The Term Structures of Equity Risk Premia in the Cross Section of Equities*

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Abstract

I provide new evidence on the properties of the term structure of equity risk premia by using replication and no-arbitrage to estimate within-firm variation in expected returns across horizons. I demonstrate that a low dimensional set of returns and state variables provide a close replication of claims to firm capital gains at different horizons. Calculating returns from the no-arbitrage prices of these claims, I show that the term structure of risk premia is unconditionally upward-sloping for commonly used test assets like the market and book-to-market sorted portfolios. I derive nonparametric upper bounds on the prices of the replication errors to argue that these results are robust to the pricing of the basis risk of the replication. My method extends the literature by expanding both the span and scope of the data available to test term structure relationships while using prices of assets that are highly liquid relative to the existing derivative datasets. My results are qualitatively consistent with the existing derivatives-based evidence when restricted to the same sample period.

1 Introduction

What is the slope of the term structure of equity risk premia? The term structure of expected returns provides a powerful set of moments to test the predictions of asset pricing models, which drives an active debate on its slope. A rapid expansion of the literature on risk premium term structures is growing out of the observation that market derivative prices may support a downward-sloping term structure of equity risk premia in conflict with the implications of many general equilibrium asset pricing theories. A significant challenge in this debate is the limited time series span and cross-sectional scope of the data available to directly test the equity term structure slope. I extend the literature by proposing a method to estimate the prices of claims to firm cash flows at different horizons via replication and no arbitrage. The benefit of my method is a large reduction in the limitations of the existing data: a 50 year increase in span and a coverage of any cross-section of interest, all while relying on relatively liquid equity security prices rather than derivatives. I find that the evidence from the replication supports more distant claims within the same firm carrying higher risk premia than short term claims, in contrast to much of the empirical literature and consistent with the qualitative predictions of many general equilibrium asset pricing theories.

I replicate the payoffs of claims to a firm's capital gains and show that the no-arbitrage prices of the replicating portfolios can be used to test the slope of the risk premium term structure. First, I replicate the capital gains of portfolios in the cross-section. I show that three variables - portfolio returns, portfolio price to dividend ratios, and their interaction - are sufficient to replicate the capital gains of the market and a variety of cross sectional test assets with R-squared values greater than 99% at horizons up to 5 years. Second, I compute the price of the replicating portfolio, which is known at each date because the price of each of the replicating variables is known. This price is, up to the value of the basis risk, the value of a claim to the continuation value of the firm at a given horizon, which I refer to as a continuation claim. I demonstrate that nonparametric asset pricing bounds on the price of the basis risk of the replication indicate error pricing is unlikely to impact my qualitative conclusions. Next, I conduct the replication and pricing for one year ahead, one year closer continuation claims. This allows me to construct a time series of realized annual holding period returns to continuation claims at various horizons because these returns are simply the one period ahead, one period closer claim price divided by the current claim price. I use these realized returns to test whether distant claims carry higher or lower risk premia than near-term claims.

I focus on claims to the continuation value of the firm, its terminal value after a set number of periods, scaled by the current firm price. I demonstrate in Section 2 that all the implications of a model for the term structure can be captured equivalently by either the stripped dividend claims or the continuation claims at various horizons. This is because both sets of claims are merely different divisions of the firm value across future horizons, and so the two term structures are linked directly by simple identities. My method closely replicates the price of continuation claims with liquid assets and a limited set of factors, yielding highly accurate estimates of the returns to continuation claims. The close relationship between dividend and continuation claims allows me to estimate the implied mean returns of cumulative dividend claims and evaluate the dividend risk premium term structure as well, permitting direct comparison to existing research.

I show that the time series of realized continuation claim returns constructed using my method support continuation claims carrying higher risk premia than both the asset and other continuation claims at shorter horizons. Both of these results imply an upward sloping risk premium term structure, and the results hold for all horizons for virtually all portfolios in the most commonly analyzed cross-sections. I also demonstrate that early dividend claims carry lower risk premia than the asset and that the earliest dividend claims have lower risk premia than more distant dividend claims. Both of these results imply an upward sloping term structure of risk premia as well. This is in contrast to previous work, which finds that early dividend strip derivatives have higher returns than the asset and that firms which deliver cash flows early tend to earn higher returns in the cross-section. I find that the difference between my results and the existing literature can be explained by the expansion of the span of the data provided by my method. My risk premium estimates are qualitatively consistent with existing work when restricted to the sample where dividend strip derivatives are available.[1]

[1] My approach and results also differ starkly from existing cross-section based term structure inference because I focus on within-firm rather than between-firm variation in risk premia. I directly estimate the object of interest, the term structure of claim prices, rather than an implied term structure based on between-firm risk premium variation. I show in Appendix A.3 that without maintaining the assumption that there are no differences in cash flow risk between firms, between-firm differences in risk premia do not identify the term structure of risk premia within any firm or for the market. By directly estimating the object of interest, the prices of claims at different horizons, while allowing for firm and term-specific heterogeneity, I am able to bypass this identification issue.

The remainder of the paper proceeds as follows. The next section briefly reviews the existing theoretical and empirical literature on the term structure of equity returns. Section 2 establishes the core relationships between the prices of dividend and continuation claims, describes the empirical method, and shows how it functions in an illustrative theoretical environment. Section 3 describes the data used in this study and implementation of the method, while Section 4 presents and discusses the core results for the market and the book-to-market sorted cross-section of equities, and Section 5 concludes.

1.1 Existing Research

The recent expansion of research on the term structure of risk premia is in part being driven by the conflict of option and traded strip-based data with existing general equilibrium consumption-based asset pricing theory. Among others, the habits model of Campbell and Cochrane (1999), the long run risks (LRR) model of Bansal and Yaron (2004), and extensions of the rare disasters (RD) model of Barro and Ursua (2008) generate upward sloping or flat term structures of risk premia, volatility, or Sharpe Ratios.[2] This is a result of the core economic mechanism that allows the models to generate large equity risk premia. Resolving this apparent conflict would require altering the mechanism or introducing first order risks present in traded equity and not in the consumption claim. Importantly, dividend strip premia and consumption premia need not follow the same pattern if dividend beta to consumption risk changes by horizon, a point raised by both Croce, Lettau, and Ludvigson (2015) and Belo, Collin-Dufresne, and Goldstein (2015a).

Investigating macroeconomic causes of a disconnect between dividend and consumption term structures is an active area of research. Hasler and Marfe (2016) examine how recession and recovery may affect the term structure, and Ai, Croce, Diercks, and Li (2018) introduce a production-based economy in which dividend strips carry a different pattern of risks by horizon than consumption claims. Andreis, Eisenbach, and Schmalz (2014) investigate the link between time variation in volatility and variation in risk preferences by horizon. Cointegration of a more volatile quantity, like dividends, with a less volatile macroeconomic

[2]Extensions of these models, including Wachter (2006), Drechsler and Yaron (2011), Bansal, Kiku, Shaliastovich, and Yaron (2014), and Gabaix (2012) share at least some of these characteristics: an upward-sloping term structure of risk premia, volatility, or Sharpe Ratios. Hansen (2013), Backus, Boyarchenko, and Chernov (2017), and Piazzesi, Schneider, and Tuzel (2007) all investigate further the implications of various asset pricing models for the term structure of returns.

variable like consumption can result in a downward-sloping or non-monotonic term structure; stationary leverage policies as in Belo, Collin-Dufresne, and Goldstein (2015b) can generate such an environment. Goncalves (2019a) shows that reinvestment risk can alter or invert the slope of the dividend risk premium term structure. Information and learning channels can also affect the term structure of returns: Hasler, Khapko, and Marfe (2019) show how learning can increase risk premia overall while driving a downward-sloping term structure of equity returns and an upward-sloping term structure of bond risk premia.

The literature examining the implications of these models for the cross-section is also extensive and often relies on substantial differences in cash flow risk between firms in the cross-section to generate risk premium differences, as in Bansal, Dittmar, and Lundblad (2005) and Hansen, Heaton, and Li (2008). I build on the latter of these, in which the authors estimate term structures implied by matching the cross-section in structural and vector autoregression models of the stochastic discount factor.[3] In contrast to Hansen, Heaton, and Li (2008), I introduce a statistical method for investigating the term structure without appealing to a specific model of the stochastic discount factor.

Early work on the relationship between equity return term structures and the cross section in Lettau and Wachter (2007, 2011) assumes no differences in cash flow risks across the cross-section in order to isolate the role of the timing of cash flows as a source of variation in risk premia. Assuming no cash flow risk differences in the cross-section allows differences in risk premia between firms with different cash flow timing to identify the term structure slope within firms. More recently, Weber (2018) uses this assumption to show that firms with a low cash flow duration, albeit not accounting for firm or term specificity of discount rates, earn a higher risk premium. Several recent papers have extended these results to show that a variety of other cross-sectional factors can be explained by this "duration premium", e.g. Chen and Li (2019), Goncalves (2019b), and Gormsen and Lazarus (2019). I show in Appendix A.3 that my results are consistent with the findings of these papers because rebalanced portfolios in the cross-section have different dividend risk term structures, which means that the term structure can be upward-sloping for every firm while short duration firms still carry higher risk premia.

[3] My work is also closely related to Menzly, Santos, and Veronesi (2004), Lettau and Ludvigson (2005), and Martin (2013) as I consider dividend growth forecasting variables, most notably aggregate market or sectoral dividend shares in consumption, used extensively therein and in subsequent research. I find that these variables are not necessary to increase the replication fit of the model I propose below, and their inclusion does not alter the qualitative conclusions of my results.

The claims of the existing derivative-based term structure literature, recently summarized in van Binsbergen and Koijen (2017), are that the term structure of equity risk premia is either downward-sloping at short horizons, downward-sloping at some horizon, or has a downward-sloping term structure of Sharpe Ratios or volatility. As van Binsbergen and Koijen (2017) discuss, any of these would be inconsistent with standard calibrations of an LRR, RD, or habit model in some respect. van Binsbergen, Brandt, and Koijen (2012) report the claim that term structures slope downward at some horizon based on the prices of continuation and dividend claims implied by no-arbitrage assumptions and the prices of market equity options. They show that very short claims seem to have higher risk premia and volatility than the asset in their data. The claims of downward sloping returns and Sharpe Ratios are based on traded equity market dividend strip data presented in van Binsbergen, Hueskes, Koijen, and Vrugt (2013) and extended in both van Binsbergen and Koijen (2017) and Gormsen (2018).

There remains considerable discussion on the implications of the dividend strip evidence; Bansal, Miller, Song, and Yaron (2018) discuss issues associated with the span and liquidity of the data and show that its support for a downward sloping term structure is limited after accounting for the data limitations.[4] They show that extending the dataset to account for a longer history of dividend growth data may result in an upward sloping unconditional term structure - a point I am able to confirm by expanding the span and scope of the test assets. Callen and Lyle (2019) document similar conditional evidence using firm-level option data, showing upward slopes in normal times and downward slopes in extreme recessions.

Another branch of the term structure literature examines the risk term structures of other, non-equity, asset classes to provide additional insight into the term structure of risk embedded in the pricing kernel, as opposed to the specific loading on priced risks embedded in equity. This paper focuses exclusively on the evidence related to equity risk term structures, so I refer the interested reader to the survey of this growing literature in van Binsbergen and Koijen (2017).

A common theme in each of these branches of the empirical term structure literature is the attempt to increase the span and scope of the data that can speak directly to the risk term

[4]Boguth, Carlson, Fisher, and Simutin (2011), Song (2018), and Schulz (2016) show why inference regarding dividend strips based on equity options is suspect due to, respectively, micro-structure effects, dealer funding costs, and tax issues. Mixon and Onur (2017), Klein (2018), and Gomes and Ribeiro (2018) raise similar issues of liquidity and price representativeness to Bansal, Miller, Song, and Yaron (2018) in the dividend strip markets.

structure. I extend the literature by developing a method that expands both the span and scope of the data available to test the slope of the equity risk premium term structure. In the next section, I describe how the values of continuation claims, claims to the terminal value of the firm or its capital gains, can be used to test the term structure predictions of an asset pricing model and show how a price series for these claims can be obtained through replication and no-arbitrage.

2 Methods

In this section, I lay out a method for estimating a term structure of expected returns from firm returns and valuations (dividend to price ratios). The benefit of term structure data for testing asset pricing models lies in dividing the infinite horizon claim to firm dividends, a stock asset or firm claim, into a set of claims that are exposed to risks at different horizons. This division provides the researcher with a powerful set of moments with which to evaluate an asset pricing model. A typical approach using the term structure, e.g. van Binsbergen and Koijen (2017) examines stripped coupon or dividend claims. I show that using claims to the continuation value of the firm at a given horizon, a claim to the firm price n periods ahead, P_{t+n}, at time t, contains the same pricing information. I then demonstrate how a straightforward replication experiment can be used to compute the prices of these claims.

2.1 Continuation and Dividend Strip Returns

First, I introduce notation and review the relationship between cash flow strip pricing and firm pricing. Denote the level of the firm dividend at time t, D_t, which is observed in the data. The price of the firm's stock at time t is P_t and its (gross) return from time t to time $t+1$ is $R_{t+1} = \frac{D_{t+1}+P_{t+1}}{P_t}$, both of which are also observed in the data. I will denote multi-period returns as $R_{t,t+n} = \prod_{h=1}^{n} R_{t+h}$. Call a security that pays D_{t+n} at time $t+n$ a dividend claim or dividend strip at horizon n and let it have price $\Pi^n_{d,t}$ at time t. Call a security that pays P_{t+n} at time $t+n$, a claim to the firm's continuation value or capital gains, a continuation claim at horizon n and let it have price $\Pi^n_{p,t}$ at time t. Then the return on a strip from time t to $t+1$ is $R^n_{d,t+1} = \frac{\Pi^{n-1}_{d,t+1}}{\Pi^n_{d,t}}$, or $R^1_{d,t+1} = \frac{D_{t+1}}{\Pi^1_{d,t}}$ for horizon one and the return on a continuation claim from time t to $t+1$ is $R^n_{p,t+1} = \frac{\Pi^{n-1}_{p,t+1}}{\Pi^n_{p,t}}$, or $R^1_{p,t+1} = \frac{P_{t+1}}{\Pi^1_{p,t}}$ for horizon one. I begin with the one period case for simplicity of exposition. Multi-period extensions are straightforward and appear in Appendix A.1.

Under the law of one price there exists a stochastic discount factor (SDF), M_{t+1}, denoted $M_{t,t+n}$ for the multi-period SDF. By definition a return is an asset with a price of one:

$$1 = E[M_{t+1}R_{t+1}] = \frac{\Pi^1_{d,t} + \Pi^1_{p,t}}{P_t} \tag{1}$$

The second equality follows from the law of one price, and shows that the asset consists of a portfolio of dividend and continuation claims. Thus the asset return can also be written as a portfolio of returns on the dividend and continuation claims:

$$R_{t+1} = \frac{\Pi^1_{d,t}}{P_t}\frac{D_{t+1}}{\Pi^1_{d,t}} + \frac{\Pi^1_{p,t}}{P_t}\frac{P_{t+1}}{\Pi^1_{p,t}} = \frac{\Pi^1_{d,t}}{P_t}R^1_{d,t+1} + \frac{\Pi^1_{p,t}}{P_t}R^1_{p,t+1} \tag{2}$$

The price and return of the asset are known, so if the price and return of the dividend claim are known, then the price of the continuation claim is also known and vice versa. A similar relationship holds for multiple horizons. This is the sense in which the continuation claim term structure and the dividend claim term structure contain the same pricing information. We can therefore use either term structure to test the predictions of an asset pricing model. The existing literature focuses on the dividend claim term structure, specifically on the term structure of dividend yields and expected returns, because derivative data exists for these assets from 2002 on, or for short horizons through option data from 1996 on. This literature uses mean realized returns or return expectations, exploiting the fact that the dividend strip yield can be decomposed into expected returns and dividend growth:

$$\frac{D_t}{P_t - \Pi^1_{p,t}} = \frac{D_t}{\Pi^1_{d,t}} = E_t\left[\frac{D_{t+1}/\Pi^1_{d,t}}{D_{t+1}/D_t}\right] = E_t\left[\frac{R^1_{d,t+1}}{D_{t+1}/D_t}\right] \tag{3}$$

The third and fourth terms show that conditional expected returns can be extracted from yields with an estimate of conditional growth expectations, which helps to explain the focus on yields in the existing literature. The first and second terms explain the relationship between this paper and previous work. The first continuation claim differs from the asset only by the first dividend claim, and a similar relationship holds for longer horizons: $\Pi_{d,t}^n = \Pi_{p,t}^{n-1} - \Pi_{p,t}^n$. For any horizon the next continuation claim only excludes the next dividend claim relative to the continuation claim at the previous horizon. I focus on the differences between continuation claims and the asset, while previous work examines the dividend claims, but the same pricing information is contained in both.

