

What does the value premium tell us about the term structure of equity returns?

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Abstract

Conventional wisdom holds that growth stocks (low book-to-market stocks) have higher future cash-flow growth rates and longer durations than value stocks, and that the value premium implies a downward sloping equity term structure. Empirical evidence suggests the opposite. Earnings of growth stocks grow more slowly than those of value stocks for both rebalanced and buy-and-hold portfolios. I point out survivorship and static biases in common empirical procedures. Growth stocks behave like short-duration assets: their prices are less sensitive to changes in discount rates, and their discount rates are more volatile. The value premium implies an upward sloping equity term structure. I argue that my results help explain a number of puzzling facts.

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1 Introduction

Leading asset pricing models such as Campbell and Cochrane (1999) and Bansal and Yaron (2004) imply that in the cross section, the term structure of equity returns is upward sloping. It is widely viewed that this implication is at odds with the value premium. Conventional wisdom holds that growth stocks, defined as stocks with low book-to-market equity, have higher future cash-flow growth rates and longer durations than value stocks, and that the value premium implies a downward sloping equity term structure. These views are suggested by the naming of growth stocks, are apparently backed by empirical results, and are matched by theoretical models that try to explain the value premium.¹

I argue that this conventional wisdom is not supported by the data. I examine growth rates. I find that annually rebalanced portfolios of growth stocks have lower growth rates than value stocks for all three cash-flow variables that I examine: earnings, accounting cash flow, and dividends. Buy-and-hold portfolios of growth stocks have lower future earnings and accounting-cash-flow growth rates than value stocks. After I account for survivorship bias, from the first year after portfolio formation to the second year, the value-weighted earnings growth rate of growth stocks (lowest 30% book-to-market) is 6.6%, while that of value stocks (highest 30% book-to-market) is almost 50%. For dividends, whether buy-and-hold portfolios of growth stocks have lower future growth rates depends on whether we examine tercile or decile portfolios. I derive a relation between growth rates of buy-and-hold and rebalanced portfolios and argue that we should focus on growth rates of rebalanced portfolios. I argue that the common practice of fixing the stocks and examining their growth rates over time is problematic; I refer to this problem as static bias.

I also find that growth stocks behave like short-duration assets. I directly examine how prices change in response to changes in expected returns. I find that prices of growth stocks are less

¹A number of authors, including me in the past, have expressed views in line with the conventional wisdom. Leading examples include Cornell (1999), DeChow, Sloan, and Soliman (2004), Zhang (2005), Wachter (2006), Lettau and Wachter (2007), Da (2009), Santos and Veronesi (2010), and Binsbergen, Brandt, and Kojen (2010). For a classic paper on the value premium, see Fama and French (1992).

sensitive to changes in discount rates than those of value stocks. I show that a key determinant of an asset's duration is the persistence of its discount rate and find that expected returns of growth stocks are less persistent than those of value stocks. Also, in common with short-duration assets, growth stocks' discount rates are more volatile than those of value stocks.

I then examine what the value premium implies about the term structure of equity returns. I use 20 portfolios sorted by book-to-market equity and compute three duration measures. The first measure is related to the cash-flow growth rates. Assets with higher expected cash-flow growth rates have longer cash-flow durations. The second measure is based on regressions of realized returns on log price-dividend ratios. The third measure is based on Binsbergen and Kojien (2010)'s present value system with the Kalman filter. Using all three measures of duration, I find that assets with longer durations have higher expected returns and volatilities, consistent with an upward sloping term structure of equity.

I can think of six reasons why the conventional wisdom is widely held. First, Gordon's formula, $\frac{P}{D} = \frac{1}{r-g}$, suggests that all else being equal, stocks with higher prices should have higher cash-flow growth rates. Second, Lakonishok, Shleifer, and Vishny (1994) find that equal-weighted portfolios of growth stocks have higher growth rates in cash flows from year 0 to year 5, and year 0 to year 2, but lower growth rates from year 2 to year 5 than value stocks. They conclude that cash flows of growth stocks initially grow faster and then reverse. Third, Fama and French (1995) show that growth stocks have persistently higher returns on equity than value stocks, even five years after they are sorted into portfolios. Fourth, in firm-level regressions of future dividend growth rates on the book-to-market ratios, the coefficients are highly negative, even for dividend growth rate ten years in the future. Fifth, evidence exists in the literature that rebalanced portfolios of value stocks have higher dividend growth rates. However, this evidence is often viewed as not clean, because it involves reinvesting capital gains and value stocks have had higher returns than growth stocks.² Finally, Gordon's formula suggests that a stock's duration (sensitivity of

²Ang and Liu (2004), Bansal, Dittmar, and Lundblad (2005), Hansen, Heaton, and Li (2008), and Chen, Petkova, and Zhang (2008) also find that the rebalanced portfolio of growth stocks has lower dividend growth rates than value stocks. The first three papers do not explain why their results differ from the conventional wisdom. The last paper argues that their finding is consistent with the conventional wisdom, and that their results are driven by reinvestment of capital gains (portfolio rebalancing). I show that earnings of buy-and-hold portfolios also grow faster for value stocks.

prices with respect to changes in expected returns) is the same as its price-dividend ratio. Or $-\frac{\partial \log P}{\partial r} = \frac{1}{r-g} = \frac{P}{D}$. Therefore, growth stocks should have longer durations.

I address each of the above reasons. First, when we compare value stocks with growth stocks, all else is not equal. Valuation models suggest that valuation ratios are driven by differences in cash-flow growth rates and expected returns. If we consider that value stocks have higher expected returns than growth stocks, valuation models actually imply that growth stocks have lower growth rates. Second, I argue that the initial growth rates are mechanically due to sorting (static bias) and cash flows of growth stocks grow consistently more slowly after portfolio formation than those of value stocks. Third, Fama and French (1995)'s results pertain to the behavior of return on equity, which is relevant for studying the growth rates of book equity. But those results do not imply that cash-flow growth rates for growth stocks are higher. In fact, some back-of-the-envelope calculations suggest that Fama and French (1995)'s results imply that growth stocks have lower earnings growth rates than value stocks. Fourth, the dividend growth rate regression is subject to survivorship bias. After I account for survivorship bias, high book-to-market equity no longer predicts a lower future dividend growth rate. Fifth, I argue that it is important to match the way we compute returns and growth rates. I show that when we rebalance portfolios, the common practice of fixing the portfolio and examining its growth rates over time suffers from static bias. That is, when we sort portfolios based on fundamental-to-price ratios, the growth rates of the fundamental are necessarily downward biased for value stocks under mild conditions. Finally, I argue that Gordon's formula assumes constant expected returns, and therefore is not suitable for studying how prices change in response to changes in discount rates. Once one models how expected returns change over time, then a key parameter is the persistence of expected returns. I find that value stocks have more persistent expected returns than growth stocks, and value stock prices are more sensitive to changes in discount rates.

My results help explain a number of related puzzles in the cross section of stock returns: the duration puzzle, the momentum-vs-value puzzle, the cash-flow risk puzzle, and the good growth puzzle. Cornell (1999), Wachter (2006), and Lettau and Wachter (2007) raise the question of why assets with long durations appear to have lower returns, counter to our intuition. My results

suggest that long-duration assets actually have higher returns. To explain the momentum effect, Johnson (2002) argues that recent winners have higher expected cash-flow growth rates. He then shows that in his model with time-varying expected returns, a higher expected growth rate translates into higher risk and returns. If one views value stocks as having lower growth rates, then this mechanism is at odds with the value premium. My results suggest that value stocks and recent winners share one important similarity: both have higher future cash-flow growth rates. Santos and Veronesi (2010) argue that value stocks do not have enough cash-flow risk to explain their returns. My results suggest that value stocks have higher growth rates and therefore should have higher returns over and above their cash-flow risk. Finally, Novy-Marx (2010) finds that more profitable firms (firms with good growth) have higher returns; his results are difficult to reconcile with popular models of the value premium, because more profitable firms have longer cash-flow duration. My results suggest that his results are consistent with the view that firms with longer cash-flow durations have higher returns.

Different asset pricing models imply different shapes of equity term structures. Classical consumption CAPM in an i.i.d. world and simple rare disaster models (Rietz (1988) and Barro (2006)) imply a flat term structure of equity returns. Models that feature time-varying expected returns typically imply an upward sloping term structure of equity returns. Examples include Campbell and Cochrane (1999) and Bansal and Yaron (2004). But such is not always the case. Lettau and Wachter (2007) build and calibrate a model with a downward sloping term structure of equity. In the appendix, I show that three simple models of time-varying expected returns all imply an upward sloping term structure, if they were to help explain the equity premium. The models all imply that stocks with higher expected growth rates should have higher expected returns, after controlling for cash-flow risk. Thus, I argue that an upward sloping term structure helps explain the equity premium, the value premium, and the momentum effect at the same time.³

The rest of the paper is organized as follows. I present variable definitions and data sources

³In a recent paper, Binsbergen, Brandt, and Koijen (2010) use data from the derivative market between 1996 and 2009 and show that short-term dividend strips have higher expected returns and volatilities than the aggregate stock market. Their results suggest that the equity term structure is downward sloping. To reconcile my results with theirs remains an important task for future research.

in Section 2. Section 3 provides evidence that cash flows of growth stocks do not grow faster than those value stocks in the future. In doing so, I also point out survivorship bias and static bias in common empirical procedures. Section 4 presents evidence that prices of growth stocks are less sensitive to changes in discount rates. Section 5 presents evidence on the shape of the term structure. Section 6 concludes.

2 Data and variable definitions

The data I use come from CRSP and Compustat. I only include stocks with share codes 10 or 11 that are listed on NYSE, AMEX, or Nasdaq. Financials and utilities are excluded. Returns and market equity ($\text{abs}(\text{prc}) \cdot \text{shrout}$) are from CRSP. Accounting variables are from Compustat fundamental file (North America). I define book equity (BE) as stockholders' equity, plus balance sheet deferred taxes (txdb) and investment tax credit (itcb) (if available), minus the book value of preferred stock. Depending on availability, I use redemption (pstkrv), liquidation (pstkl), or par value (pstk), in that order, for the book value of preferred stock. I calculate stockholders' equity used in the above formula as follows. I prefer to use the stockholders' equity number reported by Compustat (seq). If seq is not available, then I measure stockholders' equity as the book value of common equity (ceq), plus the book value of preferred stock. Note that the preferred stock is added at this stage, because it is later subtracted in the book equity formula. If common equity is not available, I compute stockholders' equity as the book value of assets (at) minus total liabilities (lt), all from Compustat.

Earnings are defined as income before extraordinary items (ib). Accounting cash flow is defined as income before extraordinary items plus depreciation and amortization (dp). Dividends are computed from CRSP, by multiplying the lagged market equity by the difference between returns with and without dividends. I then sum up the dividends for each firm between July and June of the following year. The reason that I use dividends constructed from CRSP is that I know when they are paid out. However, I can report that the results are qualitatively the same if I simply use dividends from Compustat.

When forming book-to-market portfolios in June of year t , I sort stocks according to their

book-to-market ratios. The book-to-market equity uses the book equity for the fiscal year that ends in the calendar year $t - 1$. The market equity is from CRSP in December of year $t - 1$. The breakpoints are computed using NYSE stocks only.

3 Do growth stocks grow faster than value stocks?

3.1 Two pieces of evidence that suggest growth stocks grow faster

The first piece of evidence comes from Fama and French (1995), who show that growth stocks have persistently higher returns on equity than value stocks. I update their results in Figure 1. In each year t between 1963 and 2009, I sort stocks according to their book-to-market ratios. The value, neutral, and growth portfolios consist of stocks with book-to-market equity that are in the highest 30%, middle 40% and lowest 30%. Once I have formed the portfolios, I then look at the return on equity for each portfolio five years before and ten years after portfolio formation. The return on equity in year $t + s$ for a portfolio formed in year t is computed as:

$$ROE_{t+s} = \frac{E_{t+s}}{BE_{t+s-1}}. \quad (1)$$

Portfolio earnings (E) and book equity (BE) are the sum of firm earnings and book equity in that portfolio. I treat earnings and book equity with fiscal year ends between July of year $t + s - 1$ and June of year $t + s$ as earnings and book equity in year $t + s$.⁴ I follow Fama and French (1995) and require a stock to have data for both E_{t+s} and BE_{t+s-1} to be included in the computation of the portfolio return on equity, although I show later that this requirement gives rise to survivorship bias. I average the portfolio return on equity across the 47 portfolio formation years 1963-2009.

$$ROE_s = E[ROE_{t+s}], \quad (2)$$

⁴When looking at return on equity, Fama and French (1995) treat earnings and book equity with fiscal year ends in calendar year $t + s$ as earnings and book equity in year $t + s$. Because most firms have December fiscal year ends, their year 0 roughly corresponds to my year 1.

in which taking expectation means averaging over portfolio formation years t . Because I track the portfolio five years before its formation year, accounting information between 1957 and 2010 is used.

Figure 1 plots the ROE_s for s between -5 and 10. Figure 1 shows that growth stocks have persistently higher returns on equity than value stocks, even ten years after portfolio formation. This finding led Fama and French to term the stocks with low book-to-market ratios as “growth stocks”. The return on equity reaches the highest value for growth stocks and the lowest value for value stocks in year 1. This pattern is the same as in Fama and French (1995).

Table 1 provides the second piece of evidence. In this table, I estimate firm-level regressions of log dividend growth rates on lagged book-to-market ratios. In particular, I estimate the following regression in each year:

$$\log(D_{i,t}/D_{i,t-1}) = b_0 + b_1 \log(B/M)_{i,t-k} + \epsilon_{i,t}. \quad (3)$$

I estimate the regression using the Fama-MacBeth procedure between 1965 and 2010, for k between 1 and 10. $D_{i,t}$ is the dividend from July of year $t - 1$ to June of year t computed from CRSP. Variables are winsorized at 1% and 99% in each year. Table 1 reports the results. Years negative refer to the number of years in which the coefficient b_1 is negative. I report Newey-West t -statistics with an automatically selected number of lags.

Table 1 shows that book-to-market equity appears to strongly forecast negative dividend growth. When $k = 1$, the coefficient b_1 is negative in 46 out of 46 years. The average coefficient is -0.097 and is highly statistically significant. In year 2, the coefficient b_1 is again negative, with an average coefficient of -0.055 . It is negative in 45 out of 46 years. The coefficient is significantly negative even after ten years.

I argue that the above empirical evidence does not imply that growth stocks have higher future cash-flow rates. Fama and French (1995)’s results on return on equity are related to the growth rates of book equity, but not necessarily of cash flows.⁵ I directly examine the growth rates of

⁵The clean surplus relation holds that $BE_t = BE_{t-1} + E_t - D_t$. When dividends are proportional to earnings, the return on equity is proportional to book-equity growth rates.

cash flows (earnings, accounting cash flows, and dividends) for value and growth stocks. I first examine their cash-flow growth rates corresponding to a buy-and-hold strategy. I then examine the cash-flow growth rates corresponding to an annually rebalanced strategy. In doing so, I also point out survivorship and static biases in the above procedures.

3.2 The buy-and-hold growth rates

3.2.1 The back-of-the-envelope calculation

In fact, I argue that Fama and French (1995)'s results on return on equity imply that the earnings growth rates are higher for growth stocks. Consider a back-of-the-envelope calculation for the earnings growth rates. Earnings growth rate in year s is,

$$\frac{E_s}{E_{s-1}} - 1 = \frac{\frac{E_s}{B_{s-1}} B_{s-1}}{\frac{E_{s-1}}{B_{s-2}} B_{s-2}} - 1. \quad (4)$$

Assume the clean surplus relation:

$$B_{s-1} = B_{s-2} + E_{s-1} - D_{s-1} \quad (5)$$

and a constant dividend payout ratio, $po = D_{s-1}/E_{s-1}$. I show that,

$$\frac{E_s}{E_{s-1}} - 1 = \frac{ROE_s}{ROE_{s-1}} + (1 - po)ROE_s - 1. \quad (6)$$

For value stocks, $\frac{ROE_s}{ROE_{s-1}}$ is higher than growth stocks, but $(1 - po)ROE_s$ is lower than growth stocks. It turns out that the first term dominates. For example, assume that the payout ratio is 0.5. In year 2, for value stocks, ROE_s is 0.05, ROE_{s-1} is 0.034, the earnings growth rate is $0.05/0.034 + 0.5 * 0.05 - 1 = 48.2\%$. Note that there are rounding errors in this calculation. For growth stocks, ROE_s is 0.186, ROE_{s-1} is 0.202, the earnings growth rate is $0.186/0.202 + 0.5 * 0.186 - 1 = 1.3\%$.

The results of the back-of-the-envelope calculations are plotted in Figure 2. Prior to and in the first year after portfolio formation, growth stocks have higher earnings growth rates than value

stocks. However, in year 2, the earnings growth rate of value stocks (48.2%) greatly exceeds that of growth stocks (1.3%). In year 3, the earnings growth rate of value stocks (24.4%) still exceeds that of growth stocks (3.1%). Starting in year 4, the earnings growth rates of the three portfolios become similar.

