y_t = E_t y_{t+1} - \psi(i_t - r_t^n) \tag{B.9}$$

$$i_t = \varphi_y y_t \tag{B.10}$$

where ψ is the EIS and $\varphi_y > 0$ is the policy response to the output gap y. This gives

$$\frac{\partial i_{t+s}}{\partial z_t} = \frac{\varphi_y}{1 - \rho + \psi\varphi_y}\rho^s.$$

Holding term premia fixed, the yield at maturity T responds by

$$\phi_T(\rho) = \frac{\varphi_y}{1 - \rho + \psi\varphi_y}\frac{G_T(\rho)}{T}. \tag{B.11}$$

In the main text, ϕ_k can also include changes in term premia. When $\rho < 1$, greater persistence ρ and a stronger central bank reaction to the output gap φ_y raise the yield response, while a larger EIS ψ and a longer maturity T lower it. As the shock becomes permanent ($\rho \to 1$), $\phi_T(\rho)$ converges to $1/\psi$ at every maturity, so that the yield response depends on the EIS alone.

Dividing the loss from the rise in rates by the gain holding rates fixed gives

$$\frac{d_T V_T \phi_T(\rho)}{a_T(\rho)} = \frac{\varphi_y}{1 - \rho + \psi\varphi_y}. \tag{B.12}$$

This ratio rises with persistence ρ, so more persistent shocks lead to a greater loss from higher rates relative to the payoff gain.

If this maturity-T strip is the cohort's only direct exposure to z_t and its net duration is concentrated at T, substituting (B.8) and (B.11) into the formula for $\lambda(\rho)$ gives a risk price

$$\lambda(\rho) = \frac{\gamma d_T V_T}{\bar{C}} \frac{G_T(\rho)}{T} \left[1 - \frac{\varphi_y}{1 - \rho + \psi \varphi_y} \frac{\mathcal{D}}{d_T V_T} \right]. \tag{B.13}$$

The risk price is negative exactly when the loss $\phi_T(\rho)\mathcal{D}$ on the cohort's net duration exceeds its direct gain $a_T(\rho)$, that is, when

$$\frac{\mathcal{D}}{d_T V_T} > \psi + \frac{1 - \rho}{\varphi_y}. \tag{B.14}$$

In the limit of permanent shocks ($\rho \to 1$), $G_T(\rho)/T \to 1$, so $a_T \to d_T V_T$ and $\phi_T \to 1/\psi$. If $\mathcal{D} = d_T V_T + \eta d_G V_G$, (B.14) gives $\eta d_G V_G / (d_T V_T) > \psi - 1$, as in the main text.

For two otherwise identical shocks with $\rho_L > \rho_S$, we have $\lambda_L < 0 < \lambda_S$ if

$$\psi + \frac{1 - \rho_L}{\varphi_y} < \frac{\mathcal{D}}{d_T V_T} < \psi + \frac{1 - \rho_S}{\varphi_y}.$$

For any finite $\varphi_y > 0$, the more persistent shock becomes negatively priced at a lower value of $\mathcal{D}$ than the less persistent shock. As $\varphi_y \to \infty$, the output gap is fully stabilized and the cutoff for both shocks converges to ψ.