To discuss the full term structure, I shift to a multi-horizon approach. The most important relationship for what follows is the multi-period analogue of Equation (2), which shows that the stock return can be written as a portfolio of dividend and continuation claims at any horizon:

$$R_{t+1} = \frac{\Pi_{d,t}^1}{P_t} R_{d,t+1}^1 + \frac{\Pi_{d,t}^2}{P_t} R_{d,t+1}^2 + ... + \frac{\Pi_{d,t}^n}{P_t} R_{d,t+1}^n + \frac{\Pi_{p,t}^n}{P_t} R_{p,t+1}^n \tag{4}$$

Using this fact, I document two empirically useful relationships between dividend and continuation claim term structures in the following proposition:

Proposition 2.1 *Term Structure Relationships:*

1. *If the term structure of expected returns to dividend claims is everywhere monotonic then the term structure of expected returns to continuation claims is everywhere monotonic in the same direction:*

$$E_t[R_{d,t+1}^n] \geq (\leq) E_t[R_{d,t+1}^{n-1}] \;\; \forall \;\; n \quad \Longrightarrow \quad E_t[R_{p,t+1}^n] \geq (\leq) E_t[R_{p,t+1}^{n-1}] \;\; \forall \;\; n$$

2. *The average dividend claim return for all horizons less than n is equal to the scaled difference of the asset return and the continuation claim return:*

$$\sum_{m=1}^{n} \frac{\Pi_{d,t}^m}{P_t - \Pi_{p,t}^n} R_{d,t+1}^m = \frac{1}{P_t - \Pi_{p,t}^n} (R_{t+1} - \Pi_{p,t}^n R_{p,t+1}^n)$$

While I state these facts as a proposition for easy reference, they are both direct implications of Equation (4), so the proof is uninformative. The intuition for both is simple. The first fact is immediate from taking the conditional expectation of Equation (4). The continuation claim return is a weighted average of all subsequent dividend claim returns, thus when we move from horizon $n-1$ to n we remove only the horizon n dividend claim. This claim has a lower (higher) expected return than all subsequent claims when the strip term structure is monotone increasing (decreasing), thus removing it increases (decreases) the average. The second claim is even more straightforward and follows from the same manipulation - the continuation claim at horizon n and the dividend claims for horizons less than or equal to n are the same portfolio of claims as the stock. Rearranging Equation (4) and multiplying by $P_t/(P_t - \Pi^n_{p,t})$ delivers the result.

These facts allow me to derive tests for whether distant claims have greater or lesser expected returns than near-term claims, tests that utilize only the prices of continuation claims[5]. The first fact is useful because of its contrapositive - if the term structure of continuation claims is not monotonic then the term structure of dividend claims is not everywhere monotonic. Thus, testing the slope of the continuation claim expected return term structure lets us falsify universal monotonicity of the strip term structure. The second fact suggests a direct test - since the continuation claim at horizon n contains only longer-term claims than the dividend claims up to n, testing the continuation claim return relative to the asset return directly evaluates whether the more distant continuation claim has a greater or lesser return than the nearer term dividend claims.

Finally, we can test the cumulative strip term structure directly using the second claim since the price of the cumulative claim up to n is always $P_t - \Pi^n_{p,t}$. This is empirically useful because dividend prices at long horizons are small, generally less than 4% of the asset price, and bounded below by zero, so even minuscule pricing errors in the two continuation claim prices used to compute $\Pi^n_{d,t} = \Pi^{n-1}_{p,t} - \Pi^n_{p,t}$ can result in noisy estimates of the dividend return that may come close to violating this boundedness. Comparing the price of one asset that is well estimated, the continuation claim, and one asset that is known, the return, alleviates the compounding of estimation error and results in less noisy estimates. This makes the use of cumulative dividend claims both an empirically desirable and theoretically valid method of investigating return term structures. In the next section I introduce a method for computing continuation claim prices using only stock return and valuation (dividend to price ratio) data

[5]It is worth noting in conjunction with these facts that the slope of the risk premium term structure for dividend claims is related directly to the second derivative of the slope of the continuation term structure, i.e. the slope is determined by whether $\frac{\Pi^{n-2}_{p,t}}{\Pi^{n-2}_{p,t} - \Pi^{n-1}_{p,t}}(E_t[R^{n-2}_{p,t+1}] - E_t[R^{n-1}_{p,t+1}]) \leq (\geq) \frac{\Pi^n_{p,t}}{\Pi^{n-1}_{d,t} - \Pi^n_{p,t}}(E_t[R^{n-1}_{p,t+1}] - E_t[R^n_{p,t+1}])$. This is why the converse of the first fact is not necessarily true.

and the assumption of no arbitrage that will allow me to exploit these two facts and test the slope of the term structure explicitly.

2.2 No-Arbitrage Prices of Continuation Claims

The core empirical challenge of conducting term structure inference is that the term structure of dividend claim prices is not observed at the firm level. Existing research relies on assumptions about relative firm risk or data on traded market derivatives. I introduce methods to extract implied firm continuation claim prices from the cross section via a replication exercise and the assumption of no-arbitrage. This allows me to use a dataset with substantially greater span and liquidity when analyzing market claims and also to directly estimate previously unavailable claim prices for portfolios in the cross-section.

The most important characteristic of the data that permits a replication exercise is that we know the price of assets accounting for almost all of the variation in the continuation value. We can rearrange the definition of the return as:

$$\frac{P_{t+1}}{P_t} = -\frac{D_t}{P_t} + R_{t+1} - \frac{\Delta D_{t+1}}{P_t} \tag{5}$$

$$\frac{P_{t+n}}{P_t} = -\frac{D_t}{P_t} + R_{t,t+n} - \frac{D_t}{P_t}\left(R_{t,t+n-1}\frac{D_{t+n}/D_t}{P_{t+n-1}/P_t} - 1\right) \tag{6}$$

The final term of each equation is the only component with an unknown price. The structure of Equation (6) leads me to construct the no-arbitrage prices of dividend and continuation claims using a simple replication exercise. The object of interest is the price of a claim to the per-share price of the stock n years in the future, P_{t+n}, denoted $\Pi^n_{p,t}$. The replication exercise is as follows. We desire to match the realized payoff of a continuation claim n periods in the future using realized cumulative returns, $R_{t,t+n}$, and conditioning on the firm's dividend to price ratio $\frac{D_t}{P_t}$. The essential characteristic of the replicating portfolio assets is that the price of a claim to their cash flows at $t+n$ is known at time t, so in principle additional conditioning time t variables or realized cumulative returns could be used. I find that such variables are empirically unnecessary to replicating continuation claim payoffs, and so tend towards the parsimony of the three factor model. We could write the replication exercise as:

$$\frac{P_{t+n}}{P_t} = b_0 + b_z \frac{D_t}{P_t} + b_r R_{t,t+n} + b_{zr} \frac{D_t}{P_t} R_{t,t+n} + \epsilon_{t,t+n} \tag{7}$$

If dividend to price ratios do not move much relative to the other elements, then a regression of capital gains on returns omits only the final term of the decomposition in Equation (6). At horizon 1 this piece is just the dividend growth scaled by the current price. As Equation (6) shows, at longer horizons this missing piece will be correlated with the interaction of cumulative returns and the dividend to price ratio. I decompose the covariance of the rebalanced CRSP market return into these components in Tables 1 and 2, which show that very little of the movement is driven by the dividend to price ratio or interaction terms. The contribution of the interaction terms increases somewhat with horizon but almost all the variation is driven by the capital gains term up to five years out. This suggests that a replication of capital gains with returns, dividend to price ratios, and their interaction would be highly accurate, a fact I confirm below.

Note that in Equation (7) the errors, $\epsilon_{t,t+n}$, are the basis risk of the replication. If we estimate the coefficients of the replicating portfolio using a regression, the realizations of the basis risk will equal the regression residuals in-sample. In order to proceed, I make two important economic assumptions here. The first is that there are no arbitrage opportunities in securities markets and that there would be no arbitrage opportunities in securities markets were liquid claims to firm dividends and continuation value to be traded in the market. Taking expectations under the risk-neutral measure prices Equation (7):

$$\begin{aligned} \frac{\Pi^n_{p,t}}{P_t} = E_t\left[M_{t,t+n}\frac{P_{t+n}}{P_t}\right] = b_0 E_t\left[M_{t,t+n}\right] + b_z E_t\left[M_{t,t+n}\frac{D_t}{P_t}\right] + \\ + b_r E_t\left[M_{t,t+n} R_{t,t+n}\right] + b_{zr} E_t\left[M_{t,t+n}\frac{D_t}{P_t} R_{t,t+n}\right] + E_t\left[M_{t,t+n}\epsilon_{t,t+n}\right] \end{aligned} \tag{8}$$

The right hand side of Equation (8) is straightforward to evaluate. The price of any instrument known at time t, the constant and the dividend to price ratio in this case, is simply the value of the instrument discounted at the riskfree rate. The price of a cumulative return is one by definition. Substituting the known prices gives:

Table 1: Covariance of Return Decomposition Elements - Horizon One

	$R_{t,t+n}$	P_{t+n}/P_t	D_t/P_t	Interaction
$R_{t,t+n}$	1.000	0.962	0.022	-0.007
P_{t+n}/P_t	0.962	0.931	0.017	-0.011
D_t/P_t	0.022	0.017	0.004	0.004
Interaction	-0.007	-0.011	0.004	0.004

Notes: I present the covariance matrix of returns, capital gains, dividend to price ratios, and the scaled dividend growth term as described by Equation (5), scaled by the variance of the return. This is for the horizon 1 return only. The data is the CRSP rebalanced, value weighted market index from 6/1950 to 6/2012.

Table 2: Covariance of Return Decomposition Elements - Horizon Five

	$R_{t,t+n}$	P_{t+n}/P_t	D_t/P_t	Interaction
$R_{t,t+n}$	1.000	0.960	0.021	-0.008
P_{t+n}/P_t	0.960	0.927	0.015	-0.012
D_t/P_t	0.021	0.015	0.005	0.004
Interaction	-0.008	-0.012	0.004	0.005

Notes: I present the covariance matrix of returns, capital gains, dividend to price ratios, and the interaction term as described by Equation (5), scaled by the variance of the return. This is for the horizon 5 return only. The data is the CRSP rebalanced, value weighted market index from 6/1950 to 6/2012.

$$\frac{\Pi^n_{p,t}}{P_t} = \frac{b_0}{R^f_{t,t+n}} + \frac{b_z}{R^f_{t,t+n}}\frac{D_t}{P_t} + b_r + b_{zr}\frac{D_t}{P_t} + E_t\left[M_{t,t+n}\epsilon_{t,t+n}\right] \tag{9}$$

The second assumption that is necessary to obtain a price for the dividend and continuation claims is how to price the basis risk $E_t[M_{t,t+n}\epsilon_{t,t+n}]$. Note that by construction the basis risk is conditionally uncorrelated with the cumulative returns $R_{t,t+n}$. Thus there are two sufficient conditions that would lead to negligible basis risk, $E_t[M_{t,t+n}\epsilon_{t,t+n}] \approx 0$, either $R_{t,t+n}$ is the only priced risk relevant to the continuation claims at all horizons, or the variance of the basis risk is nearly zero $V_t(\epsilon^n_{t,t+n}) \approx 0$. The former assumption is both theoretically and empirically undesirable because it requires the researcher to know the true model that prices assets, converted to a factor model. I assume the latter condition, $V_t(\epsilon^n_{t,t+n}) \approx 0$, holds throughout and provide evidence supporting this from the regression outputs for Equation (7), since if $V_t(\epsilon^n_{t,t+n}) \approx 0$ the regression R-squared must be very close to one. Note that even if jumps are present in the true data generating process, they would have to be present in $R_{t,t+n-1}\frac{D_{t+n}/D_t}{P_{t+n-1}/P_t}$ but not in $R_{t,t+n}$ and highly priced despite the difference between these two terms generating almost none of the variance of capital gains historically in order to violate my assumption.

I refer to the price estimate assuming the basis risk price is zero as $\hat{\Pi}^n_{p,t}$ when the distinction is relevant. Equation (9) and its one period ahead analogue for the same asset or portfolio give a time series of prices for each continuation claim relative to the asset, estimates of a time series of $\frac{\hat{\Pi}^n_{p,t}}{P_t}$ for each horizon for which the regression is run. From these we can construct a time series of realized annual holding period returns across the term structure by multiplying by the current firm price.

$$\hat{R}^n_{p,t+1} = \frac{\hat{\Pi}^{n-1}_{p,t+1}}{\hat{\Pi}^n_{p,t}} \tag{10}$$

The moments of Equation (10) provide a means to test the hypotheses laid out in Section 2.1. I address the specifics of data and testing using these moments in Section 3, but first I address the performance of this method in a theoretical environment.

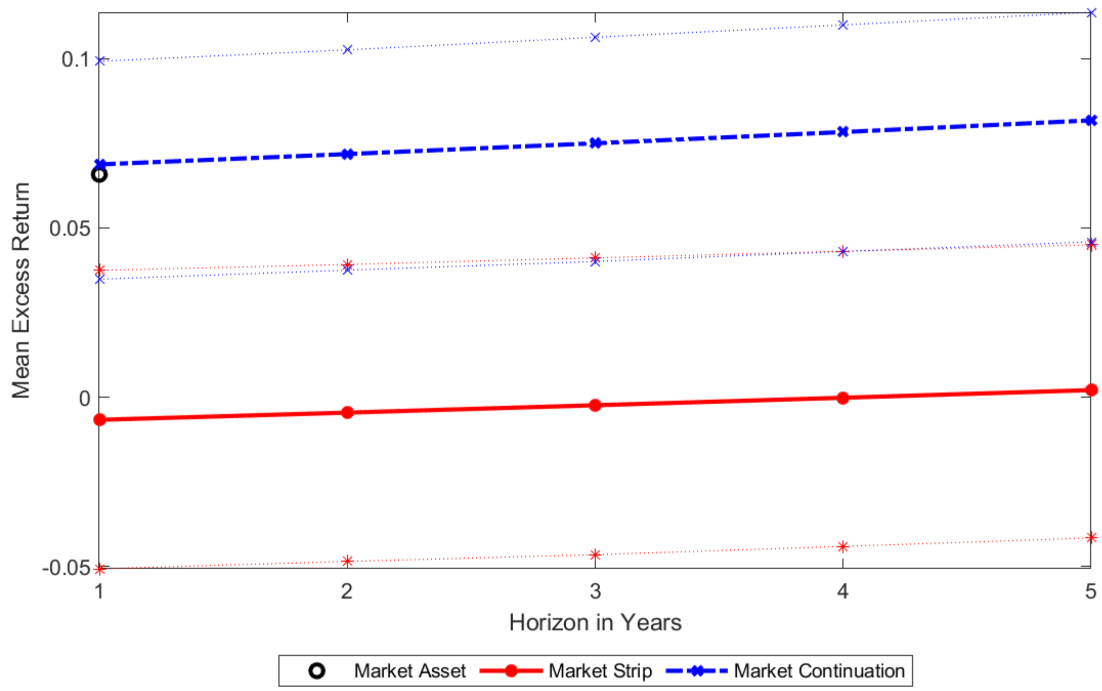
2.3 Validation of the Method

It remains to show that this method can reproduce the two necessary conditions for its validity - a high replication R-squared and the correct prices of continuation claims. I demonstrate the success of this method in a common affine theoretical environment with a vector of states evolving according to a stochastic volatility vector autoregression (SVVAR) and affine dividend betas and risk prices. This keeps the notation for the solution for strip expected returns and prices relatively compact while preserving the consumption-based general equilibrium model and allowing for some flexibility of parameterization. I present specifics of the model and the solution method in Appendix A.2 as it is entirely standard for this literature. I show that in this environment the regressions reproduce a high R-squared and the correct time series of prices.

The most important insight from the model solution is that any model of this general form generates different risk premia at different horizons solely through the different loadings of the strip pricing coefficients on the states at different horizons, which are driven entirely by difference in dividend betas and the relative persistence of the states. This is the core mechanism for generating cross-sectional differences in risk premia in work like Bansal, Dittmar, and Lundblad (2005) and Hansen, Heaton, and Li (2008). Note that models like these also imply that when firms vary in dividend beta, their cash flow risk or strip premia will also differ at every horizon, not just on average for the asset. This means that cross-sectional differences in dividend beta rule out, in the general case, the single risk term structure assumption used as a theoretical tool to isolate the impact of duration in Lettau and Wachter (2007), where only mean dividend growth rates differ across portfolios (and across time within firms).