I argue that only growth rates during and after year 2 are relevant for investors. The reason is that when we compute growth rates in year 1, the denominator involves earnings accrued between year -1 and year 0, at which point investors have not yet held the portfolio. Another way to see this argument is to consider a dividend discount model:

$$\begin{aligned} P_t &= E \left[\frac{D_{t+1}}{1 + Er_{t+1}} + \frac{D_{t+2}}{1 + Er_{t+2}} + \frac{D_{t+3}}{1 + Er_{t+3}} + \dots \right] \\ &= E \left[\frac{D_{t+1}}{1 + Er_{t+1}} + \frac{D_{t+1}(1 + g_{t+2})}{1 + Er_{t+2}} + \frac{D_{t+1}(1 + g_{t+2})(1 + g_{t+3})}{1 + Er_{t+3}} + \dots \right], \end{aligned} \quad (7)$$

where Er_{t+s} is the discount rate for year $t+s$. The first growth rate that appears in this equation is g_{t+2} .

3.2.2 The buy-and-hold growth rates without adjusting for survivorship bias

I examine the cash flows and book-equity growth rates before and after portfolio formation for value and growth stocks directly. I wish to compute:

$$g_{t+s}^F = \frac{F_{t+s}}{F_{t+s-1}} - 1, \quad (8)$$

where F_{t+s} refers to the fundamental value (earnings, accounting cash flow, dividends, and book equity) in year $t+s$ for a portfolio that is formed in June of year t . The fundamental value of a portfolio is the sum of the fundamental values across firms in that portfolio.

I initially try to use Fama and French (1995)'s method. Therefore, I require that to be included in the computation of portfolio growth rates, a stock must have data for both F_{t+s} and F_{t+s-1} .

I then average across portfolio formation years.

$$g_s^F = E[g_{t+s}^F], \quad (9)$$

where $E[.]$ means averaging across portfolio formation years t .

One issue that arises is that earnings and accounting cash flows are sometimes negative, even for portfolios. To address this issue, I first average earnings and accounting cash flows in year $t + s$ and $t + s - 1$ across portfolio formation years, then compute growth rates. To make the variables comparable, I scale cash flows by market capitalizations in June of year t . This scaling corresponds to an investment strategy that invests \$1 in each portfolio formation year. That is, I first compute,

$$\tilde{F}_{t+s} = \frac{F_{t+s}}{ME_t}. \quad (10)$$

$$g_s^F = \frac{E[\tilde{F}_{t+s}]}{E[\tilde{F}_{t+s-1}]} - 1, \quad (11)$$

where the expectation is averaging across portfolio formation years t .⁶ I compute growth rates for earnings and accounting cash flows according to Equation (11), and for dividends and book equity according to Equation (9).

Figure 3 reports the average growth rate g_s^F . Panel A reports the earnings growth rates for value, neutral, and growth stocks. Prior to and in the first year after portfolio formation, growth stocks have higher earnings growth rates than value stocks. But in year 2, the earnings growth rate of value stocks (35%) greatly exceeds growth stocks (7.6%). In year 3, the earnings growth rate of value stocks (17%) still exceeds that of growth stocks (6.9%). Starting in year 4, the earnings growth rates of the three portfolios become similar.

Panel B plots growth rates for accounting cash flows. As with earnings, the accounting-cash-flow growth rates are higher for growth stocks up to year 1 after portfolio formation. In year 2, the growth rate of value stocks (12.4%) exceeds that of growth stocks (10%). In year 3, growth rates are similar between value and growth stocks. Unlike earnings, starting in year 4, growth stocks appear to have higher growth rates in accounting cash flows than value stocks.

Panel C plots growth rates for dividends. As with earnings and accounting cash flows, dividend growth rates are higher for growth stocks up to year 1 after portfolio formation. Starting in year

⁶I include all stocks in computing the market capitalization of the portfolio in year t . But in computing the portfolio cash flows in year $t + s$ and $t + s - 1$, a stock must have cash flows in both year $t + s$ and $t + s - 1$.

2, the growth rates of dividends for value stocks increase over time, while the opposite is true for growth stocks. After portfolio formation, the growth rates of value stocks are similar to or higher than those of the neutral portfolio. However, growth rates of value stocks are lower than those of growth stocks in each year between year 2 and year 9.

Panel D plots growth rates of book equity. This graph looks similar to Figure 1. The growth rate of book equity exhibits the same pattern as return of equity, consistent with the clean surplus relation.

The evidence so far suggests that growth stocks do not always grow faster after portfolio formation.

3.2.3 Survivorship bias in portfolio growth rates

In the procedure above, I require a firm to be alive in both years $t + s - 1$ and $t + s$ to be included in the calculation for growth rates. However, when investors invest in year $t + s - 1$, they do not know whether the firm will be alive in year $t + s$. Therefore, requiring the firm to have a valid data entry in year $t + s$ gives rise to a survivorship bias. Suppose that growth stocks (such as internet firms) tend to either become extremely successful (like Google), or they die. If we only look at the firms that survive, we may see a picture that is different from investors' actual experiences.

In Table 2, I report the average transition matrix for portfolios between 1963 and 2009. The number in Row i and Column j is the probability (average percentages) of a stock belonging to book-to-market Decile j or exiting ($j = 11$) in year $t + 1$, conditional on the stock belonging to Decile i in year t . Each row sums to 100. Conditional on a firm being in the lowest book-to-market decile, there is 9.74% chance that the firm will exit (through either merger or delisting for cause) in the next year. Conditional on a firm being in the highest book-to-market decile, there is 12.65% chance that the firm will exit in the next year. Thus, it is a pervasive phenomenon that firms disappear (see also Chen (2011)).⁷ Table 2 also shows that a large fraction of firms do not stay in the same portfolio two years in a row. This means that when we rebalance portfolios, the portfolio composition changes significantly.

⁷Fama and French (2007) report the transition matrix for six size and book-to-market sorted portfolios between 1926 and 2005.

To account for survivorship bias, it is important that when computing the growth rate in year $t + s$, I do not look at just the firms that are alive in year $t + s$. Instead, I examine all firms that are alive in year $t + s - 1$, and keep track of delisting proceeds when firms exit in year $t + s$.

Thus, I follow a five-step procedure:

Step 1: I compute the fundamental-to-price ratio in year $t + s$ for a portfolio that is formed in year t ,

$$FP_{t+s} = \frac{F_{t+s}}{ME_{t+s-1}}. \quad (12)$$

In this step, F_{t+s} and ME_{t+s-1} are the sum of values across firms in that portfolio. All firms that are available in year $t + s - 1$, but not necessarily in $t + s$, are included. If a firm exits the portfolio in year $t + s$, its fundamental value is zero by default. In the next steps, I make sure that delisting proceeds are accounted in the future.⁸

Step 2: I compute value-weighted buy-and-hold portfolio returns and returns without dividends ret_{t+s} and $retx_{t+s}$. It is important to include delisting returns in this step. In the month of delisting, if there is no return in CRSP, I set the return (ret) and the return without dividends (retx) to the delisting return (dlret) and the delisting return without dividends (dlretx). When there is a return in the month of delisting, I compound the return and the delisting return. I also compound the retx and dlretx. For delisting returns that are missing and the delisting code is between 400 and 600, I set dlret and dlretx to be -30%.

Step 3: Once I have the returns series, I compute the price series for any given amount investment in an early year, say, \$1 investment in, year $t - 7$, as follows:

$$P_{t-7} = 1, \quad (13)$$

and

$$P_{t+s} = P_{t+s-1}(1 + retx_{t+s-1}). \quad (14)$$

⁸One could also take the delisting proceeds out as a form of dividends. The results are qualitatively the same but the growth rates of portfolios are more volatile due to outliers.

Step 4: I multiply $P_{t+s-1}FP_{t+s}$ to get the survivorship bias adjusted portfolio fundamental value F_{t+s}^{SA} .

Step 5: For dividends and book equity, I compute $g_{t+s}^{F,SA} = \frac{F_{t+s}^{SA}}{F_{t+s-1}^{SA}} - 1$, and then average across portfolio formation years as in Equation (9). For earnings and accounting cash flow, I first scale cash flows to correspond to a \$1 investment in portfolio formation year t , $\tilde{F}_{t+s}^{SA} = \frac{F_{t+s}^{SA}}{P_t}$. I then average across portfolio formation years before computing growth rate, as in Equation (11).

If no firm ever exits the portfolio, then this procedure should yield exactly the same value as the simple growth rates in Section 3.2.2. When firms do exit the portfolio, this procedure automatically accounts for survivorship bias because it includes all firms that are alive in year $t + s - 1$. It accounts for the delisting proceeds, because when computing returns, we implicitly assume that proceeds are reinvested when firms exit the portfolio.

The results for the four survivorship bias adjusted growth rates are plotted in Figure 4. The plots are qualitatively similar to those in Figure 3. But accounting for survivorship bias generally increases growth rates of the value portfolio and decreases those of the growth portfolio. For example, in Panel A, in year 2, without adjusting for survivorship bias, the earnings growth rates for the growth and value portfolios are 7.6% and 35%, respectively. After accounting for survivorship bias, the earnings growth rates for the growth and value portfolios become 6.6% and 49.5%. In Panel B, in year 2, the accounting-cash-flow growth rates for the growth and value portfolios change from 10% and 12.4% to 8.8% and 15%, respectively. Panels C and D are qualitatively the same as those in Figure 3, with the change generally increasing the growth rate for the value portfolio and decreasing the growth rates for the growth portfolio. After adjusting for survivorship bias, the dividend and book-equity growth rates of the value portfolio are still lower than those of the growth portfolio.⁹

Figure 4 suggests that in years 2 and 3, the value portfolio has higher growth rates in earnings and accounting cash flows than the growth portfolio. Starting in year 4, the growth rates become

⁹Unreported results show that total assets and revenues behave much like the book equity. In corporate finance, the market-to-book ratio is widely used as a proxy for growth. My results suggest that the market-to-book ratio is a proxy for assets growth, but not for cash-flow growth. Also, some sources (e.g., Investopedia) define growth stocks as shares in a company whose earnings are expected to grow at an above-average rate relative to the market. Throughout this paper, I define growth stocks as those with low book-to-market ratios. My results show that these two definitions contradict each other.

similar. This figure also suggests that the value portfolio has lower dividend and book-equity growth rates than the growth portfolio within ten years of portfolio formation. The dividend growth rate increases over time for the value portfolio, which is consistent with dividend smoothing: earnings are high in year 2, but dividends are paid out in later years.

Figure 5 shows that the finding that value portfolios have lower buy-and-hold dividend growth rates is not robust, if we examine book-to-market deciles instead of terciles. Panel A of Figure 5 plots the the average dividend growth rates for book-to-market deciles in years 2 and 3. In year 2, the dividend growth rate decreases as book-to-market increases. But in year 3, the dividend growth rate initially decreases but then increases as book-to-market increases. Panel B of Figure 5 plots the dividend growth rates for Decile 1 (growth portfolio) and Decile 10 (value portfolio). The dividend growth rate for the value portfolio by and large exceeds that of the growth portfolio starting in year 3.

3.2.4 Survivorship bias in regressions

The regression of the dividend growth rate on the book-to-market ratio in Table 1 is inherently subject to survivorship bias, because a firm has to be alive to be included in the regression. To account for survivorship bias in this regression, I include the delisting proceeds (delisting amount, $\text{abs}(\text{dlamt})$, multiplied by shares outstanding) as a form of dividends. I then re-estimate the regressions and report the new results in Table 3.

Table 3 shows a different picture from Table 1. Although the coefficient on book-to-market is still negative in year 2, it becomes positive starting in year 3. Starting in year 5, each coefficient is statistically significant at the 10% level.

The reason that adjusting for survivorship bias makes a bigger difference in the regression than in portfolio growth rates is because regressions are equal weighted in nature. Accounting for survivorship bias is more important in small firms, since large firms are less likely to exit.

3.3 Growth rates of annually rebalanced portfolios

Because the implementation of the value strategy typically involves an annually rebalanced portfolio, I study the cash-flow growth rates for rebalanced portfolios. I follow a procedure similar to that outlined in Section 3.2.3. The main difference is that when I compute price levels, I use the annually rebalanced portfolios returns.

Step 1: I compute the fundamental-to-price ratio in year $t+1$ for the portfolio formed in year t ,

$$FP_{t+1} = \frac{F_{t+1}}{ME_t}. \quad (15)$$

In this step F_{t+1} and ME_t are the sum of values across firms in that portfolio. All firms available in year t , although not necessarily in $t+1$, are included.

Step 2: I compute value-weighted rebalanced portfolio returns and returns without dividends ret_{t+1} and $retx_{t+1}$. It is important to include delisting returns in this step.

Step 3: Once I have the returns series, I compute the price series for any given amount of investment in an early year, for example, a \$1 investment in June of 1963, as follows:

$$P_{1963} = 1, \quad (16)$$

and

$$P_{t+1} = P_t(1 + retx_{t+1}). \quad (17)$$

Step 4: I multiply $P_t FP_{t+1}$ to get the rebalanced portfolio fundamental value F_{t+1}^{RP} .

Step 5: For dividends and book equity, I compute $g_{t+1}^{F,RP} = \frac{F_{t+1}^{RP}}{F_t^{RP}} - 1$, and then average across years. For earnings and accounting cash flow, I first scale cash flows to correspond to a \$1 investment in portfolio formation year t , $\tilde{F}_{t+1}^{RP} = \frac{F_{t+1}^{RP}}{P_t}$. Then I average across portfolio formation years before computing the growth rate, $g^{F,RP} = \frac{E[\tilde{F}_{t+1}^{RP}]}{E[\tilde{F}_t^{RP}]} - 1$, analogous to Equation (11).

The results are plotted in Figure 6. Panel A plots the average earnings growth rates for three book-to-market portfolios. I look at three portfolios because decile portfolios sometimes produce

negative average earnings numbers. The growth portfolio has an average earnings growth rate of 6.8%, while the value portfolio's growth rate is 9.7%. Panel B plots the average growth rate for accounting cash flow, dividends, and book equity. I now examine book-to-market deciles. The average growth rate initially slightly decreases and then strongly increases with with the book-to-market ratio. If we compare Decile 1 and Decile 10, Decile 10 has unambiguously higher growth rates in all three fundamental values. The growth decile has average accounting-cash-flow, dividend, and book-equity growth rates of 6.7%, 9.1%, and 6.5%, respectively, and the value decile has growth rates of 14.3%, 15.9% and 12.6%, respectively.

3.4 Static bias

Forming rebalanced portfolios has become second nature for empirical asset pricing researchers. To examine the value premium, we form a portfolio as of June of year t , and then hold the portfolio between July of year t and June of year $t + 1$, at which time the portfolio is rebalanced. A common procedure used to examine cash-flow growth rates is to fix the stocks in the portfolio, and then look at the cash-flow growth rates over time for that given set of stocks. This procedure is used in Lakonishok, Shleifer, and Vishny (1994) and Fama and French (1995), and has been followed by many others. Growth rates of a fixed portfolio may understate or overstate cash-flow growth rates of the rebalanced portfolio.

3.4.1 An example

Suppose that the investment opportunity set consists of only two stocks, A and B. These two stocks are ex ante identical. Assume that in each year, one of the stocks pays a dividend of \$10 and the other one pays \$20. A coin is tossed to decide which stock pays which amount. Therefore, in any given year, there is a 50% chance that A pays a dividend of \$10, and B pays a dividend of \$20, and there is a 50% chance that A pays a dividend of \$20, and B pays a dividend of \$10.

Immediately after the dividend is paid, the two stocks are identical, and should trade at the same price. Assume that the risk free rate (the appropriate discount rate since coin tosses are idiosyncratic risk) is 10%, so each stock should trade at $(10+20)/2/10\%=\$150$. Going forward,

the two stocks are the same and have expected returns of 10% per year.

Next, consider two portfolio strategies. One is the high-dividend strategy, which always buys the stock that just paid a high dividend of \$20. The other, the low-dividend strategy does exactly the opposite, always buying the stock that just paid a dividend of \$10. If we use the actual cash-flow growth rate from holding the portfolios, we will find that the two portfolios generate the same expected future dividend growth rate: zero. But if we fix the stocks in the portfolios and then look at the dividend growth rates of these stocks, then the stock in the high-dividend portfolio has a negative expected dividend growth rate, i.e., $15/20 - 1$. The stock in the low-dividend portfolio has a positive expected dividend growth rate, i.e. $15/10 - 1$.