A standard calibration of the model delivering a long run mean price to dividend ratio of 36.3, a long run mean asset risk premium of 6.54%, and asset return volatility of 15.2% gives the core predictions for the expected returns of both continuation and stripped claims as in Figure 1. The important predictions for the term structure, which I evaluate in the data, are that the continuation claim has an upward-sloping term structure that sits everywhere above the asset term structure. This is because long-duration claims hold higher risk premia than short duration claims across the term structure, so the basic shape of the continuation claim term structure follows immediately from Proposition 2.1. Cumulative dividend claim term structures approach the asset return from below. All of these relationships are displayed in

Figure 1: Expected 1 Period Risk Premia at the Unconditional Mean

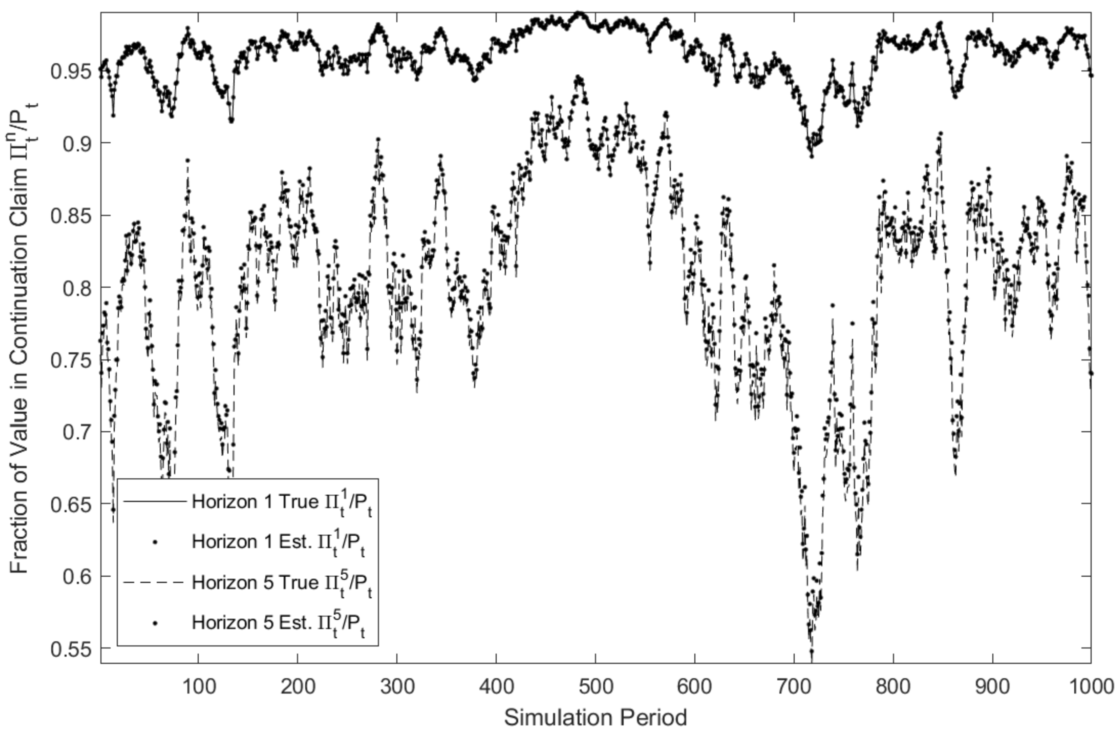


Notes: The grand mean risk premia of the asset, dividend claims, and continuation claims in the model. I simulate 1000 draws from a 60 year sample and record the grand mean and the simulated 25th and 75th percentile bands for the mean.

Figure 1, which also gives the 25th and 75th percentile of the simulated mean excess returns. Note that the earliest strips will appear to be hedge assets in nearly half of realizations because their risk premium is so small. This is also likely to be the case in the data given the minuscule contribution of short run realized growth shocks to asset returns displayed in Table 1, a fact which my results confirm.

The prices and expected returns of continuation claims are simple sums or means of the strip claim prices and returns as shown in Section 2.1. I simulate 1000 periods from the model and record the true prices of the dividend and consumption claims implied by the model. After this I run the regression proposed in Equation (7) and compute the no-arbitrage price of the continuation claims implied by applying Equation (9) using the model riskfree rate. I find an R-Squared of 0.99 or greater in both the replicating regression and for a regression

Figure 2: True Model Prices of Continuation Claims Versus No-Arbitrage Estimates



Notes: The model generated true fraction of firm value in the continuation claim and the estimate of the fraction of firm value in the continuation claim implied by applying Equation (9) using the model riskfree rate for horizons one and five. I present a 1000 year sample run.

of the model implied continuation claim prices on the estimated no-arbitrage prices from the replication experiment. Figure 2 presents a sample simulation run for two horizons, showing the continuation claim price as a line and the estimated claim prices as points. It is visually evident, confirming the high R-squared, that the price estimates track the true prices almost exactly. This confirms that the procedure indeed reproduces the correct price series when the replicating regression produces a high R-squared in a theoretical environment. I proceed to implement this procedure using the cross-section of U.S. stock returns.

3 Data and Implementation

Wherever possible I use standard, publicly available data sources. My primary source of return data is the Center for Research in Security Prices monthly stock file, Update (2018), and the associated value weighted market return index for all US exchanges. I use the Compustat Industrial file, Compustat (2018) for fundamental data including book equity, earnings, assets, and gross profitability data used in the formation of buy and hold portfolios in the cross section. I use the zero coupon nominal interest rate curve computed by Gürkaynak, Sack, and Wright (2007) throughout. I extend this data slightly using US Treasury data, however sufficient zero coupon rates to conduct this analysis do not exist prior to about 1950. The riskfree rate is an essential component of the no-arbitrage prices of dividend claims and real riskfree series do not exist for the majority of my sample, so I conduct the replication and pricing analysis in nominal terms. Finally, I use the rebalanced cross-sectional return data constructed by Fama and French (1993) directly whenever possible to provide easy comparison to earlier work. I also consider international returns as reported by the Thomson-Reuters Datastream indices.

Since I focus on firm outcomes, I use buy-and-hold portfolios for the cross-section for my primary results and present rebalanced portfolio evidence for completeness. I use the rebalanced market returns from CRSP as the market return for comparability with previous work, but the results for the buy-and-hold market are similar. A buy-and-hold portfolio, in contrast to a rebalanced portfolio, consists of the same set of firms throughout its life, up to the exclusion of exiting firms. Thus, it tracks firm performance without including rebalancing or entry effects. At each date τ from 6/1950 to 6/2012, I sort all firms on a characteristic, for example the ratio of book equity to market equity, and form decile portfolios. I refer to the formation date of a portfolio as its vintage. The buy-and hold portfolio for a given decile for a given vintage τ consists of all firms that were in that decile at date τ, regardless of future changes in characteristics. For decile portfolios, I exclude all firms with negative book value or that are missing the sort characteristic data in Compustat. The market portfolio for vintage τ consists of all firms in CRSP at date τ.

I construct capital gains and total return series for the market and the cross section of assets for monthly formed buy-and-hold portfolios, where accounting data is the most recent update as of six months prior. Using annual formation dates produces similar point estimates but noisier replication coefficients, even after accounting for the induced persistence of the data. I use standard rebalanced and buy and hold portfolio construction methods, as in Fama and French (1993). I extract three series for each cross sectional portfolio and for the market: the total return series, a capital appreciation series, and a total market capitalization series, all at a monthly frequency. For simplicity and consistency, I construct all variables using the methods of Bansal, Dittmar, and Lundblad (2005). The per share return of any security is:

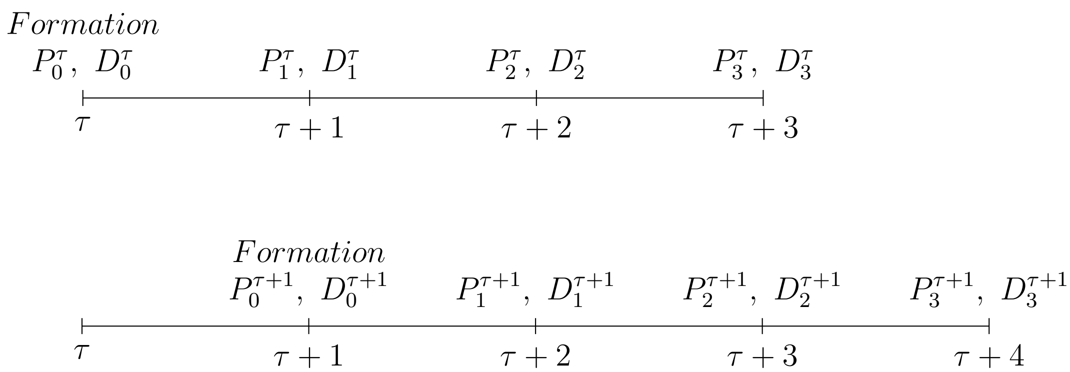
$$R_{t+1} = H_{t+1} + Y_{t+1} \tag{11}$$

Where $H_{t+1} = \frac{P_{t+1}}{P_t}$ is the per share capital gain and Y_{t+1} is the realized forward cash flow yield $\frac{D_{t+1}}{P_t}$. Given the total return and price per share capital gain series, I calculate the time series of Y_{t+1} for each portfolio at the monthly frequency. I also calculate a per share price series as the running product of H_{t+1}. I estimate the dividends paid per share for each month t+1 as the product of this price series at time t and the dividend yield variable Y_{t+1}. I estimate the aggregate dividends paid in month t+1 by multiplying Y_{t+1} by the total market capitalization variable for time t. I convert all dividend variables to the annual frequency by summing the relevant dividend series over the past 12 months. I use the per share price and dividends paid series at the annual frequency to construct the price to dividend ratio series as price divided by last 12 months dividends paid per share.

The resulting dataset consists of 11 portfolios (the market and each decile) formed at each vintage τ from 1950 to 2012. I track the outcomes of each portfolio for up to six years after formation. This gives a time series of six years of price appreciation, total return, per share dividends, and aggregate dividends for each portfolio for each vintage, forming a vintage-panel dataset. This vintage-panel dataset forms the basis of the replication exercise that allows me to estimate prices of claims to firm dividends and continuation value. I use the same vintage panel data construction process for the rebalanced portfolios, including the market, the only difference being that the return on a vintage τ rebalanced portfolio n periods ahead is just the rebalanced portfolio return at $\tau + n$, rather than the return on a buy-and-hold portfolio formed at a different date.

In implementing these regressions the continuation yields, or capital gains, $\frac{P_{\tau+n}}{P_\tau}$ are for realizations on a specific vintage τ portfolio. I then estimate the regression using a sample over vintage years for the same portfolio decile or the market for each horizon n between one and five years. I also need the one period ahead prices for the same assets to compute

Figure 3: Vintage Portfolio Formation Timeline



Notes: The upper timeline presents the data formation for the vintage τ portfolio, the lower timeline for the vintage $\tau+1$ portfolio. To emphasize the difference between this vintage data and time series data, I denote the vintage formation date as a superscript and the time since formation as a subscript, thus P_0^τ is the price at formation of the vintage τ portfolio, P_1^τ is the price 1 month later, and so on.

the numerator of Equation (10), $\hat{\Pi}_{p,t+1}^{n-1}$, and therefore run a second set of regressions, the one period ahead analogue of Equation (7). The only difference between these regressions are that all variables have been moved one period forward in time and that the regression is run at time $\tau+1$ for a vintage τ portfolio, rather than at time τ for a vintage τ portfolio. To make clear how the data is formed, I show a timeline of the data constructed as Figure 3. The upper timeline shows how prices and dividends are produced for the vintage τ portfolio, while the lower timeline does the same for the vintage $\tau+1$ portfolio. To emphasize the difference between this vintage data and time series data, I denote the vintage formation date as a superscript and the time since formation as a subscript, thus P_0^τ is the price at formation of the vintage τ portfolio, P_1^τ is the price one month later, and so on.

The underlying assumption behind this sample formation is that the vintages represent a sample from a process with stationary risk and growth prospects. In unconditional expectation the portfolios formed at the various vintages must have the same risk and growth, an assumption that is ubiquitous in the literature for cross-sectional portfolios (my test assets) but questionable for individual firms. This is why I conduct the analysis at the portfolio rather than the firm level.

The sample of prices at horizon one is therefore $\{P_1^\tau, P_1^{\tau+1}, ..., P_1^T\}$, so varying across formation vintage produces the sample. Therefore I implement Equation (7) by regressing

$\frac{P_1^\tau}{P_0^\tau}$ on $\frac{D_0^\tau}{P_0^\tau}$, R_1^τ, and $\frac{D_0^\tau}{P_0^\tau}R_1^\tau$, and so on, sampling across formation vintages τ:

$$\frac{P_n^\tau}{P_0^\tau} = b_0 + b_z\frac{D_0^\tau}{P_0^\tau} + b_r R_n^\tau + b_{zr}\frac{D_0^\tau}{P_0^\tau}R_n^\tau + \epsilon_n^\tau$$

This procedure produces a time series of prices for the continuation claims at all horizons for which the regression is run, both at the formation vintage and one year later. I use these price series to compute annual holding period returns for the continuation claim starting at each vintage formation date. This gives an overlapping vintage time series of realized holding period returns, for which I compute the mean excess return to provide my main results. In implementing the regressions I estimate both the replication coefficients and the mean returns as simultaneous equations using GMM with HAC standard errors to account for first stage estimation error in computing the mean return test statistics, as well as the induced persistence of the data. I will drop the subscripting by τ in what follows for brevity, assuming that sampling over formation vintages is understood.

4 Results

In this section, I document my main results. I begin by reporting the quality of the replication and forecasting experiments then present summary statistics for the resulting distributions of firm value and annual holding period returns.

4.1 Replication of Capital Gains

The first empirical issue is the quality of the replication. I use the book-to-market sorted cross section in my main results and produce supporting results for other cross-sectional sorts in Appendix A.4. I also consider additional predictive variables used extensively in the literature: valuations of the cross-section, aggregate dividend shares in consumption of the cross-section, and riskfree rates, finding that the parsimonious model with only the own-portfolio valuation and return is sufficient to deliver very high replication quality and additional variables do not qualitatively alter the results[6].

I report the results for the replication regressions in Tables 3 and 4. Note that because both stages, the replication and mean return estimation, of the estimation are linear the GMM point estimates are the OLS estimates but the standard errors are larger depending on the first stage estimation error. As shown in Table 3, I find that the replications are highly precise for the continuation claims throughout the cross-section and for the market, generating R^2's greater than .99 for nearly all test portfolios and horizons[7]. Much of this high replication quality is driven by the fact that I am regressing cumulative capital gains on cumulative returns. Comparing Equation (6) with the estimated price reinforces why this works so well:

$$\frac{P_n}{P_0} = 0 - \frac{D_0}{P_0} + R_n - \frac{D_0}{P_0}\left(R_{n-1}\frac{D_n/D_0}{P_{n-1}/P_0} - 1\right)$$

$$\frac{P_n}{P_0} = b_0 + b_z\frac{D_0}{P_0} + b_r R_n + b_{zr}\frac{D_0}{P_0}R_n + \epsilon_n$$

The former equation is the true relationship while the latter is the approximation. Capital gains and returns differ only by the accumulated dividend payments, and the interaction term picks up some of this at longer horizons. Note that if we executed the true relationship exactly, $b_r = 1$ and $b_z = -1$. Including the interaction terms pushes the b_r coefficient towards its true value relative to a regression of capital gains on returns alone, where b_r is lower and more distant from one. The interaction term combined with the persistence of dividend to price ratios allows for predictability in the missing dividend piece since $\frac{D_n/D_0}{P_{n-1}/P_0}$ is small up to horizon five and does not appear to cause large jumps that are missed by the replication. Table 5 shows that the same relationships are borne out in the buy-and-hold cross-section.

[6]Valuations in the cross-section and riskfree rates are standard in the consumption-based asset pricing literature. Aggregate shares are discussed and examined as predictive variables in Menzly, Santos, and Veronesi (2004), Lettau and Ludvigson (2005), and Martin (2013).

[7]The high quality of the replication is not limited to the continuation claim portion of the asset. The cumulative reinvested dividends are implicitly approximated by $R_n^\tau - \hat{P}_n^\tau/P_0^\tau$, where the latter term is the quantity being replicated directly in the regression. The pseudo-R^2 of the implied dividend regression is therefore $1 - \frac{\sum_{\tau=1}^T(\hat{P}_n^\tau/P_0^\tau - P_n^\tau/P_0^\tau)^2}{\sum_{\tau=1}^T(R_n^\tau - P_n^\tau/P_0^\tau - T^{-1}[\sum_{\tau=1}^T(R_n^\tau - P_n^\tau/P_0^\tau])^2}$. This quantity ranges from 95.9% at horizon 1 for the market to 94.4% at horizon 3 and 94.1% at horizon 5, displaying excellent fit for the cumulative dividends as well. Increasing the number of instruments or returns in the regression as described above and in the previous footnote only marginally increases the implied dividend fit and does not materially alter the results.

Table 3: R^2 and RMSE of Capital Gains Replication

Claim	Market R^2	Market RMSE	Growth (BM 2) R^2	Core (BM 5) R^2	Value (BM 10) R^2
P_1/P_0	99.9+%	0.3%	99.9+%	99.9%	99.9%
P_3/P_0	99.7%	1.4%	99.8%	99.6%	99.5%
P_5/P_0	99.5%	3.5%	99.7%	99.2%	99.0%

Notes: I present the regression R-squared and root-mean-squared-error for the replication regression $\frac{P_n}{P_0} = \frac{P_n}{P_0} = b_0 + b_z \frac{D_0}{P_0} + b_r R_n + b_{zr} \frac{D_0}{P_0} R_n + \epsilon_n$. I use monthly formation dates from 6/1950 to 6/2012 form the vintage-panel dataset used to estimate the regression. For brevity I present the results for the continuation claims at horizons 1, 3, and 5, for the market and portfolios 2, 5, and 9 in the Book-to-Market sorted cross-section.

Table 4: Capital Gains Replication Regression Coefficients - Market

	P_1/P_0	t-stat	P_3/P_0	t-stat	P_5/P_0	t-stat
b_0	0.005	[1.956]	0.011	[0.928]	0.025	[0.922]
b_z	-0.774	[-6.059]	-2.054	[-3.581]	-4.162	[-3.138]
b_r	0.994	[550.620]	0.986	[126.650]	0.976	[56.455]
b_{zr}	-0.275	[-3.370]	-1.168	[-4.450]	-1.775	[-3.600]
R^2	1.000		0.997		0.995	

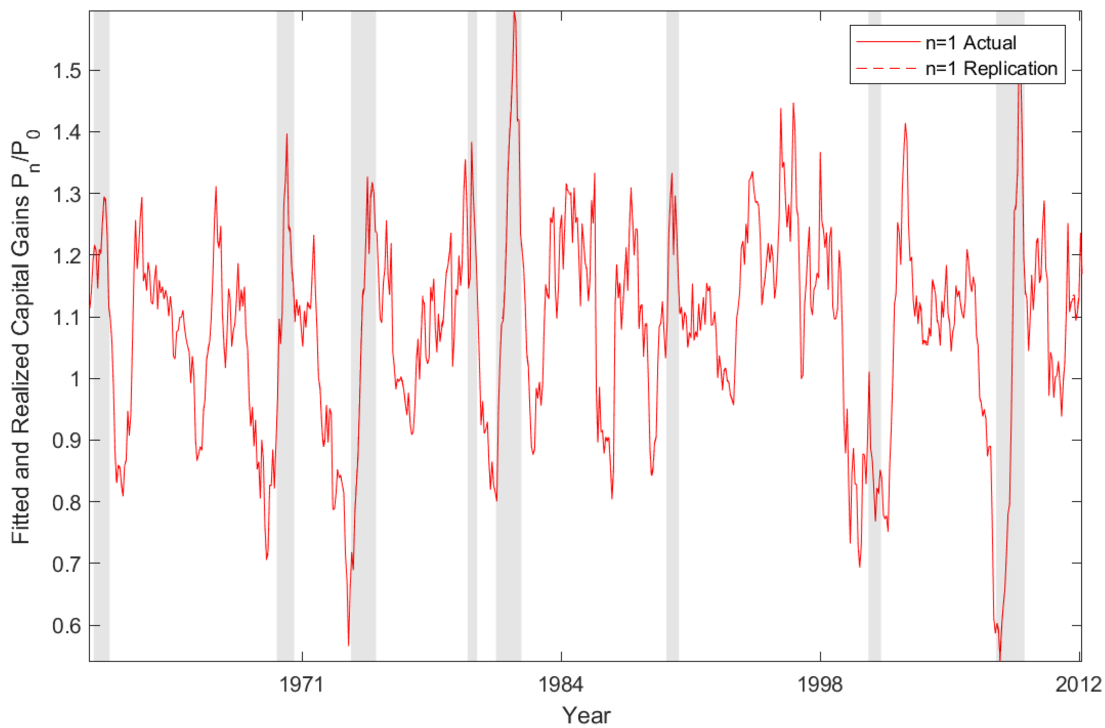
Notes: I present the coefficient estimates with t-statistics based on HAC standard errors for the replication regression $\frac{P_n}{P_0} = b_0 + b_z \frac{D_0}{P_0} + b_r R_n + b_{zr} \frac{D_0}{P_0} R_n + \epsilon_n$. I use monthly formation dates from 6/1950 to 6/2012 form the vintage-panel dataset used to estimate the regression. For brevity I present the results for the continuation claims at horizons 1, 3, and 5.

Table 5: Capital Gains Replication Regression Coefficients - Book to Market

	P_1/P_0	t-stat	P_3/P_0	t-stat	P_5/P_0	t-stat
			Portfolio 2 (Growth)			
b_0	0.001	[0.285]	-0.001	[-0.225]	0.020	[1.397]
b_z	-0.578	[-3.811]	-1.394	[-4.259]	-3.728	[-4.188]
b_r	0.996	[494.960]	0.988	[180.070]	0.961	[75.642]
b_{zr}	-0.373	[-3.241]	-1.413	[-9.464]	-1.531	[-4.102]
R^2	1.000		0.998		0.997	
			Portfolio 5 (Core)			
b_0	0.005	[1.759]	-0.002	[-0.128]	-0.017	[-0.577]
b_z	-0.717	[-8.507]	-1.267	[-3.108]	-2.085	[-1.962]
b_r	0.994	[548.880]	0.991	[170.440]	0.991	[87.780]
b_{zr}	-0.305	[-6.607]	-1.587	[-9.819]	-2.658	[-7.624]
R^2	0.999		0.996		0.992	
			Portfolio 9 (Value)			
b_0	0.007	[1.924]	0.023	[1.267]	0.013	[0.264]
b_z	-0.781	[-7.195]	-1.921	[-3.950]	-2.425	[-1.951]
b_r	0.992	[400.910]	0.967	[74.696]	0.955	[32.624]
b_{zr}	-0.205	[-2.815]	-0.924	[-4.021]	-1.851	[-3.560]
R^2	0.999		0.995		0.990	

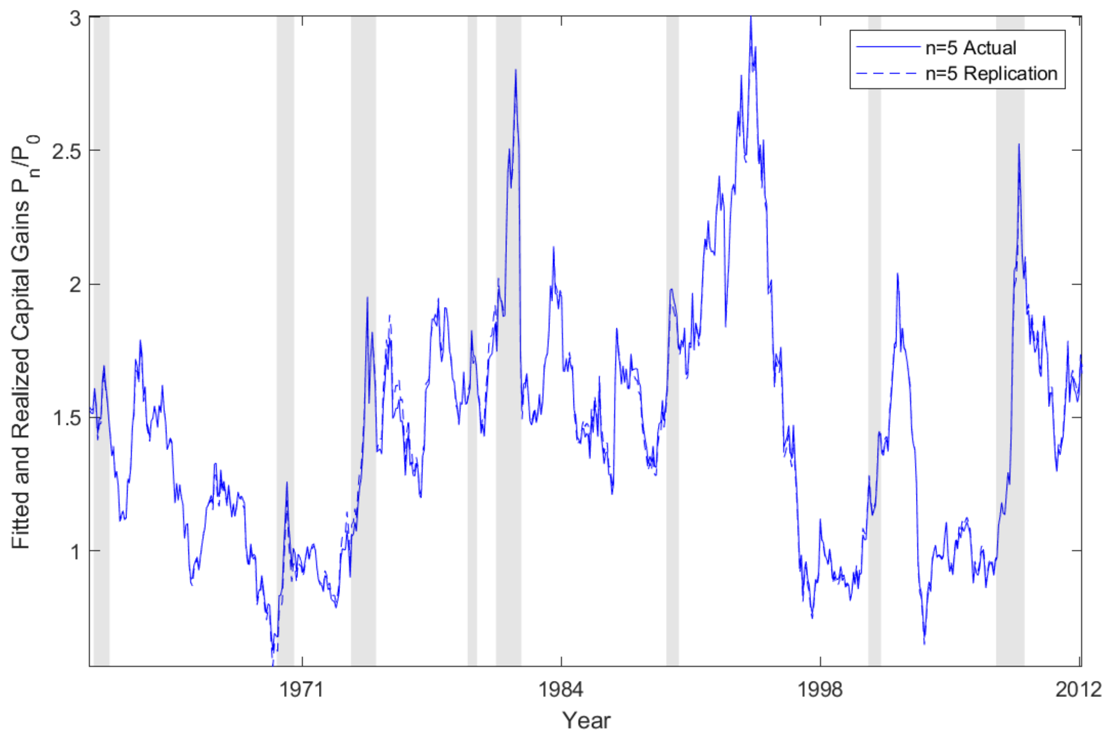
Notes: I present the coefficient estimates with t-statistics based on HAC standard errors for the replication regression $\frac{P_n}{P_0} = b_0 + b_z \frac{D_0}{P_0} + b_r R_n + b_{zr} \frac{D_0}{P_0} R_n + \epsilon_n$. I use monthly formation dates from 6/1950 to 6/2012 form the vintage-panel dataset used to estimate the regression. For brevity I present the results for the continuation claims at horizons 1, 3, and 5, for portfolios 2, 5, and 9 in the Book-to-Market sorted cross-section.

Figure 4: Continuation Claim Replication - Market Horizon 1



Notes: I present the replicated capital gains given by $b_0 + b_z \frac{D_0}{P_0} + b_r R_n + b_{zr} \frac{D_0}{P_0} R_n$ as a dashed line alongside the realized capital gains given by $\frac{P_n}{P_0}$ as a solid line for horizons one and five. I use monthly formation dates from 6/1950 to 6/2012 to compute the regression coefficients, and present the results for the rebalanced market.

Figure 5: Continuation Claim Replication - Market Horizon 5



Notes: I present the replicated capital gains given by $b_0 + b_z \frac{D_0}{P_0} + b_r R_n + b_{zr} \frac{D_0}{P_0} R_n$ as a dashed line alongside the realized capital gains given by $\frac{P_n}{P_0}$ as a solid line for horizons one and five. I use monthly formation dates from 6/1950 to 6/2012 to compute the regression coefficients, and present the results for the rebalanced market.

4.2 Non-Parametric Bounds on Error Pricing

While the replication results confirm that the assumption $E_t[M_{t,t+n}\epsilon_{t,t+n}] \approx 0$ holds in the data, it may still be the case that these errors carry a large risk premium due to a high correlation with a volatile SDF. One way to approach this issue is to approximate the maximal risk premium impact of the pricing errors for a SDF that is sufficiently volatile to price the test assets, following Hansen and Jagannathan (1991)[8]. Hansen and Jagannathan (1991) provide the following condition for a SDF which is sufficiently volatile to price a set of test assets, indexed by i:

$$\sigma_{M_{t,t+n}} \geq E_t[M_{t,t+n}] \max \left\{ \frac{E_t[R_{t,t+n}] - R^n_{f,t}}{\sigma_{R_{t,t+n}}} \right\} \equiv \sigma^{HJ}_{M,t} \tag{12}$$

Where I denote the volatility of an SDF exactly achieving this bound $\sigma^{HJ}_{M,t}$. Since the errors are mean zero by construction, we can write the price of the errors as:

$$E_t[M_{t,t+n}\epsilon_{t,t+n}] = E_t[M_{t,t+n}]E_t[\epsilon_{t,t+n}] + COV_t[M_{t,t+n}\epsilon_{t,t+n}] = COV_t[M_{t,t+n}\epsilon_{t,t+n}]$$

For an SDF which is just volatile enough to price the test assets, i.e. which achieves the bound in Hansen and Jagannathan (1991), we can write this as:

$$E_t[M_{t,t+n}\epsilon_{t,t+n}] = \rho_{M_{t,t+n},\epsilon_{t,t+n}} \sigma_{\epsilon_{t,t+n}} \sigma^{HJ}_{M,t} \tag{13}$$

The maximum risk premium impact of these errors occurs when $\rho_{M_{t,t+n},\epsilon_{t,t+n}} \in \{-1, 1\}$. Specifically, the concern may be that the errors increase the price of the continuation claims, driving down their risk premia, so I compute the unconditional mean price of the maximally valued errors in the data, i.e. when $\rho_{M_{t,t+n},\epsilon_{t,t+n}} = 1$ so that the errors are a hedge asset. Note that the price of these errors is a fraction of the asset price by construction, so I define the price of the unscaled errors as $\bar{\Pi}^n_\epsilon$:

[8] Numerous other forms of nonparametric bounds have been proposed in the literature, including growth-optimal bounds as in Bansal and Lehmann (1997) and entropy bounds as in Backus, Chernov, and Zin (2013).

Table 6: Maximum Price Impact of Capital Gains Replication Errors

Horizon n	$n=1$	$n=2$	$n=3$	$n=4$	$n=5$
Market	0.001	0.004	0.008	0.013	0.019
Growth	0.001	0.005	0.010	0.015	0.022
Core	0.001	0.005	0.010	0.016	0.023
Value	0.002	0.007	0.015	0.025	0.035

Notes: I present the upper bound for the impact of the pricing errors in $\frac{P_n}{P_0} = \frac{P_n}{P_0} = b_0 + b_z \frac{D_0}{P_0} + b_r R_n + b_{zr} \frac{D_0}{P_0} R_n + \epsilon_n$ as a fraction of the continuation claim value, $\frac{\bar{\Pi}_\epsilon^n}{E[\Pi_t^n]}$, using $\bar{\Pi}_\epsilon^n = \sigma_{\epsilon_{t,t+n}} \sigma_{M,t}^{HJ}$. I report This is the upper bound assuming the regression errors are perfectly correlated with the SDF for the SDF achieving the Hansen-Jagannathan bound.

$$\frac{\bar{\Pi}_\epsilon^n}{P_t} \equiv \sigma_{\epsilon_{t,t+n}} \sigma_{M,t}^{HJ} \geq E[M_{t,t+n} \epsilon_{t,t+n}] \tag{14}$$

I use the market portfolio as a representative asset in computing the volatility of the SDF.[9] I compute the fractional change in price resulting from these assumptions $\frac{\bar{\Pi}_\epsilon^n}{E[\Pi_t^n]}$ and present the results in Table 6.

The results in Table 6 show that for virtually all horizons, even in the case where the errors are perfectly correlated with the SDF, the impact of errors of this magnitude in the regression is small. Note that this is an upper bound, not a mean estimate, and that the true return impact of error pricing is unlikely to achieve or even approach this bound. The errors likely have a smaller correlation with the true SDF because they are uncorrelated with both the cumulative asset return and the asset return interacted with the dividend to price ratio by construction, both of which carry large risk premia and are therefore highly correlated with the true SDF themselves. Both the small magnitude of the maximal pricing impact and the unlikelihood of achieving the maximum suggest that the true pricing errors have very little

[9] If I include all test assets, both cumulative dividend and continuation claims, for all portfolios in the book-to-market sorted cross-section in computing the maximum the values are increased by approximately 1.6 times. Adding the Sharpe Ratio of the duration-sorted cross-section from Weber (2018) to the maximization approximately doubles the results. As this factor is recently discovered it is unclear whether a Sharpe Ratio of this magnitude is achievable out of sample after accounting for parameter uncertainty, so this likely provides an overestimate of the pricing bound for achievable returns. Regardless, the impact of the errors remains negligible even under more aggressive assumptions, especially at shorter horizons.

impact on the mean return estimates presented in the following sections.