3.4.2 Notations

I examine the difference between growth rates of rebalanced portfolios and static portfolios. To do so, I first introduce notations. Although I focus on dividends, the logic applies to other fundamental variables as well. Suppose there are N stocks, whose prices and dividends per share are $P_{n,t}$ and $D_{n,t}$, for $n = 1, 2, \dots, N$. Prices are measured at the end of the year. Dividends are paid shortly before the end of the year. The trading strategy uses information up to year t and calls for buying those stocks with a certain characteristic at the end of year t , and holding the stocks until the end of year $t + 1$. At the end of year $t + 1$, we take out and consume the dividend. We also rebalance the portfolio and use the proceeds from stock sales to buy stocks that fit the portfolio selection criteria at the end of year $t + 1$, and then hold those stocks in year $t + 2$. For ease of disposition, assume that there are only ten stocks, $N = 10$, and our strategy calls for holding one stock at any given point in time. Assume that the stocks selected by the strategy at the end of years t , $t + 1$, and $t + 2$, are stocks i , j , and k , respectively. Note that at time t , the identities of j and k are not known and may or may not be i . Our initial investment is $P_{i,t}$, so we can buy one share of stock i . Therefore, the portfolio generates a dividend of $D_{i,t+1}$ in year $t + 1$. The investor is left with $P_{i,t+1}$, and then can buy $\frac{P_{i,t+1}}{P_{j,t+1}}$ shares of stock j . Therefore, in year $t + 2$, the investor earns a dividend of $D_{j,t+2} \frac{P_{i,t+1}}{P_{j,t+1}}$. The dividend growth rate of the rebalanced portfolio in year $t + 2$ is

$$g_{t+2} = \frac{D_{j,t+2} \frac{P_{i,t+1}}{P_{j,t+1}}}{D_{i,t+1}} - 1. \quad (18)$$

The dividend growth rate in year $t + s$ for the buy-and-hold portfolio formed in year t is:

$$g_{t,t+s}^{BH} = \frac{D_{i,t+s}}{D_{i,t+s-1}} - 1, \text{ for } s \geq 2. \quad (19)$$

Note that when $s \leq 1$, we have not yet bought the portfolio. Nevertheless, we can compute the growth rate of such a portfolio. When $s = 1$, I call it the look-back growth rate.

$$g_{t,t+1}^{LB} = \frac{D_{i,t+1}}{D_{i,t}} - 1. \quad (20)$$

In the above example,

$$g_{t,t+2}^{BH} = \frac{D_{i,t+2}}{D_{i,t+1}} - 1, \quad (21)$$

and

$$g_{t+1,t+2}^{LB} = \frac{D_{j,t+2}}{D_{j,t+1}} - 1. \quad (22)$$

3.4.3 Static bias

I now show that the look-back growth rate is necessarily downward biased for the value portfolio and necessarily upward biased for the growth portfolio. Suppose the value strategy calls for buying the stock with the highest dividend-price ratio at the end of year t and then holding that stock during year $t + 1$. Again, assume $N = 10$ and that the stocks selected by the strategy at the end of year t , $t + 1$, and $t + 2$, are stocks i , j , and k , respectively.

For the value portfolio, $g_{t+2} \geq g_{t+1,t+2}^{LB}$, because

$$1 + g_{t+2} = \frac{D_{j,t+2} \frac{P_{i,t+1}}{P_{j,t+1}}}{D_{i,t+1}} = \frac{D_{j,t+2}}{P_{j,t+1}} \frac{P_{i,t+1}}{D_{i,t+1}} \geq \frac{D_{j,t+2}}{P_{j,t+1}} \frac{P_{j,t+1}}{D_{j,t+1}} = \frac{D_{j,t+2}}{D_{j,t+1}} = 1 + g_{t+1,t+2}^{LB}. \quad (23)$$

The inequality holds because we sort on dividend price ratios and stock j has the highest

dividend price ratio in year $t + 1$. Similar arguments show that the look-back growth rate necessarily overstates the growth rates of the growth portfolio, that is, $g_{t+2} \leq g_{t+1,t+2}^{LB}$ for the growth portfolio.

This analysis uses dividends, but the logic works for any fundamental variable. If we sort on book-to-market ratio, then as long as the sorting preserves the ranking of the fundamental-to-price ratio in the portfolio formation year, the look-back growth rate in that fundamental value understates value investors' experiences. I will test whether sorting on book-to-market preserves the ranking of $\frac{F_0}{P_0}$.

In the equations below, I show that the buy-and-hold growth rates may also be biased. For the value portfolio, $g_{t+2} \geq g_{t+1,t+2}^{BH}$, if

$$\frac{D_{j,t+2}}{P_{j,t+1}} \geq \frac{D_{i,t+2}}{P_{i,t+1}}. \quad (24)$$

This is because,

$$1 + g_{t+2} = \frac{D_{j,t+2} \frac{P_{i,t+1}}{P_{j,t+1}}}{D_{i,t+1}} = \frac{D_{j,t+2}}{P_{j,t+1}} \frac{P_{i,t+1}}{D_{i,t+1}} \geq \frac{D_{i,t+2}}{P_{i,t+1}} \frac{P_{i,t+1}}{D_{i,t+1}} = \frac{D_{i,t+2}}{D_{i,t+1}} = 1 + g_{t,t+2}^{BH}. \quad (25)$$

Thus, if we sort on book-to-market ratio, then as long as the sorting preserves the ranking of the forward fundamental-to-price ratio, the buy-and-hold growth rate in that fundamental value understates value investors' experiences. That is, the buy-and-hold growth rate is lower than the rebalanced portfolio growth rate for value investors if sorting on book-to-market preserves the ranking of $\frac{F_1}{P_0}$.

I test these two conditions. I plot $\frac{F_0}{P_0}$ and $\frac{F_1}{P_0}$ in Figure 7. The plot shows that sorting on the book-to-market ratio results in a hump shape in the earnings/price ratio. But sorting on the book-to-market ratio preserves the rankings in the accounting cash flow/price ratio, the dividend/price ratio, and of course, the book-to-market ratio. In terms of the forward fundamental to price ratio, $\frac{F_1}{P_0}$, the ranking is almost preserved for accounting cash flows and dividends, except for Deciles 9 and 10. The ranking is entirely preserved for book equity. Hence, I conclude that for the latter three variables, looking at static growth rates (both the look-back growth rate and the buy-

and-hold growth rate) understates a value investor’s experiences. Further, this understatement mechanically arises when we sort on fundamental-to-price ratios.

The look-back growth rate is not real, in that investors cannot actually experience it. It corresponds to the growth rate in year 1 after portfolio formation for the static portfolio. Therefore, the difference between the look-back growth rate and the rebalanced growth rate is clearly a bias.

The buy-and-hold growth rate is achievable if the investor buys and holds the portfolio forever. Therefore, the difference between the buy-and-hold growth rate and the rebalanced growth rate may be a difference, but not necessarily a bias. However, in asset pricing, we almost invariably consider rebalanced portfolios. It is important to match the way we compute returns and growth rates, because otherwise pricing identities are violated.

To see this point, consider the Campbell-Shiller (1988) linearized present value (ignoring a constant term),

$$pd_t = - \sum_{s=1}^{\infty} \rho^{s-1} r_{t+s} + \sum_{s=1}^{\infty} \rho^{s-1} \Delta d_{t+s} \quad (26)$$

A buy-and-hold portfolio and a rebalanced portfolio have the same pd_t , but they have different future return paths. Therefore, their future growth rates are also different.

Both the look-back and the buy-and-hold growth rates arise when we fix the portfolio and examine its growth rates over time. These growth rates typically understate the experiences of value investors who rebalance their portfolios, and they overstate the experiences of investors who invest in growth stocks and rebalance. These understatements and overstatements occur under mild conditions, and do not require a value premium. I refer to the bias arising from looking at the static portfolio when investors rebalance as static bias.

3.5 Evidence from valuation models

Gordon’s formula suggests that all else equal, stocks with higher prices should have higher cash-flow growth rates. However, all else is not equal when we compare value stocks with growth stocks because they differ in expected returns. I now examine whether Gordon’s formula actually implies that growth stocks have higher growth rates. To do so, I plot average dividend price ratios, annual

returns, and dividend growth rates for book-to-market deciles 1964 to 2010 in Figure 8. The left panel plots the value-weighted deciles and the right panel plots the equal-weighted deciles. The returns and dividend growth rates are for annually rebalanced portfolios.

The average dividend yield for the value-weighted growth decile is 1.5%. The dividend yield increases, although not monotonically, to about 3% for the value decile. The difference is 1.5%.¹⁰ However, the average return increases from 10.3% to 15.3%. The difference is 5%. Therefore, even Gordon's formula suggests that the value portfolio's expected dividend growth rates should be 3.5% higher than the growth decile. I also plot the actual average growth rates, which go from 9% to almost 16%. The difference is 7%, suggesting that Gordon's formula does not hold exactly.

The results for equal-weighted portfolios are even more striking. The average dividend yield for the equal-weighted growth decile is 0.7%. The dividend yield increases to about 1.4% for the value decile. The difference is only 0.7% per year. The average return, however, increases from 9% to 23.6%. The difference is 14.6%. Therefore, Gordon's formula suggests that the value portfolio's expected dividend growth rate should be 13.9% higher than that of the growth decile. The actual average growth rate difference is 15.7% (22%-6.3%). Thus, I conclude that valuation models also suggest that value stocks have higher cash-flow growth rates.

3.6 Volatility of cash-flow growth rates

Figure 9 shows that the way we compute growth rates also results in different cash-flow risks. Because earnings and accounting cash flows are sometimes negative, I focus on dividend and book equity in studying cash-flow volatilities. Panel A plots the standard deviation of the dividend growth rate for the static portfolio in year 1 and the rebalanced portfolio. Note that static growth rates in year 1 are subject to both survivorship and static biases. The standard deviation of the dividend growth rate increases as the book-to-market ratio increases. The growth portfolio has a standard deviation of 6.5%, and the value portfolio has 23%. But looking at the static growth rates understates the true volatility of dividend growth rates. The dash-dot line plots the cash-flow volatility for the rebalanced portfolio. The cash-flow volatility also increases as the

¹⁰Results are qualitatively the same if I use the dividend yield in the beginning of the sample period.

book-to-market ratio increases, but the range is much higher, between 25.7% and 46.6%.

Panel B plots the standard deviation of book-equity growth rates. If we look at the static growth rate, the volatility initially decreases and then increases as the book-to-market ratio increases. When we compare Decile 1 and Decile 10, there is little difference. However, if we look at the rebalanced portfolio growth rate, then the growth rate volatility increases almost monotonically from Decile 1 to Decile 10. Cohen, Polk, and Vuolteenaho (2009) show that buy-and-hold value portfolios have higher cash flow (ROE) risk and that cash-flow risk helps explain their buy-and-hold portfolio returns. My results suggest that their risk measures likely understate the risk differences between rebalanced growth and value portfolios.

4 Do growth stocks have longer durations?

4.1 Evidence from regressions

In Section 3, I find that growth stocks have lower future cash-flow growth rates than value stocks. This finding suggests that growth stocks have shorter cash-flow durations. Here, I examine whether they have lower price durations, i.e., whether their prices are less sensitive to changes in discount rates.

In principle, if we have estimates of expected returns, we can simply regress the time series of prices on expected returns to estimate the duration. Because realized returns are a proxy for expected returns with measurement error, and prices have no measure errors, I estimate the reverse regression of realized returns on price dividend ratios. Thus, I estimate the following regression,

$$r_{t+1} = b_0 + b_1 p d_t + b_2 \Delta d_{t+1} + \dots + b_{s+1} \Delta d_{t+s} + \epsilon. \quad (27)$$

In this regression, the implied duration of the asset is $-\frac{1}{b_1}$.

I estimate the regression for each of the ten value-weighted book-to-market deciles. I use annual (from July to the next June) data from 1963 to 2010. In this section, I follow Campbell and Shiller (1988) and use log returns, log price dividend ratios, and log dividend growth rates. I

consider three versions of the regression. In regression 1, no dividend growth rate is included. In regression 2, Δd_{t+1} is included. In regression 3, Δd_{t+1} through Δd_{t+5} are included.

The results are provided in Table 4. In regression 1, b_1 increases from -0.17 to -0.04 as we go from Decile 1 (growth) to Decile 10 (value). The difference is 0.14, which is close to being statistically significant (the Newey-West t-stat=1.56), but is clearly economically significant. The magnitudes imply that the duration increases from 5.74 years for the growth decile to 22.13 years for the value decile. In regression 2, b_1 increases from -0.20 to -0.05. This increase implies that the duration increases from 5.74 years to 22.13 years. In regression 3, b_1 increases from -0.20 to -0.04, corresponding to an increase from 4.96 years to 27.07 years in duration. The difference in coefficient b_1 is statistically significant under regression 3. I believe that regression 2 is the best specification of the three, because it does control for the dividend growth rate, but does not control for too many growth rates. Thus, I focus on duration implied by regression 2. I refer to it as Dur^{RB} , regression-based duration.

4.2 Duration and Gordon's formula

Using Gordon's formula, one can compute the derivative and the duration is,

$$-\frac{\partial \log P}{\partial r} = \frac{1}{r-g} = \frac{P}{D} \quad (28)$$

Why is it then that I find that growth stocks are less sensitive to changes in discount rates? I argue that Gordon's formula assumes a constant expected return and is not suitable for studying the sensitivity of prices to changes in discount rates. To study such a problem, one needs to explicitly consider how discount rates change over time. The simplest model that allows discount rates to change is an AR(1) model, so I derive a formula for duration when expected returns follow AR(1).

Consider the Campbell-Shiller linearized present value (ignoring a constant term),

$$pd_t = -\sum_{s=1}^{\infty} \rho^{s-1} r_{t+s} + \sum_{s=1}^{\infty} \rho^{s-1} \Delta d_{t+s}, \quad (29)$$

where $\rho = \frac{\exp(\bar{pd})}{\exp(pd)+1}$.

This equation holds ex ante as well:

$$pd_t = - \sum_{s=1}^{\infty} \rho^{s-1} E[r_{t+s}] + \sum_{s=1}^{\infty} \rho^{s-1} E[\Delta d_{t+s}] \quad (30)$$

Assume that:

$$r_{t+1} = \mu_t + \epsilon_{t+1}^r. \quad (31)$$

And the expected return μ_t follows an AR(1) process,

$$\mu_{t+1} = b_0 + \phi_\mu \mu_t + \epsilon_{t+1}^\mu. \quad (32)$$

Then, ignoring a constant term,

$$pd_t = - \frac{\mu_t}{1 - \rho\phi_\mu} + \sum_{s=1}^{\infty} \rho^{s-1} E[\Delta d_{t+s}] \quad (33)$$

Thus, the sensitivity of prices to discount rates (μ_t) is:

$$Duration = - \frac{\partial \log P}{\partial r} = \frac{1}{1 - \rho\phi_\mu}. \quad (34)$$

Therefore, duration is affected by both ρ and ϕ_μ . Growth stocks have higher P/D , so they have higher ρ . But duration is also affected by ϕ_μ . The more persistent the expected return, the longer the duration. The earlier regression results suggest that perhaps value stocks' expected returns are more persistent.

4.3 Evidence from the Binsbergen and Koijen (2010) system

To estimate the persistence of expected returns, I use the Binsbergen and Koijen (2010) system. Binsbergen and Koijen (2010) use the Campbell-Shiller present value equation, and assume that both expected returns and expected dividend growth rates follow AR(1) models. They use the

Kalman filter and maximum likelihood to estimate the model for the aggregate stock market. I estimate their model for each value-weighted book-to-market deciles between 1963 and 2010.

The results are reported in Table 5. The average log price dividend ratio is higher for growth stocks than for value stocks. As a result, ρ decreases from 0.986 to 0.976 as we go from growth decile to the value decile. However, the persistence of expected returns ϕ_μ increases from 0.853 to 0.967, as we go from the growth decile to the value decile. The implied duration from the Binsbergen and Koijen (2010) Kalman filter system is: $Dur^{KF} = \frac{1}{1-\rho\phi_\mu}$. I find that the Dur^{KF} is 6.27 years for the growth decile, and increases to 17.77 years for the value decile. Given the difference in the two approaches, I find Dur^{KF} remarkably similar to Dur^{RB} .

The Binsbergen and Koijen (2010) system also allows me to study the standard deviation of discount rates. $\sigma(\epsilon^\mu)$ is the standard deviation of ϵ^μ , shocks to discount rates. I find that $\sigma(\epsilon^\mu)$ decreases as the book-to-market ratio increases. The growth decile has a $\sigma(\epsilon^\mu)$ of 0.043, which decreases to 0.015 for the value decile. $\sigma(\mu)$ is the unconditional standard deviation of μ_t , which is equal to $\sigma(\epsilon^\mu)/\sqrt{1-\phi_\mu^2}$. I find that the unconditional standard deviation of the discount rate decreases from 0.082 to 0.057 as we go from the growth decile to the value decile. In the last column of Table 5, I further compute the σ_{disc} , the return standard deviation caused by changes in discount rates, which is equal to $Dur^{KF}\sigma(\mu)$. I find that σ_{disc} increases from 0.517 to 1.016 as we go from the growth decile to the value decile.