Table 7: Distribution of Value in the Book-to-Market Cross Section

Portfolio	$\hat{\Pi}^1_{p,0}/P_0$	$\hat{\Pi}^2_{p,0}/P_0$	$\hat{\Pi}^3_{p,0}/P_0$	$\hat{\Pi}^4_{p,0}/P_0$	$\hat{\Pi}^5_{p,0}/P_0$
Market	96.74%	93.52%	90.31%	87.13%	83.90%
Portfolio 1	97.39%	94.76%	92.15%	89.52%	86.65%
Portfolio 5	96.46%	92.97%	89.69%	86.38%	83.11%
Portfolio 9	96.04%	92.26%	88.65%	85.21%	81.96%

Notes: I present the mean over vintages of $\hat{\Pi}^n_{p,0}/P_0 = \frac{b_0}{R^n_{f,0}} + \frac{b_z}{R^n_{f,0}}\frac{D_0}{P_0} + b_r + b_{zr}\frac{D_0}{P_0}$ for several horizons in the cross-section. I use monthly formation dates from 6/1950 to 6/2012 form the vintage-panel dataset used to estimate the regression. For brevity I present the results for the market and portfolios 2, 5, and 9 in the Book-to-Market sorted cross-section.

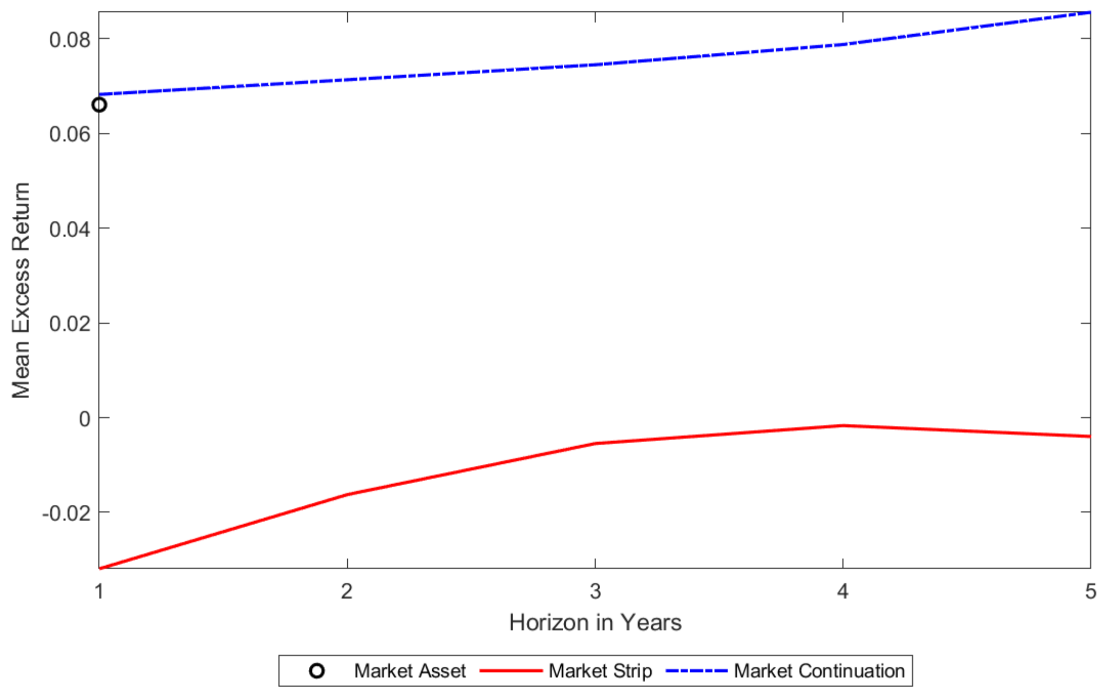
4.3 Term Structures of Risk Premia

In this section I use the time series of the estimated prices of continuation claims $\hat{\Pi}^n_{p,t}$ along with Equation (10) to create a time series of realized annual holding period returns. First, I report the mean fraction of firm value in each continuation claim, $\frac{\hat{\Pi}^n_{p,0}}{P_0}$, generated by the regression outputs in Table 7. The statistics presented are the mean over the vintages produced by applying the pricing equation Equation (9) to the replication regression outputs. I find that, consistent with intuition and the literature, value assets deliver a greater fraction of their firm value in the near term and the reverse is true of growth assets, although these differences are not statistically significant in the cross-section. One reason these firms have such close durations is that the high discount rate firms in Portfolio 9 (Value) also have relatively high near-term dividend growth rates, which compresses the relative durations towards each other in the cross-section[10]. This is not something that can be accounted for without firm and term specific discount rates, and demonstrates the possibility of the existence of firms with high returns and low durations.

I present the mean excess returns for the assets and continuation and cumulative dividend claims by horizon in Table 8. I test two hypotheses about the data, first whether the continuation or cumulative dividend claim mean return exceeds the asset mean return and second whether the continuation claim return for horizons greater than one exceeds the

[10] See Chen (2017) for confirmation of this factual claim about relative returns and growth rates in buy-and-hold portfolios.

Figure 6: Term Structures of Risk Premia - Rebalanced Market



Notes: I present results for the CRSP rebalanced market of the mean excess returns of the asset and the estimated excess returns of the continuation claim and cumulative dividend claim. The continuation claim returns are given by $\hat{R}^{n}_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^{n}_{p,0}}$ and the cumulative dividend claim returns by $\hat{\hat{R}}^{n}_{d,1} = \frac{1}{1-\hat{\Pi}^{n}_{p,0}}(R_1 - \hat{\Pi}^{n}_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^{n}_{p,0}})$. I use monthly formation dates from 6/1950 to 6/2012 to compute both the regression coefficients and the mean excess returns, and present the results for the rebalanced market.

horizon one continuation claim return. I present the results for the rebalanced market and for buy-and-hold portfolios for the cross-section, which are my main results as they represent a consistent set of firms and therefore give a better indication of within-firm variation in discount rates.

There are several aspects of this output that bear emphasis. First, all of the point estimates of excess returns for the continuation claims of each asset are above the point estimates of the asset return, and for almost all test assets this difference is statistically significant at the 1% level for all horizons greater than 1. The lack of significance at horizon 1 is

Table 8: Continuation Claim Excess Returns - Rebalanced Market

	Asset	Claim Horizon				
		1	2	3	4	5
Market $E[R^n_{p,1} - R^1_{f,0}]$	6.61%	6.82%	7.13%	7.45%	7.88%	8.56%
Market SE	[1.05]	[1.50]	[1.62]	[1.72]	[1.83]	[1.95]
Model $E[R^n_{p,1} - R^1_{f,0}]$	6.54%	6.85%	7.18%	7.51%	7.85%	8.21%
Model 25th Percentile	2.98%	3.22%	3.54%	3.86%	4.19%	4.52%
Model 75th Percentile	9.58%	9.95%	10.31%	10.69%	11.03%	11.40%

Notes: I present results for the CRSP rebalanced market of the mean excess returns of the asset and the estimated excess returns of the continuation claim. The continuation claim returns are given by $\hat{R}^n_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}}$. I use monthly formation dates from 6/1950 to 6/2012 to compute both the regression coefficients and the mean excess returns, and present the results for the rebalanced market. I also present the comparable statistics and 25th and 75th percentile bands for the model described in Section 2.3.

Table 9: Cumulative Dividend Claim Excess Returns - Rebalanced Market

	Asset	Claim Horizon				
		1	2	3	4	5
Market $E[\bar{R}^n_{d,1} - R^1_{f,0}]$	6.61%	-3.19%	-1.63%	-0.55%	-0.17%	-0.40%
Market SE	[1.05]	[2.30]	[2.55]	[2.40]	[2.11]	[1.77]
Model $E[\bar{R}^n_{d,1} - R^1_{f,0}]$	6.54%	-1.09%	-0.84%	-0.58%	-0.32%	-0.06%
Model 25th Percentile	2.98%	-5.90%	-5.59%	-5.38%	-5.11%	-4.83%
Model 75th Percentile	9.58%	3.72%	3.96%	4.18%	4.41%	4.67%

Notes: I present results for the CRSP rebalanced market of the mean excess returns of the asset and the estimated excess returns of the cumulative dividend claims. The dividend claim returns are given by $\hat{\bar{R}}^n_{d,1} = \frac{1}{1-\hat{\Pi}^n_{p,0}}(R_1 - \hat{\Pi}^n_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}})$. I use monthly formation dates from 6/1950 to 6/2012 to compute both the regression coefficients and the mean excess returns, and present the results for the rebalanced market. I also present the comparable statistics and 25th and 75th percentile bands for the model described in Section 2.3.

unsurprising given that the asset claim and the first continuation claim differ by only one dividend claim representing less than 4% of the asset's value on average. The reason the differences between the asset return and the continuation claim returns, and the differences among the continuation claim returns, are statistically significant is because the estimates are, as would be expected, highly correlated and the first stage estimation error is small. Similarly, the cumulative dividend claim returns are below the asset return and statistically significantly different from the asset return at the 1% level at all horizons. Second, all of the term structures of continuation claim returns slope upwards, with the difference between the horizon n return and the horizon 1 return being positive and significant at the 1% level for all horizons. The same is true of the cumulative dividend claims at the point estimates, although greater estimation noise and less correlated returns result in lower statistical significance. I present the equivalent of Table 8 for a variety of other cross-sections in Appendix A.4 and the conclusions are qualitatively the same the market results and generally statistically significant. The construction of these alternative sorts follows that of Fama and French (1993).

The implications for the relative risk of long duration or distant claims and short duration claims are stark: longer duration claims have higher excess returns across test assets and horizons, and most of these relationships are statistically significant. Recall from part two of Proposition 2.1 that the asset is a shorter duration claim than any of the subsequent continuation claims. My results imply that for all test assets and horizons the value-weighted average dividend claim with a horizon less than five is less risky than the asset, and also that the dividend claim at each horizon is less risky than the continuation claim at the same horizon. This is simply because the portfolio of claims representing the asset differs from the portfolio representing the continuation claim by only the intervening dividend payments as in Equation (2). Note that this is the opposite finding from that of van Binsbergen, Hueskes, Koijen, and Vrugt (2013), who show that option-implied dividend claims are riskier than the asset in their sample.

My results also show that the continuation or cumulative dividend claims at each horizon have a higher excess return than the continuation or cumulative dividend claims at lower horizons. Since the continuation claim is a longer duration asset at longer horizons because it merely strips off more early dividend payments, this shows an upward slope to risk premia for continuation claims as well. Based on part 1 of Proposition 2.1 I can also reject the hypothesis of a universally downward sloping dividend strip risk premium curve on this basis.

The cumulative strip evidence directly supports an upward-sloping strip risk premium curve. This evidence also seems to conflict with the derivatives-based return data of van Binsbergen and Koijen (2017), who find a downward or insignificant slope to dividend claims excess returns. In the following section, I show indicative evidence based on the recent subsample that both this difference in conclusions and the difference with van Binsbergen, Hueskes, Koijen, and Vrugt (2013) may be due to unique characteristics of the subsample for which those authors' data is available.

For the cumulative dividend claims my evidence now seems to present the opposite puzzle: the early strip excess returns are negative, implying that near term dividends are actually a hedge asset. This at first seems counterintuitive, however two facts lend credibility to the result. First, a standard affine model produces near-zero risk premia for early dividend claims, as I showed in Section 2.3. Second, even in a sample of 60 years the standard error bands on the mean for the strips are relatively large. The point estimate for the mean cumulative strip returns in the data is well within the 25% error bands for the model and the grand mean of the model is well within the two standard error bands of the data. My results are consistent with the model implications for a sample of this size.

In summary, I am able to use replication and no arbitrage to substantially expand the span of data available to test models' predictions on the term structure of expected equity excess returns. The increase in span allows my data to cover a substantially larger number of business cycles in the post-1950 data and provide more consistent evidence on the basic term structure facts. I find that, across the board, my expanded dataset supports longer duration, or more distant, claims to the same firm carrying higher risk premia. My method is not limited to the market or rebalanced portfolios; it also expands the scope of the data to any cross-sectional portfolio. I examine the results of applying my method to the book-to-market sorted cross-section in the following section.

4.4 Term Structures in The Cross-Section

I discuss in Section 1.1 that one approach in the literature to addressing the term structure facts is to expand the scope of the data. My method allows me to contribute to this area as well by delivering estimates of the risk premium term structure comparable to those of the previous section for a variety of cross-sectional portfolios as well. For the cross-section

I focus primarily on the buy-and hold portfolio results because these better represent the outcomes of a firm and rebalancing is more likely to have a strong effect for the cross-sectional portfolios, which my results confirm. Section 4.1 shows that the replication exercise is of similarly high quality to the market for each of these portfolios and horizons. Table 10 presents the results for the buy-and-hold book-to-market sorted cross section, while Table 11 presents the rebalanced results for completeness and comparison. I focus on the book-to-market sorted cross-section and present the results for other cross-sections with significance estimates in Appendix A.4.

The results are qualitatively similar to those for the rebalanced market. All the cross-sectional portfolios appear to display an upward sloping term structure in both the continuation claims and the cumulative strips in buy-and-hold portfolios. Further, strip returns are below asset returns and continuation returns are above asset returns across the board. This reinforces the conclusion that short duration payments carry lower risk premia. The results for rebalanced portfolios in the cross section are broadly the same and continue to support an upward sloping risk premium curve. The only result that does not strongly support an upward sloping risk term structure is the lack of an upward slope within the rebalanced growth portfolio cumulative strip returns. These dividend claim returns are still well below the asset return and the continuation claim returns remain above the asset return, which supports an overall upward slope to the curve despite the mixed slope early on.

Two other features of the cross-sectional results are notable, and help to explain the low slope of the growth dividend risk premium curve. First, the extreme portfolios display much greater differences between the rebalanced and buy-and-hold portfolio formation methods. The results for growth show a shallower, hump-shaped slope of returns within the strips, while the results for value show a substantially steeper slope relative to their buy-and-hold equivalents. This is consistent with the evolution of firm risk documented by (Chen, 2017), where value firms tend to de-risk over time while growth firms tend to become riskier. This makes the buy-and-hold value slope shallower and the growth slope steeper. Rebalancing offsets the firms' risk evolution, keeping the risk high for value over time and the risk low for growth and delivering a much higher slope for one and lower for the other. This also justifies my focus on buy-and-hold portfolios to estimate the within-firm risk premium curve because it is apparent that rebalancing alters the risk of the portfolio relative to the risk of the underlying firms. The second feature of note is that firms in the cross-section have different amounts of cash flow risk, not just different cash flow timing. This is especially

Table 10: Term Structures of Excess Returns - Buy-and-Hold Cross Section

	Asset	Claim Horizon				
		1	2	3	4	5
Growth $E[R^n_{p,1} - R^1_{f,0}]$	6.05%	6.20%	6.42%	6.58%	6.81%	7.38%
Core $E[R^n_{p,1} - R^1_{f,0}]$	7.60%	7.85%	8.25%	8.50%	8.86%	9.38%
Value $E[R^n_{p,1} - R^1_{f,0}]$	10.83%	11.26%	11.78%	12.28%	12.88%	13.49%
Growth $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−2.19%	−0.30%	1.28%	1.60%	1.19%
Core $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−3.45%	−0.73%	1.20%	2.13%	1.60%
Value $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−4.71%	−0.45%	1.94%	3.00%	2.25%

Notes: I present results for the book-to-market sorted cross-section of buy-and-hold portfolios. Portfolio vintages are formed monthly based on 6 month lagged accounting data but are otherwise formed as in Fama and French (1993). I present the mean excess returns of the asset and the estimated excess returns of the continuation and cumulative dividend claims. The continuation claim returns are given by $\hat{R}^n_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}}$ and the dividend claim returns by $\hat{\bar{R}}^n_{d,1} = \frac{1}{1-\hat{\Pi}^n_{p,0}}(R_1 - \hat{\Pi}^n_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}})$. I use monthly formation dates from 6/1950 to 6/2012 to compute both the regression coefficients and the mean excess returns, and present the results for the decile 2 (Growth), 5 (Core), and 9 (Value) portfolios.

evident for the rebalanced growth versus rebalanced value, where the strip curves and slopes are dramatically different. This supports a common mechanism used to generate differences in risk premia in the cross-section in the literature, i.e. different levels of cash flow risk.