Thus, growth stocks behave like short-term bonds. It is well known that when compared to long-term bonds, short-term bonds have shorter durations; their interest rates are more volatile, and their return volatility is also lower. I find that growth stocks have shorter durations. Their discount rates are more volatile, in that they have higher $\sigma(\mu)$. Additionally, they have lower return volatility that is caused by changes in discount rates in that they have lower σ_{disc} .

4.4 Evidence from the simplified VAR

Because the Binsbergen and Koijen (2010) system is complicated, I provide robustness checks for two key findings in Section 4.3. The first key finding is that expected returns of growth stocks are less persistent than those of value stocks. The second key finding is that the expected returns

of growth stocks are less volatile than those of value stocks. I examine this issue by using the simplified VAR system.

The simplified VAR refers to the following two equations:

$$r_{t+1} = \textit{intercept} + b_r pd_t + \epsilon^r, \quad (35)$$

and

$$pd_{t+1} = \textit{intercept} + \phi_{pd} pd_t + \epsilon^{pd}. \quad (36)$$

In this simplified VAR, the persistence of the expected return is the same as the persistence of the log price dividend ratio, ϕ_{pd} . The standard deviation of the expected return is $\sigma(\mu) = |b_r| \sigma(pd)$, where $\sigma(pd)$ is the standard deviation of the log price dividend ratio.

Table 6 reports the results for this simplified VAR. ϕ_{pd} increases from 0.719 to 0.818 as we go from the growth decile to the value decile. Although the difference is not statistically significant, its magnitude (0.10) is close to the one (0.11) from the Binsbergen and Koijen (2010) system. The standard deviation of the log price-dividend ratio is much lower for growth stocks than for value stocks. The standard deviation of the expected return $\sigma(\mu)$ decreases from 0.066 to 0.025 as we go from the growth decile to the value decile. Thus I conclude that the simplified VAR also shows that expected returns of growth stocks are less persistent and less volatile than those of value stocks, consistent with the view that growth stocks behave like short-duration assets.

5 The term structure of equity returns and volatilities

5.1 The term structure of equity returns

I examine what the value premium implies about the term structure of equity returns. I use 20 portfolios sorted by book-to-market equity between 1963 Q3 and 2010 Q2. I estimate the Fama-MacBeth regressions of returns on three duration measures, while controlling for cash-flow risks.

Table 7 reports the results for value-weighted portfolios. The left hand side variable is the

quarterly real return multiplied by four. The first duration measure is related to cash-flow growth rates. Assets with higher expected cash-flow growth rates have longer cash-flow durations. To avoid mechanical relations, I use lagged growth rate, $\bar{g}_{i,t-1}$, which is the average annual real dividend growth rate of the rebalanced portfolio i , using information up to year $t-1$. The second measure, Dur^{RB} , is based on regression 2 in Section 4.1, the regression of realized returns on log price-dividend ratios and dividend growth rates. The third measure, Dur^{KF} , is based on the Binsbergen and Koijen (2010) present value system with the Kalman filter.

I use cash-flow risk measures from Bansal, Dittmar, and Lundblad (2005). γ_i^K is measured from the regression $\log(1 + g_{i,t}) = \gamma_i^K \left(\frac{1}{K} \sum_{k=1}^K \log(1 + g_{c,t-k}) \right) + \epsilon_{i,t}$, using all information between 1963 Q3 and 2010 Q2. Here $g_{i,t}$ is the quarterly real dividend growth rate, and $g_{c,t-k}$ is the quarterly real consumption growth rate. Bansal, Dittmar, and Lundblad (2005) primarily focus on the case $K = 8$, while also considering $K = 12$. I thus use both measures for robustness.

In Table 7, I find that $\bar{g}_{i,t-1}$ is positively associated with returns, with the coefficient being 0.42 and statistically significant. The coefficient on cash-flow risk γ_i^8 is also significant, while that on γ_i^{12} is positive but statistically insignificant.

In Row 4 of Table 7, I find that after controlling for cash-flow risk γ_i^8 , the coefficient on $\bar{g}_{i,t-1}$ reduces slightly to 0.36 with a t -statistic of 1.88. The coefficient on γ_i^8 reduces to 0.0017 ($t=1.44$). In Row 5, after controlling for cash-flow risk γ_i^{12} , the coefficient on $\bar{g}_{i,t-1}$ is 0.43 with a t -statistic of 2.08. The coefficient on γ_i^{12} reduces to 0.0007 ($t=0.78$).¹¹

In the univariate regression, the coefficient on Dur^{RB} is 0.0014 with a t -statistic of 2.01. After controlling for γ_i^8 and γ_i^{12} , the coefficient on Dur^{RB} reduces to 0.0011 and 0.0013, respectively. The coefficient on Dur^{KF} is 0.0019 with a t -statistic of 2.13 in the univariate regression. After controlling for γ_i^8 and γ_i^{12} , the coefficient on Dur^{KF} reduces slightly to 0.0017 and 0.0018, respectively.

Using three measures of duration, I find that assets with longer durations have higher expected returns and volatility, consistent with an upward sloping term structure of equity returns. In all

¹¹In studying the aggregate time series, most authors find that the expected return is positively related to the expected dividend growth rate, see Menzly, Santos, and Veronesi (2004), Lettau and Ludvigson (2005), and Binsbergen and Koijen (2010).

cases, the coefficient on duration is statistically significant at the 10% level. I defer the discussion of the economic magnitude of the coefficient on $\bar{g}_{i,t-1}$ until Section 5.2. The magnitude of the coefficient on duration is reasonable. Because Dur^{RB} tends to be noisy, I focus on Dur^{KF} . In Row 10, after controlling for γ_i^8 , the coefficient on Dur^{KF} is 0.0017 is economically significant too. Recall that in Table 5, the duration increases from 6.27 to 17.77 years. Therefore, the value decile has a duration that is about 11.5 years longer than that of the growth decile. A coefficient of 0.0017 means that duration explains about 2% per year in the value premium.¹²

The results on equal-weighted portfolios are even stronger in Table 8. I find that $\bar{g}_{i,t-1}$ is positively associated with returns, with the coefficient of 0.75 and statistically highly significant with a t -statistic of 4.82. Both measures of cash-flow risk, γ_i^8 and γ_i^{12} , appear positive but statistically significant as well in univariate regressions.

In Row 4 of Table 8, after controlling for cash-flow risk γ_i^8 , the coefficient on $\bar{g}_{i,t-1}$ reduces slightly to 0.68 with a t -statistic of 4.83. The coefficient on γ_i^8 reduces from 0.0114 to 0.0031 ($t=2.44$). In Row 5, after controlling for cash-flow risk γ_i^{12} , the coefficient on $\bar{g}_{i,t-1}$ is 0.72 with a t -statistic of 4.06. The coefficient on γ_i^{12} reduces from 0.0079 to 0.0026 ($t=2.30$).

In the univariate regression, the coefficient on Dur^{RB} is 0.0008 with a t -statistic of 3.85. After controlling for γ_i^8 and γ_i^{12} , the coefficient on Dur^{RB} reduces to 0.0096 and 0.0097, respectively. The coefficient on Dur^{KF} is 0.0040 with a t -statistic of 5.08 in the univariate regression. After controlling for γ_i^8 and γ_i^{12} , the coefficient on Dur^{KF} reduces to 0.0028 and 0.0035, respectively. Thus, in equal-weighted portfolios, the coefficient on duration is always statistically significant, with the lowest t -statistic being 3.09.

5.2 Are the results mechanical?

So far, I find that the value premium implies that stocks with higher expected dividend growth rate and longer duration have higher future returns. One concern is that the result on the expected dividend growth rate is mechanical. The reason is that in the long run, if the dividend price ratio

¹²In a related study, Campbell and Vuolteenaho (2004) find that the price of risk for the discount-rate beta is positive. Campbell, Polk, and Vuolteenaho (2010) find that discount rates of value stocks are more sensitive to changes in market discount rates before and after 1963.

is to stay stationary, the expected dividend growth rate should align with the expected price growth rate (capital gains).

To address this concern, I resort to theory. In the Appendix, I analyze three one-factor affine models with time-varying expected returns that match most of the stylized facts in the time series. The first model has time-varying market price of risk, which captures the habit formation; the second has time-varying amount of risk; and the third has both time-varying market price of risk and time-varying amount of risk. All three models imply that the expected return is an increasing function of the expected growth rate, after controlling for cash-flow risk, if these models are to help explain the equity premium puzzle.

I provide two intuitions for this result. The mathematical intuition for the above implication is the following. A stock is the sum of claims to all short- and long-term dividends. The expected return of a stock is the weighted average of the expected return on all its stripped dividend claims. Because of the one-factor affine structure of the three models, these models can only generate a monotonically increasing or decreasing term structure. These models do not change the expected return of a very-short-duration claim because time-varying expected returns need time to work. To produce a high equity premium, these models must produce a high expected return on assets with long durations. This implies that, in the cross section, stocks with more cash flow coming in the distant future (i.e., stocks with higher dividend growth rates) should have higher expected returns, after controlling for cash-flow risk.

The economic intuition is that time-varying expected returns only increase risk if expected returns are countercyclical. If expected returns are countercyclical, then in bad times, prices will go down not only because cash flows decrease, but also because expected returns increase. Thus time-varying expected returns make stocks more risky. This mechanism also implies that longer duration assets are more risky because they go through more cycles. The opposite is true if expected returns are procyclical. In that case, in bad times, prices tend to decrease because of negative cash flow shocks, but they tend to go up because expected returns also decrease. Thus, stocks are less risky than they would be otherwise. Longer-duration assets are less risky than short-duration assets, because procyclical expected returns essentially provide a hedge.

Figures 10 and 11 depict these two cases in Model 1 (time-varying price of risk). In Figure 10, I plot the expected excess return, expected capital gain, and dividend yield when the price of risk is countercyclical. The expected excess return is equal to expected capital gain plus dividend yield minus interest rate (assumed to be 10%). In this case, as the expected growth rate increases, the expected capital gain increases, the dividend yield decreases, and the expected excess return increases. The expected capital gain increases in the expected dividend growth, because in the long run dividend price ratios are stationary. Dividend price ratios decrease because all else equal, a higher growth rate leads to a higher price dividend ratio and a lower dividend price ratio. In this case, the capital gain effect dominates, and the expected return increases as the expected dividend growth rate increases.

In Figure 11, I plot the three quantities when the price of risk is procyclical. Again, the expected excess return is equal to expected capital gain plus dividend yield minus interest rate (10%). In this case, as the expected growth rate increases, the expected capital gain again increases, and the dividend yield again decreases. But in this case, the dividend yield effect dominates, and the expected return decreases as the expected dividend growth rate increases. Therefore, I conclude that my finding that expected returns increase in expected dividend growth rate is not mechanical, because theory suggests the opposite could happen.

This exercise also allows me to examine whether the coefficient on the expected growth rate is reasonable. In Figure 10, as the expected growth rate increases from 0 to 0.1, the expected excess return increases approximately from 0.04 to 0.09. These numbers suggest a slope coefficient of about 0.5. In Row 4 of Table 7 (value weighted), the coefficient on the expected growth rate is 0.36. In Row 4 of Table 8 (equal weighted), the coefficient on the expected growth rate is 0.68. Notwithstanding the fact that Figure 10 uses a set of parameter values that are not empirically estimated, I conclude that the magnitude of my empirical findings does not seem unreasonable.

5.3 Volatilities

A direct implication of duration is that it tends to increase volatilities. To test this implication, I again use 20 value-weighted portfolios sorted by book-to-market equity for the period between 1963

Q3 and 2010 Q2. I compute annualized standard deviation of returns by using monthly returns. I then estimate Fama-MacBeth regressions of return standard deviations on three duration measures $(\bar{g}_{i,t-1}, Dur^{RB}, Dur^{KF})$, while controlling for cash-flow risk. Because volatility is total risk instead of systematic risk, I compute $\sigma(\Delta d)$ as the standard deviation of the previous five years' quarterly dividend growth rates.

I report the results in Table 9. I find that $\bar{g}_{i,t-1}$ is positively associated with return volatility, with the coefficient of 0.28 and the Newey-West (with automatically selected lags) t -statistic of 3.08. Cash-flow risk $\sigma(\Delta d)$ is also significant. In Row 3 of Table 9, I find that, after controlling for cash-flow risk, the coefficient on $\bar{g}_{i,t-1}$ reduces slightly to 0.23 with a t -statistic of 2.63.

In the univariate regression, the coefficient on Dur^{RB} is 0.0007 with a t -statistic of 2.47. After controlling for $\sigma(\Delta d)$, the coefficient on Dur^{RB} reduces to 0.0005.

In Rows 6 through 9, I use Dur^{KF} as the proxy for duration. In the univariate regression, the coefficient on duration is 0.0008 with a t -statistic of 2.24. After controlling for $\sigma(\Delta d)$, the coefficient on Dur^{KF} reduces to 0.0006 ($t=1.90$). By using the Binsbergen-Koijen system, I can also directly compute the standard deviation of expected returns, $\sigma(\mu)$, and return standard deviation caused by changes in discount rates, σ_{disc} . σ_{disc} is the product of $\sigma(\mu)$ and Dur^{KF} . For ease of interpretation, in this table, I demean both variables before forming the interaction term σ_{disc} . In Rows 8 and 9, I find that both $\sigma(\mu)$ and σ_{disc} are positively associated with the return standard deviation. I conclude that longer duration assets are associated with higher return volatilities as well.

6 Conclusions

Conventional wisdom holds that growth stocks, defined as low book-to-market stocks, have higher future cash-flow growth rates and longer durations than value stocks, and that the value premium implies a downward sloping equity term structure. I find exactly the opposite. I find that cash flows of growth stocks grow more slowly than those of value stocks. Growth stocks behave like short-duration assets; their prices are less sensitive to changes in discount rates, and their discount rates are more volatile. Therefore, the value premium implies an upward sloping equity term

structure.

An upward sloping equity term structure is consistent with a class of asset pricing models that feature counter-cyclical risk premiums. My results show that this class of models helps explain not only the time series of the aggregate stock market, but also the cross section of stock returns, notably the momentum effect and the value premium, all at the same time.

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7 Appendix

7.1 Three models of time-varying expected returns

In this section, I present three simple models with time-varying expected returns. The first model has time-varying market price of risk, which is a continuous-time version of Campbell and Cochrane (1999)'s habit formation model. The second model has time-varying amount of risk. The third model has both time-varying price of risk and amount of risk.

Before presenting the three models, I reformulate the equity premium puzzle within constant expected return models. Assume that the representative agent's consumption is a simple geometric Brownian motion with a constant expected growth rate and a constant volatility.

$$\frac{dC_t}{C_t} = \mu_c dt + \sigma_c dB_t^c, \quad (37)$$

where μ_c is the constant expected growth rate, σ_c is the constant volatility, and B_t^c is a standard scalar Brownian motion. Further assume that the representative agent has a power utility function

$$U(C_t, t) = e^{-\delta t} \frac{(C_t)^{1-\gamma}}{1-\gamma}, \quad (38)$$

where δ is the intertemporal discount rate, and γ is the relative risk-aversion parameter.

Under these assumptions, it can be shown that the marginal utility (U_c) of the representative agent follows the process:

$$\frac{dU_c}{U_c} = -r dt - \gamma \sigma_c dB_t^c, \quad (39)$$

where r is the constant interest rate.

Now assume that the market portfolio has the following dividend process:

$$\frac{dD_t}{D_t} = g dt + \sigma_D^c dB_t^c + \sigma_D^Z dB_t^Z, \quad (40)$$

where g is the expected dividend growth rate. B_t^Z is a Brownian motion that is orthogonal to B_t^c . For this stock, the expected return turns out to be $r + \gamma \sigma_D^c \sigma_c$. The equity premium puzzle, thus, is the puzzle that $\gamma \sigma_D^c \sigma_c$ is too low compared to the empirical equity premium.

In more general terms, let the pricing kernel M_t (the representative agent's marginal utility U_c) follow a geometric Brownian motion,

$$\frac{dM_t}{M_t} = -r dt - \sigma_M dB_t^M. \quad (41)$$

Accordingly, the dividend process can be expressed as:

$$\frac{dD_t}{D_t} = gdt + \sigma_D^M dB_t^M + \sigma_D^Z dB_t^Z. \quad (42)$$

Under these assumptions, the equity premium (the excess expected return for stock over the interest rate) is $\sigma_D^M \sigma_M$. Throughout the rest of the paper, I view the equity premium puzzle as the puzzle of $\sigma_D^M \sigma_M$ being too low.

In the following three simple models, the dividend process can be understood as that of the market portfolio (D_t^M) or individual stocks (D_t^i). For ease of exposition, the superscripts are dropped out throughout this section. To focus on time-varying market price of risk and time-varying amount of risk, I assume the interest rate to be constant.

7.1.1 Model 1: Time-varying price of risk

Assume that the pricing kernel follows:

$$\frac{dM_t}{M_t} = -r dt - x_t dB_t^M, \quad (43)$$

where r is the constant interest rate, and x_t is the time-varying market price of risk. x_t can be roughly thought of as the time-varying risk-aversion coefficient for the representative agent. Without formally writing down a utility function, I assume that the market price of risk follows a mean-reverting process:

$$dx_t = \phi_x (\bar{x} - x_t) dt + \sigma_x dB_t^M, \quad (44)$$

where ϕ_x measures the convergence speed of x_t to the long-run average price of risk \bar{x} . Without loss of generality, I assume that the innovation to x_t is perfectly correlated with innovations to the pricing kernel process.