4.5 Term Structures in Subsamples

In section 4.3 I present evidence that seems to conflict with existing research on the term structure of equity returns, finding strong and consistent evidence of an upward slope. It is possible that the post-2002 subsample for which dividend strip data is available contains too few business cycles to accurately estimate the unconditional mean excess return with the sample average. This argument is expanded on extensively in Bansal, Miller, Song, and Yaron (2018) using the strip data, who argue that when the balance of good and bad times is misrepresented in a subsample the sample mean can be a biased estimate of the unconditional mean and give evidence that this is the case in the recent subsample. My method allows a direct comparison of the impact of subsampling from only the recent years on the means,

Table 11: Continuation Claim Excess Returns - Rebalanced Cross Section

	Asset	Claim Horizon				
		1	2	3	4	5
Growth $E[R^n_{p,1} - R^1_{f,0}]$	6.50%	6.63%	6.71%	6.79%	7.23%	7.73%
Core $E[R^n_{p,1} - R^1_{f,0}]$	7.55%	7.83%	8.10%	8.58%	9.07%	9.21%
Value $E[R^n_{p,1} - R^1_{f,0}]$	11.13%	11.63%	12.23%	12.38%	12.20%	12.61%
Growth $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−2.82%	0.46%	1.86%	0.90%	0.57%
Core $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−2.69%	−0.45%	0.61%	1.25%	2.49%
Value $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−2.41%	1.04%	5.80%	7.51%	8.12%

Notes: I present results for the book-to-market sorted cross-section of rebalanced portfolios. The data is the decile portfolio data constructed as in Fama and French (1993) as presented on Kenneth French's webpage. I present the mean excess returns of the asset and the estimated excess returns of the continuation and cumulative dividend claims. The continuation claim returns are given by $\hat{R}^n_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}}$ and the dividend claim returns by $\hat{\bar{R}}^n_{d,1} = \frac{1}{1-\hat{\Pi}^n_{p,0}}(R_1 - \hat{\Pi}^n_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}})$. I use monthly formation dates from 6/1950 to 6/2012 to compute both the regression coefficients and the mean excess returns, and present the results for the decile 2 (Growth), 5 (Core), and 9 (Value) portfolios.

while limiting the possibility that the data is contaminated by illiquidity. To investigate indicative results, I compute the mean excess returns based on the full-sample replication, but only the return realizations from post-2004 in Table 12. I use the post-2004 subsample due to the availability of dividend strip data in that sample, from which I construct the cumulative strip returns in the derivative data. This derivative data is discussed in Bansal, Miller, Song, and Yaron (2018) and is provided by a major financial intermediary in the OTC strip markets for S&P 500 dividends. Table 12 shows that the qualitative results for returns are similar between the replication in the short sample and the dividend strip derivatives, which is confirmed by a 76% correlation of the derivative and replicated prices in this sample at horizon 1.

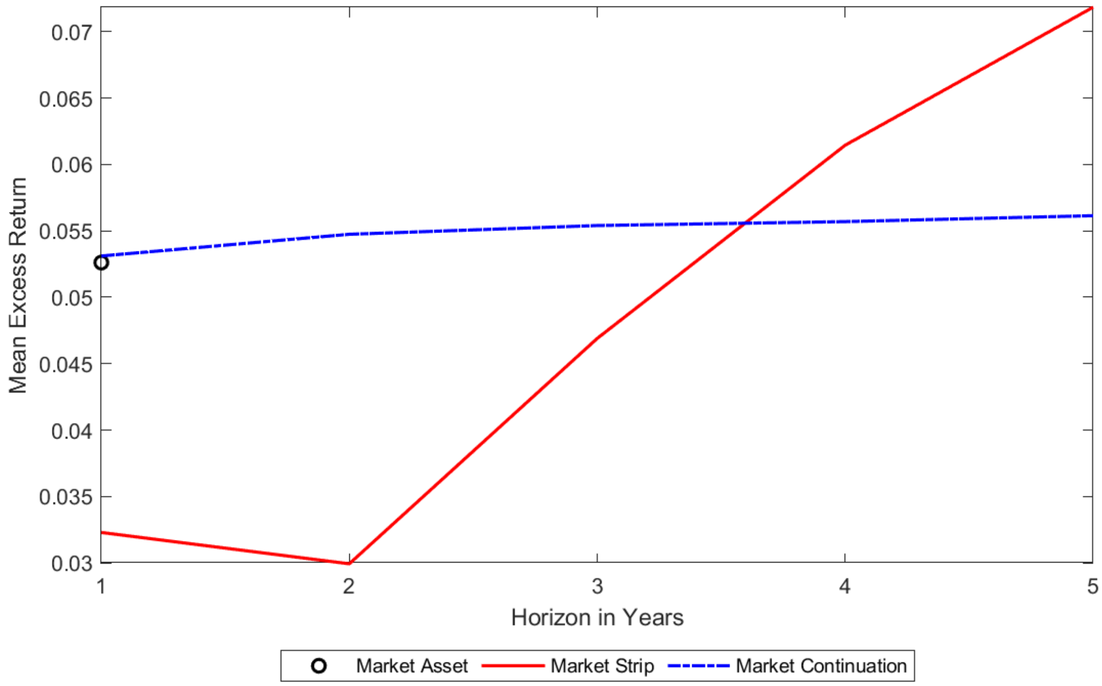
There are important differences between the point estimates in Table 12 relative to the full sample - differences that are immediately visually evident when comparing Figures 6 and 7. The shortness of the small sample renders most of the differences statistically insignificant, but the consistency of the results and economic significance of the magnitudes are both telling. The differences between the continuation claims and the asset are generally much smaller and universally statistically insignificant, implying a much higher risk premium for the first dividend claim in the subsample. The cumulative dividend claim returns bear this out, being 3-6% higher than their overall mean in this subsample. Unlike the full sample, the cumulative dividend claim returns are relatively close to the asset return, rather than substantially below it, and cross it before horizon 5.

The term structure slope within the continuation claims is also much shallower, implying that the early dividend claims are not as far below the asset return as in the full sample and may cross it earlier, which again is borne out in the cumulative dividend claims. While estimation noise and the shortness of the sample make the differences for statistically insignificant for most horizons, this indicates the strong possibility that the particular subsample for which strip data is available may not have a subsample mean term structure consistent with the unconditional mean. A possible reason for the much higher strip risk premia observed in this sample is the presence of the 2008 recession. In Table 12 I also present the mean returns of the asset, continuation claims, and cumulative strips produced by my method in the subsample starting in recessions. These returns are much higher for both strips and continuation claims across horizons, but the difference is considerably larger for the strips. This supports the conclusion that the presence of a major recession in this relatively short sample may substantially raise the mean strip returns relative to their unconditional mean. The possibility of bias introduced by the short sample makes the expansion of time series span offered by my method all the more valuable in using term structure data to falsify the unconditional predictions of a model.

5 Conclusion

In this study I contribute to the fast-growing literature on the term structure of equity risk premia by introducing empirical methods based on replication and no-arbitrage that dramatically expand the span and scope of the data available to use in estimating risk premium term structures. I show that a reliable and parsimonious replication of the payoffs of claims to a firm's capital gains or continuation value can be achieved with three factors: firm returns, firm dividend to price ratios, and their interaction. I demonstrate the success of this method in a standard theoretical environment, showing a high replication R-squared and faithful reproduction of the price series. I then apply the method to the market and cross

Figure 7: Continuation Claim Excess Returns - Recent (2004-2012) Sample



Notes: I present results for the CRSP rebalanced market of the mean excess returns of the asset and the estimated excess returns of the continuation claim and cumulative dividend claim. The continuation claim returns are given by $\hat{R}^n_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}}$ and the cumulative dividend claim returns by $\hat{\hat{R}}^n_{d,1} = \frac{1}{1-\hat{\Pi}^n_{p,0}}(R_1 - \Pi^n_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}})$. I use monthly formation dates from 6/1950 to 6/2012 to compute the regression coefficients and from 12/2004 to 6/2012 to compute the mean excess returns.

section of U.S. equity securities and show that the faithful replication of continuation claim payoffs is also possible in practice. Using the no-arbitrage prices of these payoffs implied by the replication, I am able to estimate a time series of realized returns to claims to a firm's continuation value at various horizons in the future. The term structure of these claims' as well as their corresponding cumulative dividend claims' risk premia relative to each other and their underlying asset strongly support more distant or longer duration claims carrying larger risk premia unconditionally. This is true both for the market and across a variety of cross-sections.

Table 12: Term Structures of Excess Returns - Subsamples

	Sample	Asset	Claim Horizon				
			1	2	3	4	5
Replication $E[R^n_{p,1} - R^1_{f,0}]$	2004-2012	5.26%	5.31%	5.47%	5.54%	5.57%	5.61%
Replication $E[\bar{R}^n_{d,1} - R^1_{f,0}]$	2004-2012		3.23%	2.99%	4.69%	6.15%	7.18%
Derivatives $E[\bar{R}^n_{d,1} - R^1_{f,0}]$	2004-2012		2.48%	3.35%	4.13%	5.11%	6.11%
Recession $E[R^n_{p,1} - R^1_{f,0}]$	1950-2012	13.98%	13.85%	14.02%	14.20%	14.53%	15.20%
Recession $E[\bar{R}^n_{d,1} - R^1_{f,0}]$	1950-2012		10.58%	13.03%	14.44%	14.74%	14.23%

Notes: I present results for the CRSP rebalanced market of the mean excess returns of the asset and the estimated excess returns cumulative dividend claim. The continuation claim returns are given by $\hat{R}^n_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}}$ and the cumulative dividend claim returns by $\hat{\bar{R}}^n_{d,1} = \frac{1}{1-\hat{\Pi}^n_{p,0}}(R_1 - \hat{\Pi}^n_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}})$. I use monthly formation dates from 6/1950 to 6/2012 to compute the regression coefficients and from 12/2004 to 6/2012 to compute the mean excess returns. I also compute the mean returns conditional on starting in a recession over the full 6/1950 to 6/2012 sample.

My conclusions are qualitatively consistent with the predictions of standard general equilibrium asset pricing models, and inconsistent with some of the existing derivatives-based literature and cross-sectional literature on risk term structures. I show two likely avenues that drive these differences, the effects of rebalancing on relatively small market subsections and the impact of using relatively short subsamples. In this study I focus exclusively on mean excess returns in order to preserve the parsimony of the replicating regressions. I conjecture that applying this method to price series conditioned on additional state variables may lead to productive future research on the conditional term structure of expected returns, volatility, and Sharpe Ratios. A core limitation facing researchers in the area of asset pricing term structures, the availability of long, liquid datasets that speak directly to the object of economic interest, can be substantively reduced with this simple exercise, providing useful avenues for future research.

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A Appendices

A.1 Multi-Period Dividend and Continuation Claims

If the law of one price holds, the price of the stock, P_t, can always be written as the sum of the prices of claims to only the dividends delivered at a given horizon n, the dividend strips at horizon n, $\Pi^n_{d,t}$[11]:

$$1 = E[M_{t+1}R_{t+1}] = \frac{\Pi^1_{d,t} + \Pi^2_{d,t} + ... + \Pi^n_{d,t} + ...}{P_t} \tag{A-1}$$

It can also be written as a finite sum of dividend claims and a continuation claim:

$$P_t = \Pi^1_{d,t} + \Pi^2_{d,t} + ... + \Pi^n_{d,t} + \Pi^n_{p,t} \tag{A-2}$$

This is the standard decomposition of the firm price used in education and research. Dividing through by the price, we can see that $\Pi^n_{d,t}/P_t$ sums to 1, and the relative weights on each strip give the term distribution of the firm's value across cash flows delivered at different horizons. It is immediate that the term structure of $\Pi^n_{p,t}$ represents the same division of the asset price across horizons, it is simply the remaining piece after the intermediate dividends are stripped out. The prices of two adjacent claims to the continuation value of the firm differ by only a single dividend claim, that is $\Pi^n_{d,t} = \Pi^{n-1}_{p,t} - \Pi^n_{p,t}$. It is clear from comparing the decompositions that all the pricing information in the term structure of $\Pi^n_{d,t}$ is also contained in the term structure of $\Pi^n_{p,t}$ since there is always a sum of the two that reproduces the asset price. Note that this also implies we can write the return on the stock or a continuation claim as the return on a portfolio of dividend claims, and similarly for continuation claims:

$$R^n_{p,t+1} = \frac{\Pi^n_{d,t+1} + \Pi^{n+1}_{d,t+1} + \Pi^{n+2}_{d,t+1} + ...}{\Pi^{n+1}_{d,t} + \Pi^{n+2}_{d,t} + \Pi^{n+3}_{d,t} + ...} = \frac{\Pi^{n+1}_{d,t}}{\Pi^n_{p,t}} R^{n+1}_{d,t+1} + \frac{\Pi^{n+2}_{d,t}}{\Pi^n_{p,t}} R^{n+2}_{d,t+1} + \frac{\Pi^{n+3}_{d,t}}{\Pi^n_{p,t}} R^{n+3}_{d,t+1} + ... \tag{A-3}$$

[11] We can write the asset price in terms of the projections of the dividend claim prices onto the payoff space as well, see Hansen and Richard (1987).

Where the second equality arises from collecting the denominator then multiplying and dividing each term by $\Pi_{d,t}^{m}$ for the appropriate m. It is important that the continuation claim consists of all subsequent dividend claims, and is therefore longer duration, delivers more of its cash flows in the distant future, than all previous dividend claims.

Similarly, the multiperiod analogue of Equation Equation (3) shows how this term structure is used in the existing literature:

$$\frac{D_t}{\Pi_{p,t}^{n-1} - \Pi_{p,t}^{n}} = \frac{D_t}{\Pi_{d,t}^{n}} = E_t\left[\frac{D_{t+n}/\Pi_{d,t}^{n}}{D_{t+n}/D_t}\right] = E_t\left[\frac{R_{t,t+n}}{D_{t+n}/D_t}\right] \tag{A-4}$$

A.2 Affine Model Exposition

The solution method for strip prices in the model presented in Section 2.3 are as follows. First, let the demeaned vector of state variables of the model evolve as a SVVAR with multiple volatility processes scaling independent, multivariate standard normal shocks $\epsilon_{k,t+1}$, $k \in \{1, 2, ..., K\}$:

$$x_{t+1} = \Gamma x_t + \sum_{k=1}^{K} \sqrt{\sigma_{k,0} + \sigma_k x_t} \Sigma_k \epsilon_{k,t+1}$$

The stochastic discount factor follows the standard Epstein and Zin (1989) form:

$$m_{t,t+1} = \theta log\beta - \frac{\theta}{\psi}\Delta c_{t+1} - (1-\theta) r_{t+1}^{c}$$

Consumption growth is an affine function of the states and shocks, as is dividend growth:

$$\Delta c_{t+1} = \mu_c + \delta_c x_t + \sum_{k=1}^{K} \sqrt{\sigma_{k,0} + \sigma_k x_t} \sigma_{c,k} \epsilon_{k,t+1}$$

$$\Delta d_{t+1} = \mu_d + \delta_d x_t + \sum_{k=1}^{K} \sqrt{\sigma_{k,0} + \sigma_k x_t} \sigma_{d,k} \epsilon_{k,t+1}$$

Finally, for simplicity I use the linearized asset return to solve for the parameters of the SDF in closed form by conjecturing the price to consumption ratio is given by $a + bx_t$:

$$r^c_{t+1} = ln(1 + exp\{a\}) + \frac{exp\{a\}}{1 + exp\{a\}} bx_{t+1} - a - bx_t + \mu_c + \delta_c x_t + \sum_{k=1}^{K} \sqrt{\sigma_{k,0} + \sigma_k x_t} \sigma_{c,k} \epsilon_{k,t+1}$$

Standard solution methods deliver the log stochastic discount factor:

$$m_{t,t+1} = -\lambda_0 - \lambda_x x_t - \sum_{k=1}^{K} \sqrt{\sigma_{k,0} + \sigma_k x_t} \lambda_k \epsilon_{k,t+1} - \sum_{k=1}^{K} \frac{1}{2} \lambda_k \lambda'_k (\sigma_{k,0} + \sigma_k x_t)$$

Thus the dividend prices and expected returns are given by a linear function of the states with $a_0 = 0$ and $b_0 = 0$:

$$pd_{n,t} = a_n + b_n x_t$$

The recursion for b_n shows how dividend beta accumulates over horizons to form strip beta based on the persistence of the states Γ and its covariance with the priced risks:

$$b_n = b_{n-1}\Gamma + \delta_d - \lambda_x + \sum_{k=1}^{K} (\frac{1}{2} b_{n-1} \Sigma_k \Sigma'_k b'_{n-1} + \delta_d \Sigma_k \Sigma'_k b'_{n-1} - \delta_d \Sigma_k \Sigma'_k \lambda'_k - b_{n-1} \Sigma_k \Sigma'_k \lambda'_k) \sigma_{d,k} \quad \text{(A-5)}$$

The price of a 1 period riskfree bond is $-\lambda_0 - \lambda_x x_t = a^f_1 + b^f_1 x_t$ and the recursion for multi-period riskfree rates is standard for the affine pricing literature.

I use two states, conditional mean and volatility, and two shock sets $K = 2$, with one having state dependence (the consumption and dividend shocks and the conditional mean shock, impacted by stochastic volatility) and the other having only a mean (the volatility of volatility shock). The specific calibration I use, in the standard LRRM notation for easy comparison with existing work, is, for the dividend and consumption dynamics, the persistence of expected consumption growth $\rho = .98$, the persistence of volatility $\nu = .98$, the mean of consumption and dividend growth $\mu_c = \mu_d = .02$, the exposure of conditional mean growth to the stochastic shock $\varphi_c = 0.44$, The unconditional mean of stochastic volatility $\sigma_0 = .0078$, the unconditional mean volatility of volatility $\sigma_w = .0000065$, the exposure of dividends to the conditional mean $\phi_d = 2.5$, the exposure of dividends to the consumption shock $\varsigma_d = 2.6$, and the exposure of dividends to the unpriced dividend shock $\varphi_d = 6$. For the preference parameters I use $\gamma = 13$, $\psi = 1.5$, and $\beta = .9989$.

A.3 Comparison to Alternative Cross-Sectional Methods

A core quantity in existing work using the cross-section to investigate the term structure of equity returns is the duration of the firm, the weighted average time of arrival of its cash flows. To show the difference between my approach and existing work that exploits between-firm, rather than within-firm, variation in risk premia I distinguish between the distribution of the value of the firm across the dividend strips of various horizons, the term distribution of firm value, and a firm's duration, a summary statistic for this quantity. The term distribution of firm value is:

$$w^n_{d,t} = \frac{\Pi^n_{d,t}}{\sum_{n=1}^{\infty} \Pi^n_{d,t}} = \frac{\Pi^n_{d,t}}{P_t} \quad \forall \quad n \in \{1, 2, ...\} \tag{A-6}$$

This is the portfolio weights in value terms of a dividend strip trading strategy that purchases the firm. This requires a transversality condition on the price in order to be well defined, which I assume holds throughout this exposition. I will refer to the mean in years of this distribution as the (true) firm duration:

$$Duration_t = \bar{w}_{d,t} = \sum_{n=1}^{\infty} n w^n_{d,t} \tag{A-7}$$

This is the object of interest in early cross-sectional approaches to the term structure, which estimate $\bar{w}_{d,t}$ by forecasting growth rates and making an assumption about returns by horizon. These studies then compare between-firm differences in returns and argue that low duration firms having high risk premia implies a downward sloping term structure of risk. Remember, the within-firm term structure of expected returns, $\{E_t[R^n_{d,t+1}]\}_{n \in \mathbb{N}}$, answers the question of what happens to the firm's discount rate if money is moved from the firm's projects which generate cash flows in the near future to those that generate cash flows in the distant future. This is the object of economic interest. To see this, we can rewrite the expected return on the firm as:

$$E_t[R_{t+1}] = \sum_{n=1}^{\infty} w^n_{d,t} E_t[R^n_{d,t+1}] \tag{A-8}$$

Which is just Equation (2) in the differing notation. The firm expected return is a weighted average of the strip expected returns where the weights are the term distribution of the firm's value. Changing the duration of the firm by taking fraction w of firm value from a typical project that delivers value solely at horizon n to a typical project that delivers value solely at $m \neq n$ changes the firm's expected return by $w(E_t[R^m_{d,t+1}] - E_t[R^n_{d,t+1}])$, assuming that the firm value remains unchanged. Finally, note that we can tautologically decompose $\Pi^n_{d,t}/D_t$ into:

$$\frac{\Pi^n_{d,t}}{D_t} = E_t\left[\frac{G_{t,t+n}}{R^n_{d,t,t+n}}\right] \tag{A-9}$$

Where $G_{t,t+n} = \frac{D_{t+n}}{D_t}$ s the cumulative firm dividend growth rate and $R^n_{d,t,t+n} = \frac{D_{t+n}}{\Pi^n_{d,t}}$ is the cumulative return on strip n. This establishes that the distribution of firm value across future payments contains firm and term specific risk and growth information. The approach proposed in section Section 2.2 implicitly accounts for both the firm specificity of risk and growth, by varying the regression coefficients across portfolios in the cross-section, and the term specificity of risk and growth by running the regression at multiple horizons. As demonstrated both in theory and in practice this replication can be done with high quality and a limited number of factors across firms and horizons, and regenerates the true term distribution of firm value in a theoretical environment where it is known. It remains to show the impact of applying alternative assumptions to obtain duration estimates.

The decomposition of the firm returns into strip returns in Equation (A-8) demonstrates that there are several types of variation captured by a comparison of firm returns. Such a comparison, e.g. $E_t[R_{i,t+1}] > E_t[R_{j,t+1}]$, holds if and only if:

$$\sum_{n=1}^{\infty} w^n_{i,t} E_t[R^n_{i,t+1}] > \sum_{n=1}^{\infty} w^n_{j,t} E_t[R^n_{j,t+1}] \tag{A-10}$$

All terms indexing firms, i or j, represent possible sources of variation leading to the difference in firm expected returns. Since Equation (A-9) shows that $w^n_{i,t}$ contains firm and term specific discount rate and growth information, a difference in firm expected returns could be driven by any of these sources of variation in addition to the average term structure slope. Explicitly, if both firms have the same amount of cash flow risk, i.e. $E_t[R^n_{i,t+1}] = E_t[R^n_{j,t+1}] \;\; \forall \;\; n \in \{1, 2, ...\}$, but there is a slope to the discount rate term structure, $E_t[R^n_{i,t+1}] \neq E_t[R^{n+1}_{i,t+1}]$ for some n, then Equation (A-10) holds when i delivers more of its value at high discount rate horizons because its cumulative growth is higher at those times. If firms differ in their amount of cash flow risk but have the same distribution of value, Equation (A-10) holds when i has more cash flow risk on average than j. Thus a difference in cash flow risk between i and j breaks the identification of the term structure from between-firm variation in the cross section, regardless of the assumptions used to estimate the terms in Equation (A-7). Tables 10 and 11 provide evidence that there is a difference in cash flow risk between growth and value firms directly, since the cumulative dividend claim term structures do not overlap and are generally higher for riskier firms. This is consistent with models driven by dividend risk differences in the cross section, but inconsistent with between firm risk premium differences identifying the term structure.

A stylized numerical example will make the intuition concrete. There are two firms, i and j, and two dates, 1 and 2. Firm i is expected to grow at rate 5% to both dates, firm j at 10% to date 1 then 0% to date 2. Both have upward sloping term structures but firm j has more cash flow risk so that $E[R^1_{i,t+1}] = 5\%$ and $E[R^2_{i,t+1}] = 6\%$, but $E[R^1_{j,t+1}] = 15\%$, and $E[R^2_{j,t+1}] = 18\%$. Assuming no updating between periods and that these are the correct discount rates for the firms' expected growth we can simply apply Equation (A-9) to determine the firm distributions of value. Firm j has lower duration (54% vs 50% in claim 1) and higher mean returns. The same is true if the discount rate is assumed to be, counterfactually, shared and flat at 5% (51% vs 50% in claim 1). The essential component here is that one firm has high discount rates and high expected near term growth - this is the evidence on the value sorted buy-and-hold cross-section in Chen (2017). The implication is that the between-firm difference in growth rates, and therefore duration, does not mean the between-firm difference in discount rates identifies the term structure of either firm or of both firms on average. Only the case where the true discount rate is shared across horizons guarantees identification of the within-firm term structure by between-firm differences in risk premia.

Evidence based on between firm discount rate differences can only identify within-firm term structure variation by assuming other types of variation do not exist[12]. Recall from equation

[12] For example, Weber (2018) uses a constant, flat, shared discount rate assumption for all firms and terms, while Lettau and Wachter (2007) assumes a constant, sloping, shared discount rate assumption. Under these assumptions, differences in firm returns are sufficient to identify the slope of the discount rate curve. Weber (2018) argues that he identifies duration as an unspanned cross-sectional factor, so this analysis only critiques the interpretation that his evidence supports within-firm term structure conclusions.

Equation (A-5) that the core mechanisms generating cross-sectional differences in risk premia in typical general equilibrium cross-sectional pricing theory, differences in dividend beta to priced states, imply differences in cash flow strip beta at every horizon, not just overall. In order to falsify these theories with between-firm differences in risk premia we must assume their core mechanism does not hold in practice in order to provide identification.

A.4 Alternative Sorts

In this appendix I present the results of the pricing and return computation experiments for buy-and-hold and rebalanced portfolios based on alternative cross-sectional sorts. These sorts demonstrate the flexibility of my method in expanding the scope of term structure data while also confirming the consistency of my core conclusions across various cross-sections. I present only the return regressions with their significance estimates for brevity, but can provide the replicating regression outputs on request.

Table 13: Term Structures of Excess Returns - Value Sorted Cross-Section

				Buy and Hold		
	Asset			Claim Horizon		
		1	2	3	4	5
Market $E[R^n_{p,1} - R^1_{f,0}]$	6.83%	$7.05\%^{*}$	$7.38\%^{***}_{***}$	$7.68\%^{***}_{***}$	$8.18\%^{***}_{***}$	$8.99\%^{***}_{***}$
Portfolio 2 $E[R^n_{p,1} - R^1_{f,0}]$	6.05%	6.20%	$6.42\%^{**}_{***}$	$6.58\%^{*}_{**}$	$6.81\%^{*}_{**}$	$7.38\%^{**}_{**}$
Portfolio 5 $E[R^n_{p,1} - R^1_{f,0}]$	7.60%	7.85%	$8.25\%^{***}_{***}$	$8.50\%^{***}_{***}$	$8.86\%^{**}_{***}$	$9.38\%^{***}_{***}$
Portfolio 9 $E[R^n_{p,1} - R^1_{f,0}]$	10.83%	$11.26\%^{***}$	$11.78\%^{***}_{***}$	$12.28\%^{***}_{***}$	$12.88\%^{***}_{***}$	$13.49\%^{***}_{***}$
Market $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.82\%^{***}$	$-1.45\%^{***}_{**}$	$-0.33\%^{***}$	$-0.24\%^{***}$	$-0.71\%^{***}$
Portfolio 2 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.19\%^{***}$	$-0.30\%^{***}_{*}$	$1.28\%^{***}$	$1.60\%^{***}$	$1.19\%^{**}$
Portfolio 5 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-3.45\%^{***}$	$-0.73\%^{***}_{***}$	$1.20\%^{***}_{***}$	$2.13\%^{***}_{**}$	$1.60\%^{***}_{***}$
Portfolio 9 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-4.71\%^{***}$	$-0.45\%^{***}_{***}$	$1.94\%^{***}_{***}$	$3.00\%^{***}_{**}$	$2.25\%^{***}_{**}$
				Rebalanced		
	Asset			Claim Horizon		
		1	2	3	4	5
Market $E[R^n_{p,1} - R^1_{f,0}]$	6.61%	$6.82\%^{*}$	$7.13\%^{***}_{***}$	$7.45\%^{***}_{***}$	$7.88\%^{***}_{***}$	$8.56\%^{***}_{***}$
Portfolio 2 $E[R^n_{p,1} - R^1_{f,0}]$	6.50%	6.63%	6.71%	6.79%	$7.23\%^{*}_{**}$	$7.73\%^{*}_{*}$
Portfolio 5 $E[R^n_{p,1} - R^1_{f,0}]$	7.55%	$7.83\%^{*}$	$8.10\%^{***}_{***}$	$8.58\%^{**}_{**}$	$9.07\%^{*}_{*}$	$9.21\%^{*}_{*}$
Portfolio 9 $E[R^n_{p,1} - R^1_{f,0}]$	11.13%	$11.63\%^{***}$	$12.23\%^{***}_{***}$	$12.38\%^{**}_{*}$	12.20%	12.61%
Market $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-3.19\%^{***}$	$-1.63\%^{***}_{***}$	$-0.55\%^{***}$	$-0.17\%^{***}$	$-0.40\%^{***}$
Portfolio 2 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.82\%^{***}$	$0.46\%^{***}_{***}$	$1.86\%^{**}_{***}$	$0.90\%^{***}$	$0.57\%^{*}$
Portfolio 5 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.69\%^{***}$	$-0.45\%^{***}_{***}$	$0.61\%^{***}$	$1.25\%^{**}$	$2.49\%_{**}$
Portfolio 9 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.41\%^{***}$	$1.04\%^{***}_{***}$	$5.80\%^{*}_{**}$	$7.51\%_{*}$	8.12%

Notes: The sort is based on the most recent book equity to market equity ratio for the firm. Portfolio vintages are formed monthly based on 6 month lagged accounting data but are otherwise formed as in Fama and French (1993) for buy-and-hold portfolios. For rebalanced portfolios the data is as in Fama and French (1993). I present the mean excess returns of the asset and the estimated excess returns of the continuation and cumulative dividend claims. The continuation claim returns are given by $\hat{R}^n_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}}$ and the dividend claim returns by $\hat{\bar{R}}^n_{d,1} = \frac{1}{1-\hat{\Pi}^n_{p,0}}(R_1 - \hat{\Pi}^n_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}})$. I use monthly formation dates from 6/1950 to 6/2012 to compute both the regression coefficients and the mean excess returns, and present the results for the decile 2, 5 , and 9 portfolios. I present significant differences from the asset excess return as superscript stars (*** for significance at the 1% level, ** at 5%, and * at 10%), and significant differences from the horizon 1 excess returns as subscript stars.

Table 14: Term Structures of Excess Returns - Size Sorted Cross-Section

		Buy and Hold				
	Asset	Claim Horizon				
		1	2	3	4	5
Market $E[R^n_{p,1} - R^1_{f,0}]$	6.83%	$7.05\%^{*}$	$7.38\%^{***}_{***}$	$7.68\%^{***}_{***}$	$8.18\%^{***}_{***}$	$8.99\%^{***}_{***}$
Portfolio 2 $E[R^n_{p,1} - R^1_{f,0}]$	11.34%	11.64%	$12.17\%^{**}_{***}$	$12.86\%^{**}_{***}$	$13.42\%^{**}_{**}$	12.40%
Portfolio 5 $E[R^n_{p,1} - R^1_{f,0}]$	9.31%	9.60%	$9.96\%^{**}_{***}$	$10.31\%^{**}_{**}$	$10.30\%^{**}_{***}$	$10.49\%^{***}_{***}$
Portfolio 9 $E[R^n_{p,1} - R^1_{f,0}]$	8.29%	$8.52\%^{*}$	$8.86\%^{***}_{***}$	$9.28\%^{***}_{***}$	$9.80\%^{***}_{***}$	$10.42\%^{***}_{***}$
Market $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.82\%^{***}$	$-1.45\%^{***}_{**}$	$-0.33\%^{***}$	$-0.24\%^{***}$	$-0.71\%^{***}$
Portfolio 2 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.57\%^{***}$	$-0.32\%^{***}$	2.84%	8.76%	$7.93\%_{***}$
Portfolio 5 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-5.26\%^{***}$	$-1.48\%^{***}_{***}$	$1.56\%^{***}_{***}$	$2.74\%^{***}_{***}$	$2.36\%^{***}_{***}$
Portfolio 9 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-4.83\%^{***}$	$-2.83\%^{***}_{**}$	$-1.57\%^{***}_{*}$	$-1.03\%^{***}$	$-0.96\%^{***}$
		Rebalanced				
	Asset	Claim Horizon				
		1	2	3	4	5
Market $E[R^n_{p,1} - R^1_{f,0}]$	6.61%	$6.82\%^{*}$	$7.13\%^{***}_{***}$	$7.45\%^{***}_{***}$	$7.88\%^{***}_{***}$	$8.56\%^{***}_{***}$
Portfolio 2 $E[R^n_{p,1} - R^1_{f,0}]$	9.54%	9.80%	$10.20\%^{*}_{**}$	10.12%	$9.94\%^{*}$	10.32%
Portfolio 5 $E[R^n_{p,1} - R^1_{f,0}]$	9.48%	9.75%	$10.13\%^{**}_{***}$	$10.39\%^{*}_{*}$	$10.43\%^{*}_{*}$	$10.65\%^{*}$
Portfolio 9 $E[R^n_{p,1} - R^1_{f,0}]$	7.57%	$7.81\%^{**}$	$8.16\%^{***}_{***}$	$8.58\%^{***}_{***}$	$8.91\%^{***}_{***}$	$9.39\%^{***}_{***}$
Market $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-3.19\%^{***}$	$-1.63\%^{***}_{***}$	$-0.55\%^{***}$	$-0.17\%^{***}$	$-0.40\%^{***}$
Portfolio 2 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.76\%^{***}$	$0.40\%^{**}$	$3.98\%_{**}$	$5.46\%^{***}_{***}$	$4.70\%_{*}$
Portfolio 5 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-4.35\%^{***}$	$-1.85\%^{***}_{*}$	$1.53\%^{**}$	$3.17\%^{**}_{***}$	$2.87\%^{**}_{**}$
Portfolio 9 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-3.16\%^{***}$	$-1.67\%^{***}_{**}$	$-0.55\%^{***}$	$0.39\%^{***}$	$0.57\%^{***}_{**}$

Notes: The sort is based on the most recent market equity capitalization value of the firm's primary security. Portfolio vintages are formed monthly based on 6 month lagged accounting data but are otherwise formed as in Fama and French (1993) for buy-and-hold portfolios. For rebalanced portfolios the data is as in Fama and French (1993). I present the mean excess returns of the asset and the estimated excess returns of the continuation and cumulative dividend claims. The continuation claim returns are given by $\hat{R}^n_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}}$ and the dividend claim returns by $\hat{\bar{R}}^n_{d,1} = \frac{1}{1-\hat{\Pi}^n_{p,0}}(R_1 - \hat{\Pi}^n_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}})$. I use monthly formation dates from 6/1950 to 6/2012 to compute both the regression coefficients and the mean excess returns, and present the results for the decile 2, 5 , and 9 portfolios. I present significant differences from the asset excess return as superscript stars (*** for significance at the 1% level, ** at 5%, and * at 10%), and significant differences from the horizon 1 excess returns as subscript stars.