The dividend process is assumed to be:

$$\frac{dD_t}{D_t} = gdt + \sigma_D^M dB_t^M + \sigma_D^Z dB_t^Z, \quad (45)$$

where g is the expected dividend growth rate. $\sigma_D^M dB_t^M$ denotes the systematic component of the dividend process, where $\sigma_D^Z dB_t^Z$ is the idiosyncratic component of the dividend process. Under these assumptions, the stock price has the following semi closed-form solution that involves an integral of closed-form quantities.

Under these conditions, the price of the stock is

$$P_t = D_t \int_0^{+\infty} e^{gN+A(N)+B(N)x_t} dN, \quad (46)$$

where $A(N)$ and $B(N)$ are defined in the appendix.

The instantaneous expected excess return is:

$$\mu_R = x_t \left(\sigma_D^M + \frac{\int_0^{+\infty} e^{gN+A(N)+B(N)x_t} B(N) \sigma_x dN}{\int_0^{+\infty} e^{gN+A(N)+B(N)x_t} dN} \right), \quad (47)$$

and

$$\begin{aligned} \sigma_R^2 = & (\sigma_D^M)^2 + 2\sigma_D^M \sigma_x \frac{\int_0^{+\infty} e^{gN+A(N)+B(N)x_t} B(N) dN}{\int_0^{+\infty} e^{gN+A(N)+B(N)x_t} dN} \\ & + \sigma_x^2 \left(\frac{\int_0^{+\infty} \exp(gN + A(N) + B(N)x_t) B(N) dN}{\int_0^{+\infty} e^{gN+A(N)+B(N)x_t} dN} \right)^2 + (\sigma_D^Z)^2. \end{aligned} \quad (48)$$

I now define a very-short-duration claim. In this economy, consider the following instrument I_T that pays a liquidating dividend Y_T . The expectation of Y_T at time t is denoted as Y_t . Further assume that the cash-flow expectation evolves as follows $\frac{dY_t}{Y_t} = \sigma_D^M dB_t^M + \sigma_D^Z dB_t^Z$. Then the expected instantaneous return of this instrument is $x_t(\sigma_D^M + B(N)\sigma_x)$, where $N = T - t$, and $B(N)$ is defined in the appendix. The very-short-duration claim is the limiting case of such I_T as $T \rightarrow t$. The expected return on the very-short-duration claim is:

$$\lim_{N \rightarrow 0} x_t(\sigma_D^M + B(N)\sigma_x) = x_t \sigma_D^M \quad (49)$$

the expected return in a model with constant cash-flow risk σ_D^M and constant market price of risk equal to x_t .

In loose terms, a model of constant expected returns dictates that the expected return is the product of risk aversion and dividend risk. In a model with time-varying risk aversion, the average expected return is not equal to the average risk aversion multiplied by average dividend risk. When risk aversion is countercyclical, the long-run average return is greater than the product of average risk aversion and average dividend risk. This inequality is reversed when the risk aversion is procyclical.

Formally, I prove the following proposition.

Proposition 1. *This model of time-varying market price of risk does not change the expected return of the very-short-duration claim. The necessary and sufficient condition for the model to generate a higher equity*

premium than $\sigma_M \sigma_D^M$ is $\sigma_x < 0$; that is, the market price of risk is countercyclical. Under the above condition, stocks with higher expected growth rate have higher expected returns, all else being equal.

Proof: See Appendix.

Figure 10 plots the expected excess returns of stocks that only differ in their dividend growth rate g . The parameters used in this plot are $x_t = 0.3$, $\sigma_D^M = 0.005$, $\phi_x = 5.05$, $\bar{x} = 0.3$ and the interest rate is 10%. A high interest rate of 10% is chosen only for computational convenience. But the shape of the curve is not affected by a particular choice of interest rate as long as the expected growth rate is not so high that the price is infinite. As the expected growth rate g increases from 0 to 10%, the expected excess stock return increases from approximately 4% to 9%. These parameters are chosen to illustrate the working of time-varying market price of risk on the equity premium. If the market price of risk x_t is constant (equal to \bar{x}), then that stock's equity premium would be $\sigma_D^M * \bar{x} = 0.005 * 0.3 = 0.15\%$. With time-varying price of risk x_t , the model can deliver a much higher equity premium.¹³

7.1.2 Model 2: Time-varying amount of risk

I consider another model with time-varying amount of risk. In this model, the market price of risk is constant. However, the amount of risk is time varying. This model also generates time-varying expected returns and the cross-sectional implication on growth rates.

In this model, I assume that the pricing kernel follows:

$$\frac{dM_t}{M_t} = -r dt - \sigma_M dB_t^M, \quad (50)$$

where r is the constant interest rate and σ_M is the constant market price of risk.

The dividend process is assumed to be:

$$\frac{dD_t}{D_t} = g dt + x_t dB_t^M + \sigma_D^Z dB_t^Z, \quad (51)$$

where g is the constant expected growth rate. $x_t dB_t^M$ is the systematic component of the dividend process, and $\sigma_D^Z dB_t^Z$ is the idiosyncratic component of the dividend process. The time-varying amount of risk is

¹³This model matches the facts about the equity premium, the volatility puzzle, and predictability. The advantage of this model is that we do not have to model the heteroskedasticity of the dividend in order to get closed-form solutions. However, with a countercyclical market price of risk, it cannot replicate the leverage effects. Thus, this model is not suitable for drawing inferences about the time-series behavior of stock return volatility. The other drawback of this model is that sometimes the market price of risk can be negative.

assumed to follow a mean-reverting process:

$$dx_t = \phi_x(\bar{x} - x_t)dt + \sigma_x dB_t^M, \quad (52)$$

where ϕ_x measures the speed of convergence of x_t to the long-run amount of risk \bar{x} . σ_x is the volatility of the x_t process. For convenience, I assume that x_t is perfectly correlated with the innovations of the pricing kernel.

The stock price, expected return, and volatility have semi-closed-form solutions that involve the integral of closed-form quantities. The solutions can be found in the Appendix. In this economy, the very-short-duration claim as the limit of instrument I_T that pays a liquidating dividend of Y_T , the expectation of which follows the process: $\frac{dY_t}{Y_t} = x_t dB_t^M + \sigma_D^Z dB_t^Z$, where x_t follows the process as in equation (52). With this, I prove the following proposition.

Proposition 2. *This model of time-varying amount of risk does not change the expected return of the very-short-duration claim. The necessary and sufficient condition for the average expected return of the stock to be greater than $r + \bar{x}\sigma_M$ is that $\sigma_x < 0$; that is, the cash flow is more risky when times are bad. In this case, after controlling for cash flow risk x_t , the expected return is increasing in g .*

Proof: See Appendix.

7.1.3 Model 3: Time-varying price of risk and amount of risk

I now consider the third model, with both time-varying price of risk and amount of risk. Although this model involves both time-varying market price of risk and time-varying cash-flow risk, it does not nest the above two models. This model generates time-varying expected returns and the cross-sectional implication on growth rates.

In this model, I assume the pricing kernel to follow:

$$\frac{dM_t}{M_t} = -r dt - \sqrt{x_t} dB_t^M, \quad (53)$$

where r is the constant interest rate, and $\sqrt{x_t}$ is the market price of risk. To obtain semi closed-form solutions, I assume that the process x_t follows the square-root process of

$$dx_t = \phi_x(\bar{x} - x_t)dt + \sigma_x \sqrt{x_t} dB_t^M, \quad (54)$$

where ϕ_x measures the speed of convergence of x_t to the long-run value \bar{x} . $\sigma_x \sqrt{x_t}$ is the volatility of the

x_t process. I assume that x_t is perfectly correlated with the innovations of the pricing kernel.

I assume that the dividend process also follows a square-root process:

$$\frac{dD_t}{D_t} = gdt + \sigma_D^M \sqrt{x_t} dB_t^M + \sigma_D^Z dB_t^Z, \quad (55)$$

where g is the constant expected growth rate. $\sigma_D^M \sqrt{x_t} dB_t^M$ is the systematic component of the dividend process, and $\sigma_D^Z dB_t^Z$ is the idiosyncratic component of the dividend process.

The very-short-duration claim in this economy is the limit of instrument I_T that pays a liquidating dividend of Y_T , the expectation of which follows the process: $\frac{dY_t}{Y_t} = \sigma_D^M \sqrt{x_t} dB_t^M + \sigma_D^Z dB_t^Z$. This model also implies that stocks with higher growth rates have higher expected returns, all else being equal.

Proposition 3. *This model of time-varying price of risk and amount of risk does not change the expected return of the very-short-duration claim. The necessary and sufficient condition for the unconditional expected return of the stock to be greater than $r + \bar{x}\sigma_x$ is that $\sigma_x < 0$; that is, the market price of risk is countercyclical and the cash flow is more risky when times are bad. In this case, controlling for cash-flow risk σ_D^M , the expected return is increasing in g .*

Proof: See Appendix.

To recap, the two robust predictions from all three models are: (1) Models of time-varying expected returns do not change the expected return on a very-short-duration claim. (2) In the cross section, the expected return increases in the expected dividend growth rate, controlling for cash flow risk. I test the second prediction in the next section.

In all three models, I assume that the expected growth rates are constant. However, the main result can be extended to more general cases. Suppose all growth rates follow the mean-reverting process,

$$dg_t^i = \phi_g(\bar{g}^i - g_t^i)dt + \sigma_g^i dB_t^i. \quad (56)$$

Then the prediction is that controlling for ϕ_g^i , and cash-flow risk, the higher \bar{g}^i , the higher the expected return.

The difference in expected growth rate need not be permanent. Consider the above case again. Suppose two stocks have the same cash-flow risk, mean reversion parameter ϕ_g , \bar{g} , and σ_g . However, one stock has had a good shock recently; therefore $g_t^i > g_t^j$. It can be shown that the expected return of stock i should be higher than that of stock j . Johnson (2002) uses this mechanism to explain the momentum effect.

7.2 Proofs

Proposition 1 stated in the text follows from the following expanded exposition.

The price of the stock is

$$P_t = D_t \int_0^{+\infty} e^{gN+A(N)+B(N)x_t} dN, \quad (57)$$

where

$$B(N) = -\frac{\sigma_D^M (1 - e^{-(\phi_x + \sigma_x)N})}{\phi_x + \sigma_x}, \quad (58)$$

$$A(N) = A_1 B(N)^2 + A_2 [\sigma_D^M N + B(N)] - rN, \quad (59)$$

$$A_1 = -\frac{\sigma_x^2}{4(\phi_x + \sigma_x)}, \text{ and } A_2 = -\frac{\phi_x \bar{x} + \sigma_D^M \sigma_x}{\phi_x + \sigma_x} + \frac{\sigma_D^M \sigma_x^2}{2(\phi_x + \sigma_x)^2}.$$

There are some regularity conditions that have to be satisfied. These are: 1). $\sigma_D^M > 0$ (positive cash-flow risk); 2) $x_t > 0$ (positive market price of risk); 3) $\phi_x + \sigma_x > 0$ and $g + A_2 \sigma_D^M - r < 0$ (conditions for price of the stock to be finite). Under the above conditions, the following holds for the stock that pays a continuous stream of dividends according to $\frac{dD_t}{D_t} = gdt + \sigma_D^M dB_t^M + \sigma_D^Z dB_t^Z$.

The price-dividend ratio is increasing in g and decreasing in σ_D^M (cash-flow risk). The volatility is increasing in σ_D^M (cash-flow risk).

1) When $\sigma_x < 0$ (countercyclical market price of risk), the unconditional expected return of the stock is greater than $r + \bar{x}\sigma_D^M$, thus helping to produce a higher equity premium. Controlling for cash-flow risk σ_D^M the expected return is increasing in g .

2) When $\sigma_x = 0$ (constant discount rate), the volatility and expected returns are only determined by the cash-flow risk and do not depend on g . The expected return is $r + x_t \sigma_M = r + \bar{x} \sigma_M$.

3) When $\sigma_x > 0$ (procyclical market price of risk), the unconditional expected return of a stock is less than $r + \bar{x}\sigma_D^M$, thus, in this case, the time-varying market price of risk does not help us with the equity premium puzzle. In the cross section, the expected return is decreasing in g . The volatility decreases in g at first and eventually increases in g .

To show the above, first consider an instrument that pays a liquidating dividend D_T at time T. With abuse of notation, let $D_t = E[D_T|F_t]$ denote the expectation of D_T at time t. By the law of iterated expectations, D_t is a Martingale. Suppose the expectation evolves according to $\frac{dD_t}{D_t} = \sigma_D^M dB_t^M + \sigma_D^Z dB_t^Z$. The price of this instrument S_t has to satisfy the following condition:

$$E \left[\frac{dS_t}{S_t} \right] - rdt = -E_t \left[\frac{dS_t}{S_t} \frac{dM_t}{M_t} \right], \quad (60)$$

by definition of the pricing kernel. I posit that S is a function of D_t, x_t and $N = T - t$, time to expiration. Then S has to satisfy the following Partial Differential Equation:

$$\begin{aligned} \frac{\partial S}{\partial x} \phi_x(\bar{x} - x_t) + \frac{1}{2} \frac{\partial^2 S}{\partial x^2} \sigma_x^2 + \frac{\partial^2 S}{\partial x \partial D} D_t \sigma_x \sigma_D^M + \frac{1}{2} \frac{\partial^2 S}{\partial D^2} D_t^2 [(\sigma_D^M)^2 + (\sigma_D^z)^2] - \frac{\partial S}{\partial N} - rS \\ = \frac{\partial S}{\partial x} \sigma_x x_t + \frac{\partial S}{\partial D} \sigma_D^M x_t D_t, \end{aligned} \quad (61)$$

with the boundary condition $S(D, x, 0) = D$. It can be verified that the solution to the above equation is $S_t = D_t e^{A(N)+B(N)x_t}$ where $A(N)$ and $B(N)$ are specified as in the text.

Now suppose the expectation evolves according to $dD_t/D_t = gdt + \sigma_D^M dB_t^M + \sigma_D^z dB_t^z$ (so it is not a rational expectation). Redo the PDE; it is easy to find that the price of this instrument is now $S_t = D_t e^{gN+A(N)+B(N)x_t}$. The price of the stock, which has a real dividend that evolves according to: $\frac{dD_t}{D_t} = gdt + \sigma_D^M dB_t^M + \sigma_D^z dB_t^z$, is the sum of all S , i.e. $P_t = D_t \int_0^\infty e^{gN+A(N)+B(N)x_t} dN$.

The instantaneous return $\frac{dP_t + D_t dt}{P_t}$ can be derived with a straightforward application of Ito's Lemma. The expected excess return is $x_t \left(\sigma_D^M + \frac{\int_0^{+\infty} e^{gN+A(N)+B(N)x_t} B(N) \sigma_x dN}{\int_0^{+\infty} e^{gN+A(N)+B(N)x_t} dN} \right)$. Since $B(N)$ is negative (immediate from the functional form of $B(N)$), and $x_t, \sigma_D^M, \exp(gN + A(N) + B(N)x_t)$ are assumed to be positive, the necessary and sufficient condition for the expected return to be greater than $x_t \sigma_D^M$ is that $\sigma_x < 0$. Noting that the unconditional expectation of x_t is \bar{x} , we show that the necessary and sufficient condition for the unconditional expected return to be greater than $\bar{x} \sigma_D^M$ is $\sigma_x < 0$.

To prove the expected return increases in the expected growth rate, it suffices to show that $f = \frac{\int_0^{+\infty} e^{gN+A(N)+B(N)x_t} B(N) \sigma_x dN}{\int_0^{+\infty} e^{gN+A(N)+B(N)x_t} dN}$ is an increasing function of g when $\sigma_x < 0$. For ease of exposition, define $Z = e^{gN+A(N)+B(N)x_t}$. Therefore,

$$\begin{aligned} \frac{\partial f}{\partial N} &= \frac{\int_0^{+\infty} e^Z N B(N) \sigma_x dN \int_0^{+\infty} e^Z dN - \int_0^{+\infty} e^Z B(N) \sigma_x dN \int_0^{+\infty} e^Z N dN}{\left(\int_0^{+\infty} e^Z dN \right)^2} \\ &= E^g[N B(N) \sigma_x] - E^g[B(N) \sigma_x] E^g[N] \\ &= Cov^g[N, B(N) \sigma_x], \end{aligned} \quad (62)$$

where E^g is defined on the probability density over N : $\frac{e^Z}{\int_0^{+\infty} e^Z dN}$. Because $B(N)$ is monotonically decreasing in N , $Cov^g[N, B(N) \sigma_x] > 0$, iff $\sigma_x < 0$.

To prove that

$$\lim_{N \rightarrow 0} x_t (\sigma_D^M + B(N) \sigma_x) = x_t \sigma_D^M, \quad (63)$$

plug in the functional form of $B(N)$, and it follows immediately.

For Model 2, consider the following instrument that pays a liquidating dividend Y_T . The expectation of Y_T at time is denoted as Y_t . Further assume that the cash-flow expectation follows: $\frac{dY_t}{Y_t} = x_t dB_t^M + \sigma_D^Z dB_t^Z$, where x_t follows the same process as above. Then the expected instantaneous return of this instrument is $\sigma_M(x_t + B(N)\sigma_x)$, where $N = T - t$. Furthermore,

$$\lim_{N \rightarrow 0} \sigma_M(x_t + B(N)\sigma_x) = \sigma_M x_t, \quad (64)$$

the expected return that would be in a model with constant cash-flow risk that equals to x_t and constant market price of risk σ_M .

For the stock that pays a continuous stream of dividend according to: $\frac{dD_t}{D_t} = gdt + x_t dB_t^M + \sigma_D^Z dB_t^Z$, the price of the stock is

$$P_t = D_t \int_0^{+\infty} e^{gN + A(N) + B(N)x_t} dN, \quad (65)$$

where

$$B(N) = \frac{\sigma_M(1 - e^{(\sigma_x - \phi_x)N})}{\sigma_x - \phi_x}, \quad (66)$$

$$A(N) = A_1 B(N)^2 + A_2 [\sigma_M N + B(N)] - rN, \quad (67)$$

$$A_1 = \frac{\sigma_x^2}{4(\sigma_x - \phi_x)}, \quad (68)$$

and

$$A_2 = \frac{\phi_x \bar{x} - \sigma_M \sigma_x}{\sigma_x - \phi_x} + \frac{\sigma_M \sigma_x^2}{2(\sigma_x - \phi_x)^2}. \quad (69)$$

The instantaneous return of the stock is

$$\begin{aligned} \frac{dP_t + D_t dt}{P_t} &= \left(r + \sigma_M \left(x_t + \frac{\int_0^{+\infty} e^{gN + A(N) + B(N)x_t} B(N) \sigma_x dN}{\int_0^{+\infty} e^{gN + A(N) + B(N)x_t} dN} \right) \right) dt \\ &+ \left(x_t + \frac{\int_0^{+\infty} e^{gN + A(N) + B(N)x_t} B(N) \sigma_x dN}{\int_0^{+\infty} e^{gN + A(N) + B(N)x_t} dN} \right) dB_t^M + \sigma_D^Z dB_t^Z. \end{aligned} \quad (70)$$

For Model 3, consider the following instrument that pays a liquidating dividend Y_T . The expectation of Y_T at time is denoted as Y_t . Further assume that the cash-flow expectation follows information structure that is $\frac{dY_t}{Y_t} = \sigma_D^M \sqrt{x_t} dB_t^M + \sigma_D^Z dB_t^Z$, where x_t follows the same process as above. Then the expected instantaneous return of this instrument is $\sqrt{x_t}(\sigma_D^M \sqrt{x_t} + B(N)\sigma_x)$, where $N = T - t$. See below for the

functional form of $B(N)$. Furthermore,

$$\lim_{N \rightarrow 0} \sqrt{x_t} (\sigma_D^M \sqrt{x_t} + B(N) \sigma_x) = \sigma_D^M x_t, \quad (71)$$

the expected return that would be in a model with constant cash-flow risk that equals to $\sigma_D^M \sqrt{x_t}$ and constant market price of risk $\sqrt{x_t}$.

Now for the stock that pays a continuous stream of dividend according to $\frac{dD_t}{D_t} = gdt + \sigma_D^M \sqrt{x_t} dB_t^M + \sigma_D^Z dB_t^Z$, the price of the stock is then

$$P_t = D_t \int_0^{+\infty} e^{gN + A(N) + B(N)x_t} dN, \quad (72)$$

where

$$B(N) = -\frac{2\sigma_D^M (e^{\delta N} - 1)}{(\delta + \sigma_D^M \sigma_x - \phi_x - \sigma_x)(e^{\delta N} - 1) + 2\delta}, \quad (73)$$

$$A(N) = \frac{\phi_x \sigma_D^M \bar{x}}{\sigma_x^2} (2 \log(\frac{2\delta}{(\sigma_D^M \sigma_x - \phi_x - \sigma_x + \delta)(e^{\delta N} - 1) + 2\delta})) + (\sigma_D^M \sigma_x - \phi_x - \sigma_x + \delta)N - rN, \quad (74)$$

and

$$\delta = \sqrt{(\sigma_D^M \sigma_x - \phi_x - \sigma_x)^2 + 2\sigma_x^2}. \quad (75)$$

The instantaneous return of the stock is

$$\frac{dP_t + D_t dt}{P_t} = \left(r + \sqrt{x_t} \left(\sigma_D^M \sqrt{x_t} + \frac{\int_0^{+\infty} e^{gN + A(N) + B(N)x_t} B(N) \sigma_x dN}{\int_0^{+\infty} e^{gN + A(N) + B(N)x_t} dN} \right) \right) dt \quad (76)$$

$$+ \left(\sigma_D^M \sqrt{x_t} + \frac{\int_0^{+\infty} e^{gN + A(N) + B(N)x_t} B(N) \sigma_x dN}{\int_0^{+\infty} e^{gN + A(N) + B(N)x_t} dN} \right) dB_t^M + \sigma_D^Z dB_t^Z. \quad (77)$$

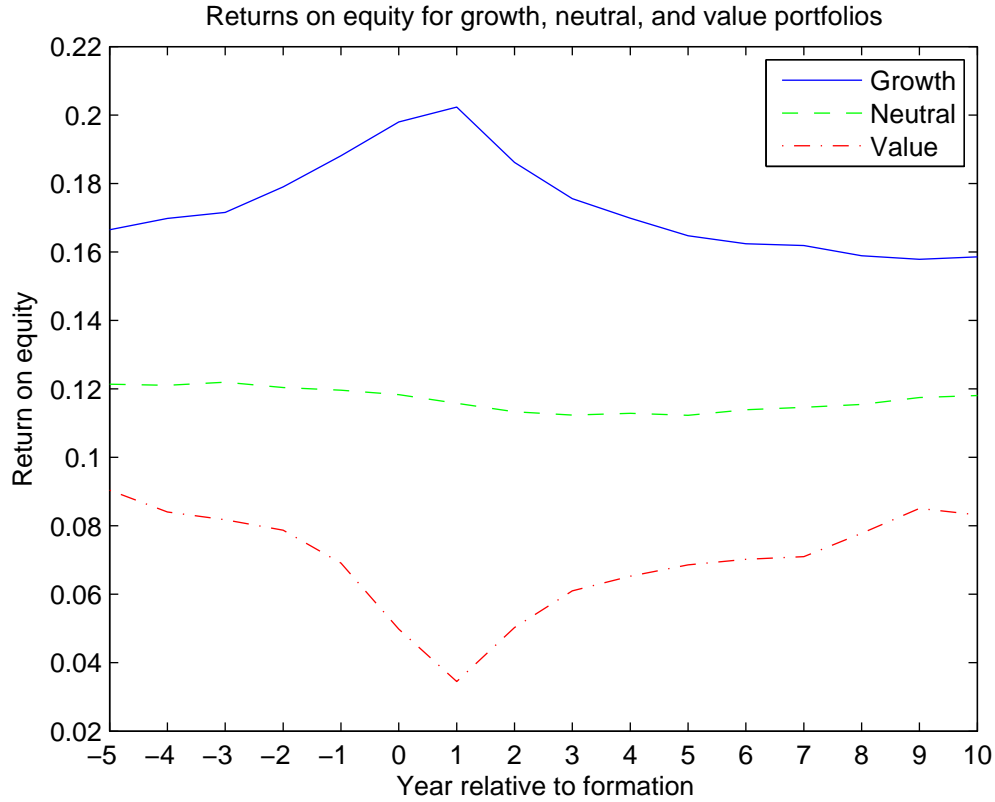


Figure 1: **Returns on equity for portfolios sorted by book-to-market ratios.** In each year t between 1963 and 2009, I sort stocks according to their book-to-market ratios. The growth, neutral, and value portfolios consist of stocks with book-to-market equity that are in the lowest 30%, middle 40%, and highest 30%. The breakpoints are computed using NYSE stocks only. Portfolio return on equity is the sum of earnings (ib) over the sum of book equity. In computing the return on equity, I treat earnings and book equity with fiscal year ends between July of year $t + s - 1$ and June of year $t + s$ as earnings and book equity in year $t + s$. I require a stock to have data for both E_{t+s} and BE_{t+s-1} to be included in the computation of the portfolio return on equity. I then average the portfolio return on equity across the 47 portfolio formation years 1963-2009.

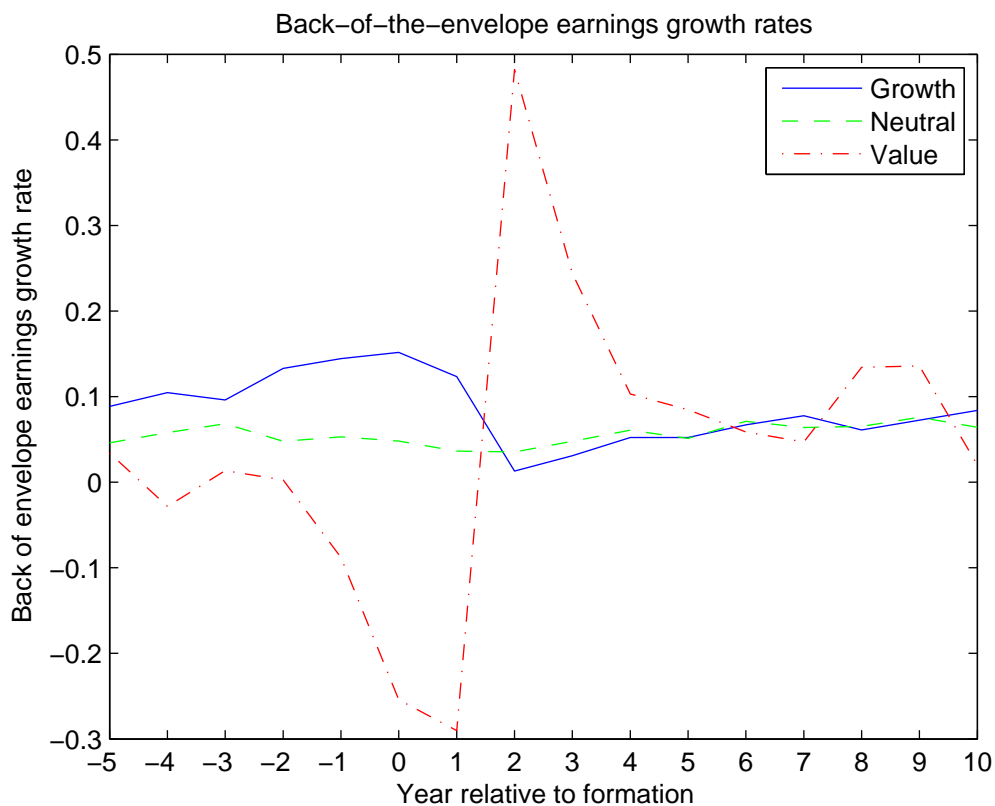


Figure 2: **Back-of-the-envelope earnings growth rates.** Back-of-the-envelope earnings growth rates are computed based on information in Figure 1 and the following formula: $\frac{E_s}{E_{s-1}} - 1 = \frac{ROE_s}{ROE_{s-1}} + (1 - po)ROE_s - 1$. E_s , ROE_s , and po refer to earnings, return on equity and dividend payout ratio. po is assumed to be 0.5 in the back-of-the-envelope calculations. The growth, neutral, and value portfolios consist of stocks with book-to-market equity that are in the lowest 30%, middle 40%, and highest 30%.

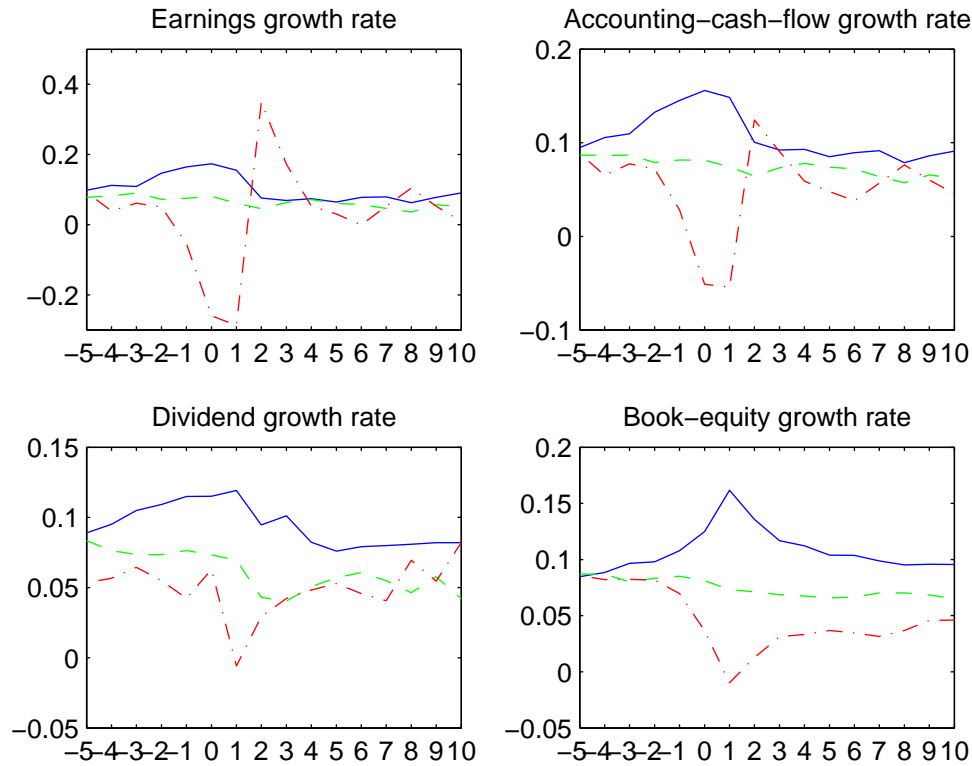


Figure 3: **Simple buy-and-hold growth rates not adjusted for survivorship bias.** In each year t between 1963 and 2009, I sort stocks according to their book-to-market ratios. The growth (blue solid line), neutral (green dashed line), and value (red dash-dot line) portfolios consist of stocks with book-to-market equity that are in the lowest 30%, middle 40%, and highest 30%. The breakpoints are computed using NYSE stocks only. In computing the return on equity, I treat earnings, accounting cash flow, dividends, and book equity with fiscal year ends between July of year $t + s - 1$ and June of year $t + s$ as those variables in year $t + s$. I require a stock to have data in both years $t + s$ and $t + s - 1$ to be included in the computation of the portfolio growth rates in year $t + s$. Panel A, B, C, and D plot the average growth rate of earnings (ib), accounting cash flow (ib+dp), dividend (CRSP lagged market equity times the difference between returns with and without dividends), and book equity. For earnings and accounting cash flow, I first scale the portfolio fundamental values in years $t + s$ and $t + s - 1$ by the market capitalizations in June of year t . I then average the scaled fundamental values across portfolio formation years before computing the portfolio growth rate. For dividends and book equity, the portfolio growth rate in year $t + s$ is the sum of the accounting variable in year $t + s$ across firms in that portfolio over the sum of that accounting variable in year $t + s - 1$, minus one. I then average across portfolio formation years t .