Table 15: Term Structures of Excess Returns - Gross Profitability Sorted Cross-Section

		Buy and Hold				
	Asset	Claim Horizon				
		1	2	3	4	5
Market $E[R^n_{p,1} - R^1_{f,0}]$	5.21%	5.36%	$5.61\%^{**}_{**}$	$5.72\%^{***}_{***}$	$5.95\%^{***}_{***}$	$6.48\%^{***}_{***}$
Portfolio 2 $E[R^n_{p,1} - R^1_{f,0}]$	3.94%	4.04%	$4.20\%_{***}$	$4.36\%_{**}$	4.54%	$5.09\%^{***}_{***}$
Portfolio 5 $E[R^n_{p,1} - R^1_{f,0}]$	5.69%	5.82%	$6.03\%^{**}_{***}$	$6.07\%^{*}_{**}$	6.23%	$6.42\%^{**}_{**}$
Portfolio 9 $E[R^n_{p,1} - R^1_{f,0}]$	7.19%	7.31%	$7.61\%^{**}_{*}$	$7.73\%^{**}$	$7.93\%^{**}_{*}$	$8.38\%^{**}_{*}$
Market $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.14\%^{*}$	$-1.21\%^{*}_{***}$	$0.31\%^{*}$	$0.78\%^{*}$	0.43%
Portfolio 2 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−1.06%	−0.23%	$0.49\%^{*}$	$0.63\%^{*}$	0.34%
Portfolio 5 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-1.16\%^{*}$	$0.65\%_{*}$	2.76%	$3.36\%^{*}$	3.87%
Portfolio 9 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−1.17%	−0.35%	$2.34\%_{***}$	$3.18\%_{***}$	$3.01\%_{***}$
		Rebalanced				
	Asset	Claim Horizon				
		1	2	3	4	5
Market $E[R^n_{p,1} - R^1_{f,0}]$	4.92%	5.06%	$5.28\%^{**}_{**}$	$5.39\%^{***}_{***}$	$5.55\%^{**}_{**}$	$5.95\%^{***}_{***}$
Portfolio 2 $E[R^n_{p,1} - R^1_{f,0}]$	3.68%	3.84%	$4.09\%^{**}_{***}$	$4.32\%^{***}_{***}$	$4.71\%^{***}_{***}$	$5.26\%^{***}_{***}$
Portfolio 5 $E[R^n_{p,1} - R^1_{f,0}]$	5.87%	6.04%	$6.36\%^{*}_{**}$	$6.67\%^{***}_{***}$	6.60%	6.88%
Portfolio 9 $E[R^n_{p,1} - R^1_{f,0}]$	7.23%	7.40%	$7.74\%^{***}_{***}$	$7.67\%^{*}_{*}$	7.73%	$8.03\%^{*}$
Market $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.52\%^{*}$	$-1.30\%^{*}_{***}$	$0.22\%^{**}$	$0.93\%^{*}$	$0.85\%_{*}$
Portfolio 2 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−1.23%	−1.62%	−0.80%	0.34%	1.71%
Portfolio 5 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-1.59\%^{*}$	$-0.27\%^{**}$	$1.27\%^{***}$	2.98%	3.95%
Portfolio 9 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-1.96\%^{*}$	$-1.26\%^{*}$	$2.54\%^{**}$	3.49%	2.95%

Notes: The sort is based on the most recent observation of the firm's gross profitability to book equity ratio. Portfolio vintages are formed monthly based on 6 month lagged accounting data but are otherwise formed as in Fama and French (2015) for buy-and-hold portfolios. For rebalanced portfolios the data is as in Fama and French (2015). I present the mean excess returns of the asset and the estimated excess returns of the continuation and cumulative dividend claims. The continuation claim returns are given by $\hat{R}^n_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}}$ and the dividend claim returns by $\hat{\bar{R}}^n_{d,1} = \frac{1}{1-\hat{\Pi}^n_{p,0}}(R_1 - \hat{\Pi}^n_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}})$. I use monthly formation dates from 6/1966 to 6/2012 to compute both the regression coefficients and the mean excess returns, and present the results for the decile 2, 5 , and 9 portfolios. I present significant differences from the asset excess return as superscript stars (*** for significance at the 1% level, ** at 5%, and * at 10%), and significant differences from the horizon 1 excess returns as subscript stars.

Table 16: Term Structures of Excess Returns - Asset Growth Sorted Cross-Section

		Buy and Hold				
	Asset	Claim Horizon				
		1	2	3	4	5
Market $E[R^n_{p,1} - R^1_{f,0}]$	5.21%	5.36%	$5.61\%^{**}_{**}$	$5.72\%^{***}_{***}$	$5.95\%^{***}_{***}$	$6.48\%^{***}_{***}$
Portfolio 2 $E[R^n_{p,1} - R^1_{f,0}]$	8.70%	8.90%	$9.19\%^{*}_{***}$	$9.49\%^{**}_{***}$	$9.87\%^{**}_{**}$	10.45%
Portfolio 5 $E[R^n_{p,1} - R^1_{f,0}]$	5.99%	6.14%	$6.39\%^{*}$	$6.56\%^{*}$	$6.81\%^{**}_{**}$	$7.19\%^{*}_{**}$
Portfolio 9 $E[R^n_{p,1} - R^1_{f,0}]$	4.59%	4.64%	4.73%	4.79%	4.97%	5.21%
Market $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.14\%^{*}$	$-1.21\%^{*}_{***}$	$0.31\%^{*}$	$0.78\%^{*}$	0.43%
Portfolio 2 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-5.80\%^{***}$	$-1.66\%^{***}_{***}$	$0.88\%^{**}_{***}$	$1.36\%^{**}_{***}$	$2.40\%_{*}$
Portfolio 5 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-1.11\%^{**}$	$0.63\%_{***}$	$2.01\%_{***}$	$2.86\%_{***}$	$3.13\%_{**}$
Portfolio 9 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−2.12%	$1.17\%_{*}$	2.94%	3.15%	3.93%
		Rebalanced				
	Asset	Claim Horizon				
		1	2	3	4	5
Market $E[R^n_{p,1} - R^1_{f,0}]$	4.92%	5.06%	$5.28\%^{**}_{**}$	$5.39\%^{***}_{***}$	$5.55\%^{**}_{**}$	$5.95\%^{***}_{***}$
Portfolio 2 $E[R^n_{p,1} - R^1_{f,0}]$	8.96%	9.15%	9.44%	9.41%	9.81%	10.11%
Portfolio 5 $E[R^n_{p,1} - R^1_{f,0}]$	6.15%	6.35%	$6.60\%^{*}$	$6.79\%^{**}_{**}$	$7.26\%^{***}_{**}$	$7.56\%^{*}$
Portfolio 9 $E[R^n_{p,1} - R^1_{f,0}]$	4.80%	4.88%	$5.06\%_{**}$	$5.15\%^{*}_{**}$	$5.28\%^{**}_{*}$	$5.44\%^{**}_{**}$
Market $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-2.52\%^{*}$	$-1.30\%^{*}_{***}$	$0.22\%^{**}$	$0.93\%^{*}$	$0.85\%_{*}$
Portfolio 2 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-1.92\%^{***}$	$1.73\%^{*}$	$5.07\%_{*}$	3.87%	5.40%
Portfolio 5 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		$-3.28\%^{**}$	$-0.69\%^{*}_{***}$	$1.12\%^{**}_{*}$	$0.93\%^{***}$	$1.57\%^{*}$
Portfolio 9 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$		−2.34%	$0.46\%_{***}$	$1.05\%_{**}$	$1.87\%_{*}$	$2.80\%_{**}$

Notes: The sort is based on the most recent observation of the firm's annual asset growth. Portfolio vintages are formed monthly based on 6 month lagged accounting data but are otherwise formed as in Fama and French (2015) for buy-and-hold portfolios. For rebalanced portfolios the data is as in Fama and French (2015). I present the mean excess returns of the asset and the estimated excess returns of the continuation and cumulative dividend claims. The continuation claim returns are given by $\hat{R}^n_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}}$ and the dividend claim returns by $\hat{\bar{R}}^n_{d,1} = \frac{1}{1-\hat{\Pi}^n_{p,0}}(R_1 - \hat{\Pi}^n_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}})$. I use monthly formation dates from 6/1966 to 6/2012 to compute both the regression coefficients and the mean excess returns, and present the results for the decile 2, 5 , and 9 portfolios. I present significant differences from the asset excess return as superscript stars (*** for significance at the 1% level, ** at 5%, and * at 10%), and significant differences from the horizon 1 excess returns as subscript stars.

Table 17: Term Structures of Excess Returns - Momentum Sorted Cross-Section

		Buy and Hold				
	Asset	Claim Horizon				
		1	2	3	4	5
Market $E[R^n_{p,1} - R^1_{f,0}]$	6.83%	$7.05\%^{*}$	$7.38\%^{***}_{***}$	$7.68\%^{***}_{***}$	$8.18\%^{***}_{***}$	$8.99\%^{***}_{***}$
Portfolio 2 $E[R^n_{p,1} - R^1_{f,0}]$	5.45%	$5.69\%^{*}$	$6.13\%^{***}_{***}$	$6.41\%^{***}_{***}$	$6.72\%^{**}_{**}$	$7.98\%^{**}_{**}$
Portfolio 5 $E[R^n_{p,1} - R^1_{f,0}]$	7.33%	$7.55\%^{*}$	$7.91\%^{***}_{***}$	$8.28\%^{***}_{***}$	$8.80\%^{***}_{***}$	$9.72\%^{***}_{***}$
Portfolio 9 $E[R^n_{p,1} - R^1_{f,0}]$	8.81%	9.00%	$9.29\%^{**}_{***}$	$9.55\%^{*}_{**}$	9.67%	10.14%
Market $E[\bar{R}^n_{d,1} - R^1_{f,0}]$	6.83%	$-2.82\%^{***}$	$-1.45\%^{***}_{**}$	$-0.33\%^{***}$	$-0.24\%^{***}$	$-0.71\%^{***}$
Portfolio 2 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$	5.45%	$-8.38\%^{***}$	$-4.40\%^{***}_{**}$	$-0.90\%^{***}_{*}$	$-0.03\%^{**}$	-0.99%
Portfolio 5 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$	7.33%	$-2.11\%^{***}$	$-0.61\%^{**}$	$0.94\%^{**}_{**}$	$1.59\%^{***}_{*}$	$1.10\%^{***}$
Portfolio 9 $E[\bar{R}^n_{d,1} - R^1_{f,0}]$	8.81%	$2.19\%^{***}$	$5.47\%_{*}$	6.65%	7.49%	7.44%

Notes: The sort is based on the most recent observation of the firm's 11 month prior to two month prior return. I present the mean excess returns of the asset and the estimated excess returns of the continuation and cumulative dividend claims. The continuation claim returns are given by $\hat{R}^n_{p,1} = \frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}}$ and the dividend claim returns by $\hat{\bar{R}}^n_{d,1} = \frac{1}{1-\hat{\Pi}^n_{p,0}}(R_1 - \hat{\Pi}^n_{p,0}\frac{\hat{\Pi}^{n-1}_{p,1}}{\hat{\Pi}^n_{p,0}})$. I use monthly formation dates from 6/1950 to 6/2012 to compute both the regression coefficients and the mean excess returns, and present the results for the decile 2, 5 , and 9 portfolios. I present significant differences from the asset excess return as superscript stars (*** for significance at the 1% level, ** at 5%, and * at 10%), and significant differences from the horizon 1 excess returns as subscript stars.

Table 18: Term Structures of Continuation Excess Returns - International

		Rebalanced				
	Asset	Continuation Claim Horizon				
		1	2	3	4	5
EU $E[R_{p,1}^n - R_{f,0}^1]$	7.73%	7.90%	8.12%	8.19%	8.58%	9.13%
Europe $E[R_{p,1}^n - R_{f,0}^1]$	7.94%	8.12%	8.34%	8.44%	8.84%	9.40%
Japan $E[R_{p,1}^n - R_{f,0}^1]$	5.88%	5.94%	6.04%	6.12%	6.25%	6.35%
UK $E[R_{p,1}^n - R_{f,0}^1]$	8.65%	8.89%	9.10%	9.25%	9.46%	10.11%
US $E[R_{p,1}^n - R_{f,0}^1]$	6.71%	6.93%	7.31%	7.70%	8.18%	8.79%
World $E[R_{p,1}^n - R_{f,0}^1]$	6.54%	6.72%	6.98%	7.17%	7.56%	8.06%

Notes: All international indices are US dollar returns to the relevant Datastream/Thompson Reuters Index. I present the mean excess returns of the asset and the estimated excess returns of the continuation and cumulative dividend claims. The continuation claim returns are given by $\hat{R}_{p,1}^n = \frac{\hat{\Pi}_{p,1}^{n-1}}{\hat{\Pi}_{p,0}^n}$ and the dividend claim returns by $\hat{\bar{R}}_{d,1}^n = \frac{1}{1-\hat{\Pi}_{p,0}^n}(R_1 - \hat{\Pi}_{p,0}^n \frac{\hat{\Pi}_{p,1}^{n-1}}{\hat{\Pi}_{p,0}^n})$. I use monthly formation dates from 6/1974 to 6/2012 to compute both the regression coefficients and the mean excess returns.

Table 19: Term Structures of Dividend Excess Returns - International

		Rebalanced				
	Asset	Cumulative Dividend Claim Horizon				
		1	2	3	4	5
EU $E[\bar{R}_{d,1}^n - R_{f,0}^1]$	7.73%	−1.73%	0.71%	2.74%	2.32%	2.05%
Europe $E[\bar{R}_{d,1}^n - R_{f,0}^1]$	7.94%	−1.83%	0.69%	2.61%	2.27%	2.06%
Japan $E[\bar{R}_{d,1}^n - R_{f,0}^1]$	5.88%	−1.89%	0.44%	1.85%	2.65%	2.55%
UK $E[\bar{R}_{d,1}^n - R_{f,0}^1]$	8.65%	−2.20%	1.18%	3.06%	3.59%	2.88%
US $E[\bar{R}_{d,1}^n - R_{f,0}^1]$	6.71%	−4.14%	−3.37%	−2.24%	−1.81%	−1.42%
World $E[\bar{R}_{d,1}^n - R_{f,0}^1]$	6.54%	−3.23%	−1.36%	0.40%	0.66%	0.62%

Notes: All international indices are US dollar returns to the relevant Datastream/Thompson Reuters Index. I present the mean excess returns of the asset and the estimated excess returns of the continuation and cumulative dividend claims. The continuation claim returns are given by $\hat{R}_{p,1}^n = \frac{\hat{\Pi}_{p,1}^{n-1}}{\hat{\Pi}_{p,0}^n}$ and the dividend claim returns by $\hat{\bar{R}}_{d,1}^n = \frac{1}{1-\hat{\Pi}_{p,0}^n}(R_1 - \hat{\Pi}_{p,0}^n \frac{\hat{\Pi}_{p,1}^{n-1}}{\hat{\Pi}_{p,0}^n})$. I use monthly formation dates from 6/1974 to 6/2012 to compute both the regression coefficients and the mean excess returns.