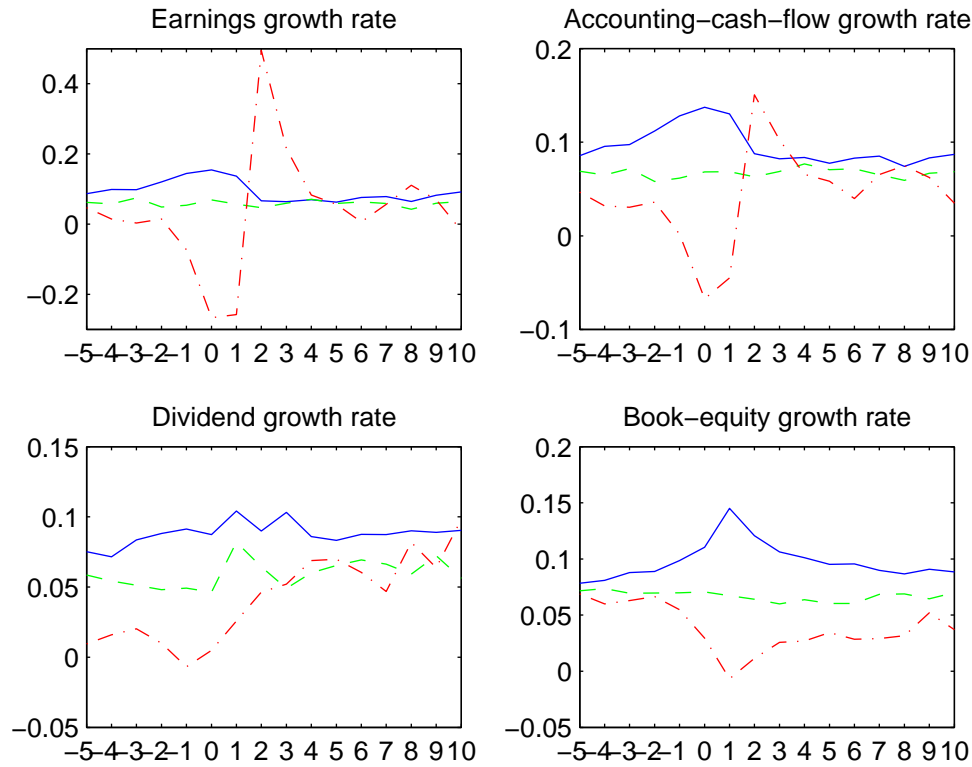


Figure 4: **Buy-and-hold growth rates adjusted for survivorship bias.** In each year t between 1963 and 2009, I sort stocks according to their book-to-market ratios. The growth (blue solid line), neutral (green dashed line), and value (red dash-dot line) portfolios consist of stocks with book-to-market equity that are in the lowest 30%, middle 40%, and highest 30%. The breakpoints are computed using NYSE stocks only. In computing the return on equity, I treat earnings, accounting cash flow, dividends, and book equity with fiscal year ends between July of year $t + s - 1$ and June of year $t + s$ as those variables in year $t + s$. Survivorship bias is adjusted according to the text. Panel A, B, C, and D plot the average growth rate of earnings (ib), accounting cash flow (ib+dp), dividend (CRSP lagged market equity times the difference between returns with and without dividends), and book equity.

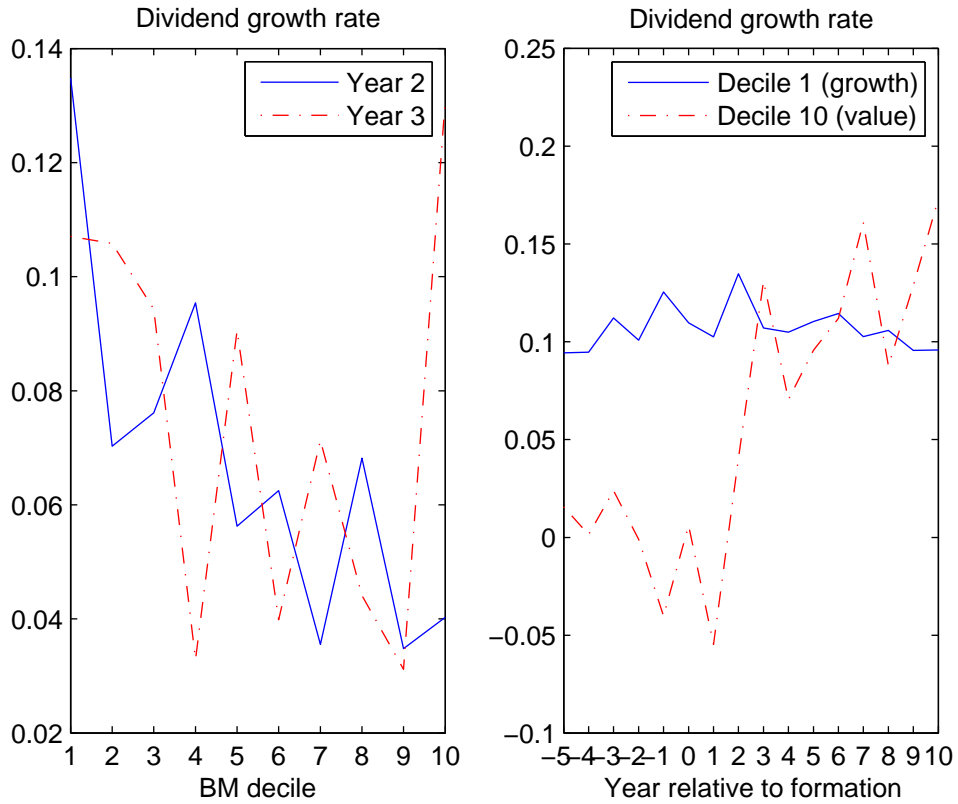


Figure 5: **Buy-and-hold dividend growth rates for book-to-market deciles adjusted for survivorship bias** . The left panel plots the average survivorship-bias adjusted buy-and-hold dividend growth rates in years 2 and 3 after portfolio formation. The breakpoints are computed using NYSE stocks only. I average the portfolio growth rates across the 47 portfolio formation years 1963-2009. The right panel plots the average survivorship-bias adjusted buy-and-hold dividend growth rates for Deciles 1 and 10.

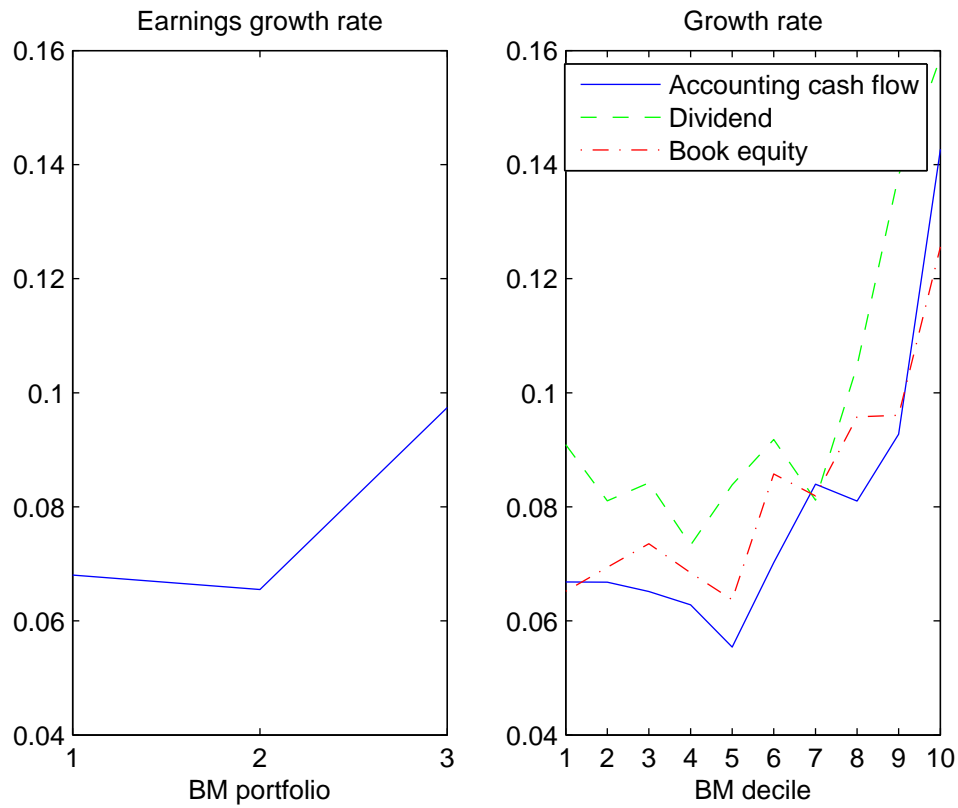


Figure 6: **Rebalanced portfolio growth rates 1964-2010.** The left panel plots the earnings (ib) growth rate for rebalanced portfolios. Portfolio 1, 2, and 3 refer to portfolios with the lowest 30%, middle 40%, and highest 30% book-to-market equity. The right panel plots rebalanced portfolios' growth rates in accounting cash flow (ib+dp), dividends, and book equity. I average the portfolio growth rates of dividends and book equity across the 47 portfolio formation years 1963-2009.

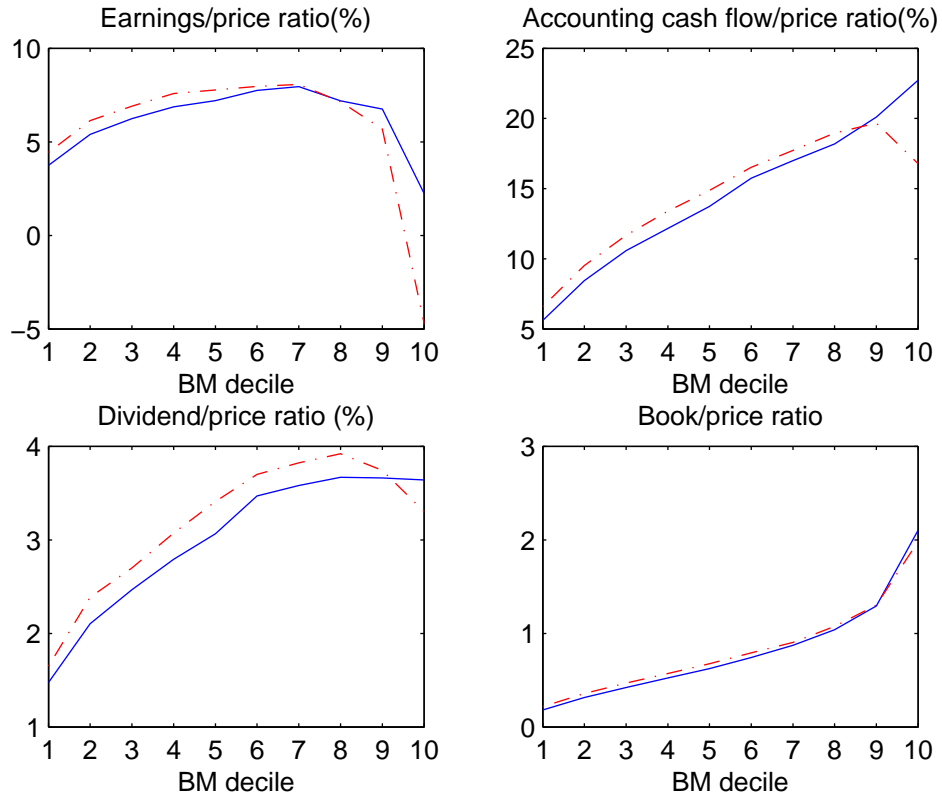


Figure 7: **Fundamental-to-price ratios.** This figure plots average $\frac{F_0}{P_0}$ (blue solid line) and $\frac{F_1}{P_0}$ (red dash-dot line). Ten value-weighted book-to-market portfolios are formed in June of each year. F_0 and F_1 stand for fundamentals in the formation year and the year after. Fundamental refers to earnings (Panel A), accounting cash flow (Panel B), dividend (Panel C) and book equity (Panel D). Earnings, accounting cash flow, and book equity in year t are for the fiscal year that ends between July of year $t - 1$ and June of year t . Dividend in year t is the total dividend accumulated between July of year $t - 1$ and June of year t . P_0 is the market equity in June of portfolio formation year t . The ratios is averaged between 47 portfolio formation years between 1963 and 2009.

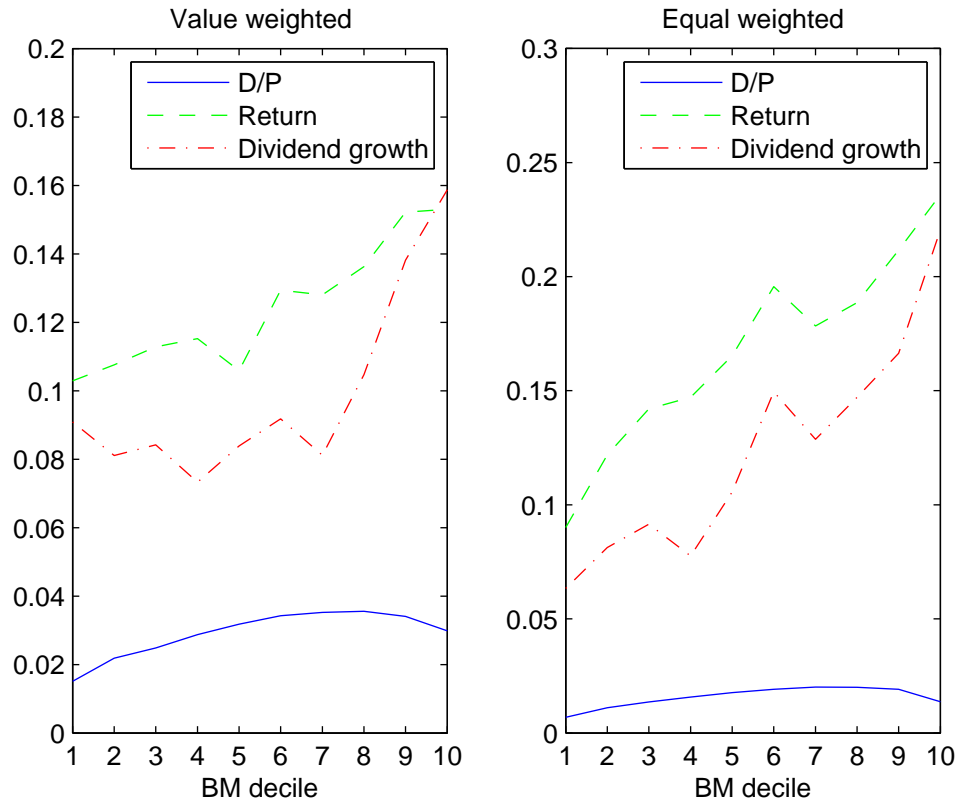


Figure 8: **Average dividend price ratios, returns, and dividend growth rates for book-to-market deciles 1964 to 2010.** The left panel plots the value-weighted deciles and the right panel plots the equal-weighted deciles. The returns and dividend growth rates are for annually rebalanced portfolios. Annual data are used.

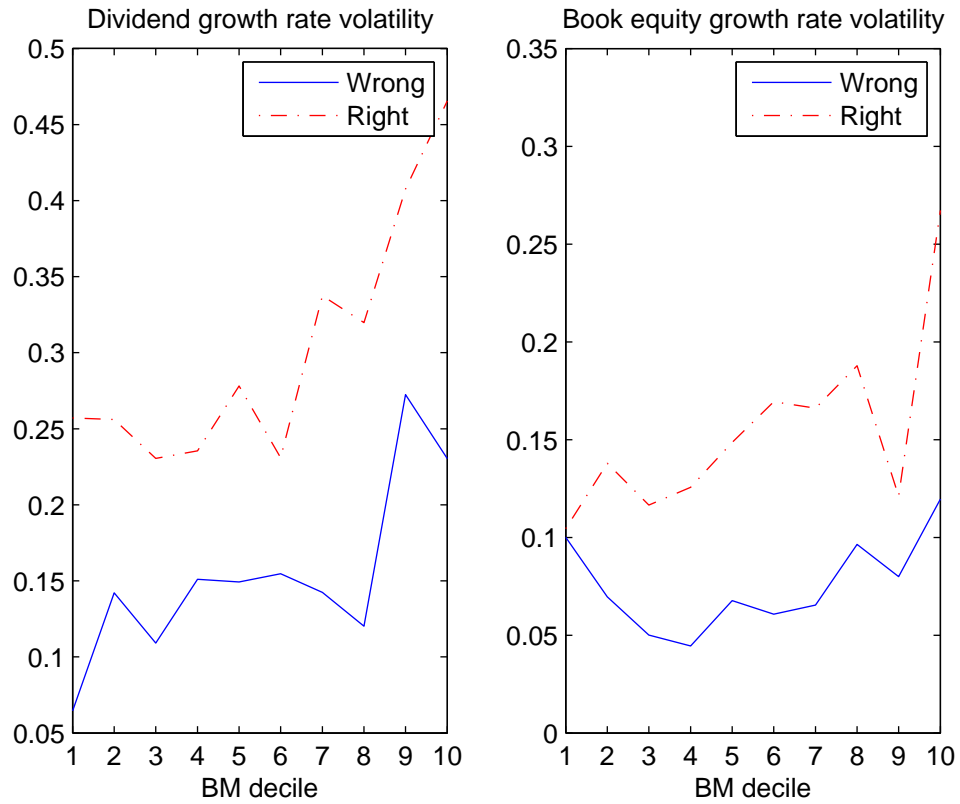


Figure 9: **The standard deviation of static growth rates with survivorship bias and rebalanced portfolio growth rates.** The left panel plots the standard deviation of dividend growth rates. The right panel plots the standard deviation of book-equity growth rates. The static growth rates with survivorship bias (wrong) refers to the growth in year 1 after portfolio formation without adjusting for survivorship bias. I average across portfolio formation years 1963-2009.

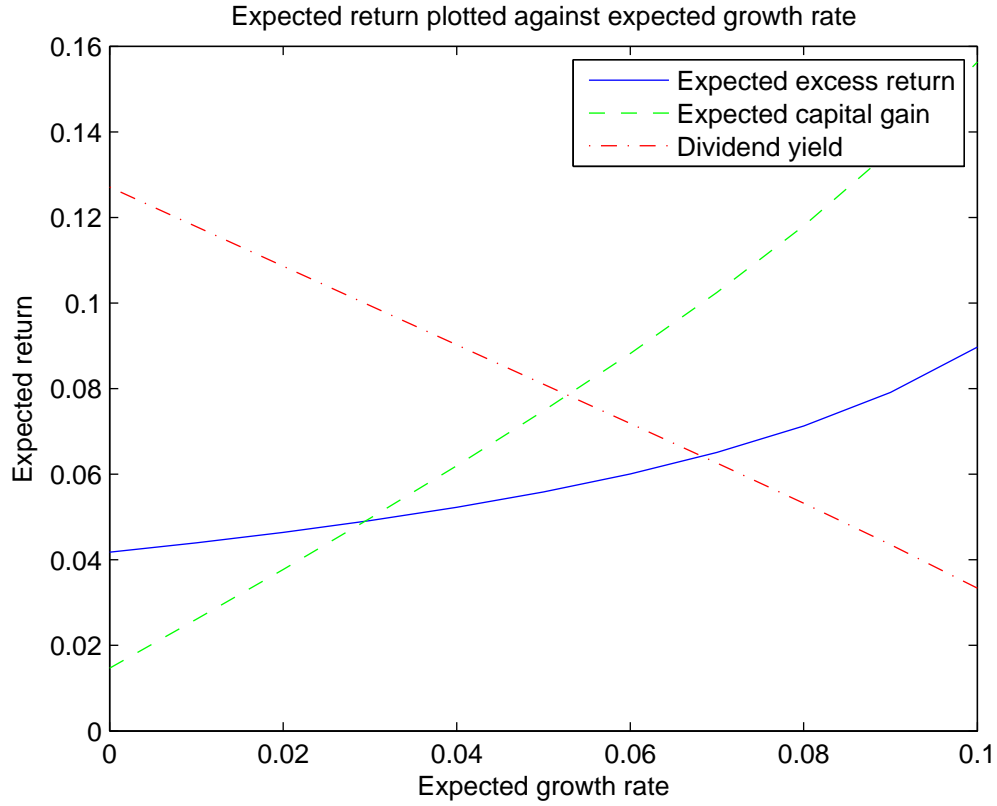


Figure 10: **Plot of the expected excess return, the expected capital gain, and the dividend yield against the expected dividend growth rate g under Model 1 when the term structure of equity returns is upward sloping.** In Model 1, the pricing kernel M_t follows $\frac{dM_t}{M_t} = -r dt - x_t dB_t^M$, where x_t , the market price of risk, is mean reverting and follows $\frac{dx_t}{x_t} = \phi_x(\bar{x} - x_t)dt - \sigma_x dB_t^M$. The stock's dividend process is assumed to follow $\frac{dD_t}{D_t} = g dt + \sigma_D^M dB_t^M + \sigma_D^Z dB_t^Z$, where B_t^Z is orthogonal to B_t^M . The parameter values used here are: $x_t = 0.3$, $\sigma_D^M = 0.005$, $\phi_x = 5.05$, $\sigma_x = -5$, $\bar{x} = 0.3$, $r = 0.10$.

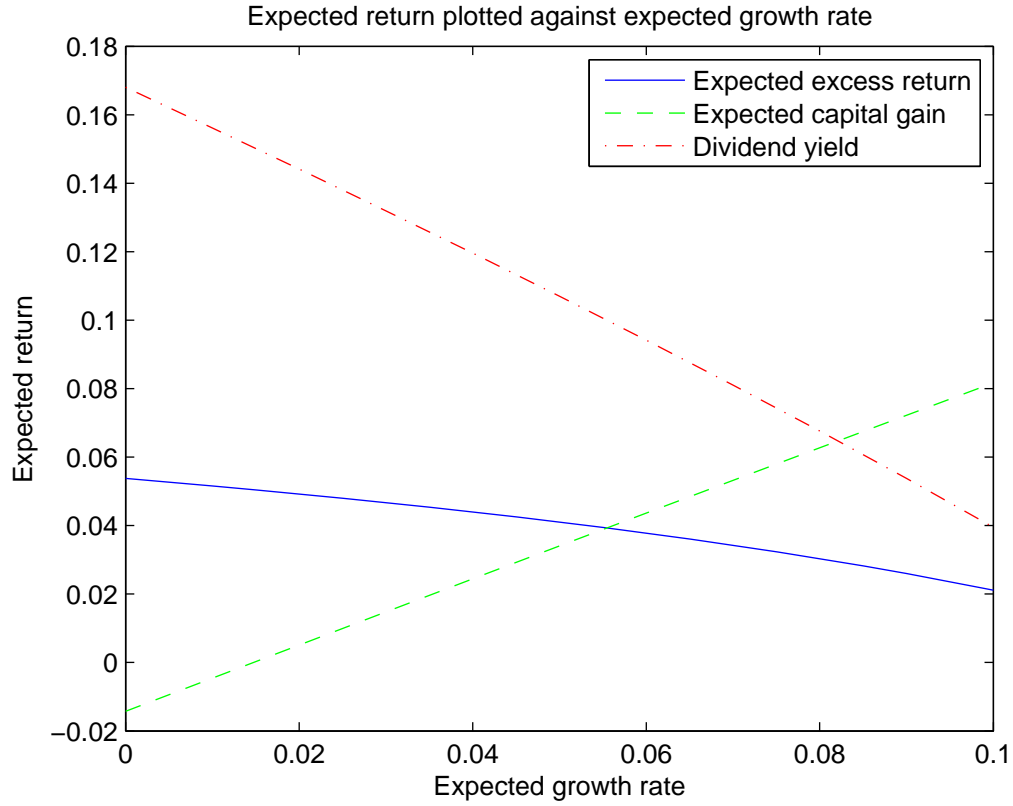


Figure 11: **Plot of the expected excess Return, the expected capital gain, and the dividend yield against the expected dividend growth rate g under Model 1 when the term structure of equity returns is downward sloping.** In Model 1, the pricing kernel M_t follows $\frac{dM_t}{M_t} = -r dt - x_t dB_t^M$, where x_t , the market price of risk, is mean reverting and follows $\frac{dx_t}{x_t} = \phi_x(\bar{x} - x_t)dt - \sigma_x dB_t^M$. The stock's dividend process is assumed to follow $\frac{dD_t}{D_t} = g dt + \sigma_D^M dB_t^M + \sigma_D^Z dB_t^Z$, where B_t^Z is orthogonal to B_t^M . The parameter values used here are: $x_t = 0.6$, $\sigma_D^M = 0.2$, $\phi_x = 0.01$, $\sigma_x = 0.2$, $\bar{x} = 0.6$, $r = 0.10$.

Table 1: Regressions of firm level dividend growth rates on lagged book-to-market ratios. $\log(D_{i,t}/D_{i,t-1}) = b_0 + b_1 \log(B/M)_{i,t-k} + \epsilon_{i,t}$. I follow the Fama-MacBeth procedure. Newey-West t-stat with automatically selected number of lags are reported. $D_{i,t}$ is the dividend from July of year $t - 1$ to June of year t computed from CRSP. Variables are winsorized at 1% and 99% in each year. Years negative refers to the number of years in which the coefficient b_1 is negative.

k	$\log(BM)_{i,t-k}$	Years negative	Number of years	years	Avg. Obs.	Adj. R^2
1	-0.097 (-9.45)	46	46	1965-2010	1186.30	3.72%
2	-0.055 (-8.04)	45	46	1965-2010	1136.07	1.32%
3	-0.037 (-6.88)	39	45	1966-2010	1093.36	0.75%
4	-0.029 (-6.29)	38	44	1967-2010	1049.57	0.52%
5	-0.026 (-5.37)	33	43	1968-2010	1005.19	0.42%
6	-0.023 (-4.37)	32	42	1969-2010	962.71	0.40%
7	-0.021 (-5.16)	31	41	1970-2010	921.34	0.29%
8	-0.019 (-5.14)	31	40	1971-2010	881.18	0.28%
9	-0.016 (-3.91)	29	39	1972-2010	842.23	0.28%
10	-0.016 (-3.22)	28	38	1973-2010	804.39	0.31%

Table 2: Transition matrix. Cell (i, j) in this table reports the probability (average percentages) of a stock belonging to book-to-market Decile j or exiting ($j = 11$) in year $t + 1$, conditionally on it belonging to Decile i in year t . Each row adds up to 100. I average across 47 portfolio formation years t from 1963 to 2009. Book-to-market breakpoints from NYSE are used.

$Decile_t$	$Decile_{t+1}$										
	Growth	2	3	4	5	6	7	8	9	Value	Exit
Growth	56.24	16.92	6.79	3.55	2.02	1.70	0.98	0.83	0.61	0.63	9.74
2	19.05	30.35	18.76	10.36	5.28	3.57	2.20	1.59	1.12	0.93	6.78
3	7.79	17.78	23.03	18.34	10.38	6.80	4.16	2.44	1.51	0.96	6.81
4	4.11	8.31	15.56	20.48	17.46	11.18	6.57	4.59	2.75	1.58	7.41
5	2.52	4.92	9.15	14.77	18.37	17.38	11.98	7.20	4.28	2.16	7.26
6	1.98	3.06	5.25	8.93	14.51	18.71	17.93	12.41	7.20	3.06	6.97
7	1.36	1.88	3.13	5.69	9.42	14.13	19.71	19.29	12.36	5.68	7.36
8	1.17	1.15	1.96	3.15	5.29	8.42	15.84	23.18	22.18	10.71	6.96
9	0.93	0.93	1.25	1.93	2.79	4.81	8.38	16.93	29.17	24.93	7.95
Value	0.69	0.59	0.71	1.00	1.28	1.82	3.09	6.20	15.24	56.75	12.65

Table 3: Regressions of firm level dividend growth rates on lagged book-to-market ratios revisited. $\log((D_{i,t} + dl_{i,t})/D_{i,t-1}) = b_0 + b_1 \log(B/M)_{i,t-k} + \epsilon_{i,t}$. I follow the Fama-MacBeth procedure. Newey-West t-stat with automatically selected number of lags are reported. $D_{i,t}$ is the dividend from July of year $t - 1$ to June of year t computed from CRSP. $dl_{i,t}$ is the delisting proceeds for a firm that is delisted in that year. Variables are winsorized at 1% and 99% in each year. Years negative refers to the number of years in which the coefficient b_1 is negative.

k	$\log(BM)_{i,t-k}$	Years negative	Number of years	years	Avg. Obs.	Adj. R^2
1	-0.093 (-5.99)	42	46	1965-2010	1201.87	1.17%
2	-0.020 (-1.99)	31	46	1965-2010	1151.61	0.31%
3	0.000 (0.03)	25	45	1966-2010	1108.27	0.23%
4	0.011 (1.07)	22	44	1967-2010	1064.16	0.18%
5	0.024 (2.10)	18	43	1968-2010	1019.28	0.17%
6	0.022 (2.01)	18	42	1969-2010	975.64	0.13%
7	0.021 (1.67)	17	41	1970-2010	933.80	0.15%
8	0.026 (1.81)	16	40	1971-2010	892.98	0.21%
9	0.028 (2.20)	14	39	1972-2010	853.54	0.19%
10	0.031 (2.27)	12	38	1973-2010	815.29	0.18%

Table 4: Duration from regressions. I report the coefficient b_1 in the following regressions: $r_{t+1} = b_0 + b_1pd_t + b_2\Delta d_{t+1} + \dots + b_{s+1}\Delta d_{t+s} + \epsilon$. Annual (from July to the next June) log returns, log price dividend ratios, and log dividend growth rates are used. The data used are from 1963 and 2010. In regression 1, no dividend growth rates are included. In regression 2, Δd_{t+1} is included. In regression 3, Δd_{t+1} through Δd_{t+5} are included. b_1^i and Dur^i refer to the b_1 coefficients and the implied duration $Dur^i = -1/b_1^i$. Superscript i refers to the regression model. Regressions are estimated for each value-weighted book-to-market decile. Newey-West t -statistics with automatically selected lags are provided.

	b_1^1	t-stat	Dur^1	b_1^2	t-stat	Dur^2	b_1^3	t-stat	Dur^3
Growth	-0.17	(-2.28)	5.74	-0.20	(-2.29)	4.90	-0.20	(-3.51)	4.96
2	-0.12	(-2.12)	8.06	-0.15	(-3.11)	6.48	-0.14	(-2.24)	7.31
3	-0.10	(-2.02)	10.23	-0.09	(-1.69)	10.65	-0.09	(-1.70)	10.70
4	-0.09	(-2.06)	10.65	-0.09	(-1.89)	10.83	-0.10	(-1.55)	10.28
5	-0.06	(-1.17)	17.51	-0.08	(-1.97)	11.91	-0.07	(-1.46)	15.36
6	-0.05	(-0.99)	22.18	-0.07	(-1.52)	15.28	-0.07	(-1.43)	15.30
7	-0.12	(-2.58)	8.11	-0.13	(-3.01)	7.70	-0.13	(-2.66)	7.94
8	-0.07	(-2.80)	14.54	-0.09	(-2.58)	11.75	-0.07	(-2.21)	13.94
9	-0.11	(-2.23)	8.93	-0.11	(-2.28)	9.27	-0.10	(-3.12)	10.26
Value	-0.04	(-0.83)	27.88	-0.05	(-1.28)	19.18	-0.04	(-1.25)	27.07
Value-Growth	0.14	(1.56)	22.13	0.15	(1.66)	14.28	0.16	(2.00)	22.11

Table 5: Duration implied from the Binsbergen-Koijen system. The Binsbergen-Koijen Kalman filter present value system is estimated for each value-weighted book-to-market decile. Annual (from July to the next June) log returns (r_t), log price dividend ratios (pd_t), and log dividend growth rates are used. The data used are from 1963 and 2010. $\rho = PD/(1 + PD)$, where PD is the exponential of the average pd . ϕ_μ is the persistence coefficient for the expected return μ_t . Note that $\mu_{t+1} = b_0 + \phi_\mu \mu_t + \epsilon^\mu$. s.e. is the standard error. $Dur^{KF} = \frac{1}{1 - \rho \phi_\mu}$. It is the Kalman-filter based duration measure. $\sigma(\epsilon^\mu)$ is the standard deviation of ϵ^μ . $\sigma(\mu)$ is the unconditional standard deviation of μ_t , which is equal to $\sigma(\epsilon^\mu)/\sqrt{1 - \phi_\mu^2}$. σ_{disc} is the return standard deviation caused by changes in discount rates, which is equal to $Dur^{KF} \sigma(\mu)$.

	Avg. log(P/D)	ρ	ϕ_μ	s.e.	Dur^{KF}	$\sigma(\epsilon^\mu)$	s.e.	$\sigma(\mu)$	σ_{disc}
Growth	4.245	0.986	0.853	(0.0706)	6.273	0.043	(0.0190)	0.082	0.517
2	3.869	0.980	0.864	(0.0606)	6.487	0.035	(0.0130)	0.069	0.446
3	3.760	0.977	0.935	(0.0576)	11.570	0.020	(0.0131)	0.057	0.661
4	3.628	0.974	0.918	(0.0587)	9.446	0.021	(0.0120)	0.054	0.506
5	3.535	0.972	0.942	(0.0509)	11.773	0.019	(0.0114)	0.056	0.658
6	3.466	0.970	0.963	(0.0458)	15.183	0.014	(0.0093)	0.052	0.783
7	3.445	0.969	0.915	(0.0435)	8.825	0.024	(0.0111)	0.060	0.526
8	3.462	0.970	0.943	(0.0380)	11.630	0.021	(0.0089)	0.062	0.719
9	3.528	0.971	0.916	(0.0490)	9.113	0.025	(0.0127)	0.063	0.575
Value	3.700	0.976	0.967	(0.0365)	17.770	0.015	(0.0100)	0.057	1.016

Table 6: Estimates from the simplified VAR. The simplified VAR is estimated for each value-weighted book-to-market decile. The simplified VAR refers to the following two equations: $r_{t+1} = intercept + b_r pd_t + \epsilon^r$ and $pd_{t+1} = intercept + \phi_{pd} pd_t + \epsilon^{pd}$. Annual (from July to the next June) log returns (r_t) and log price dividend ratios (pd_t) are used. The data from 1963 and 2010 are used. $\sigma(pd)$ is the standard deviation of the log price dividend ratio. $\sigma(\mu)$ refers to the implied standard deviation of the discount rate, which is equal to $|b_r| \sigma(pd)$. Newey-West t -statistics with automatically selected lags are provided.

	ϕ_{pd}	t-stat	$\sigma(pd)$	b_r	$\sigma(\mu)$
Growth	0.719	(5.71)	0.380	-0.174	0.066
2	0.796	(10.45)	0.393	-0.124	0.049
3	0.763	(9.47)	0.409	-0.098	0.040
4	0.796	(9.92)	0.439	-0.094	0.041
5	0.828	(10.32)	0.466	-0.057	0.027
6	0.871	(12.50)	0.489	-0.045	0.022
7	0.843	(10.29)	0.508	-0.123	0.063
8	0.901	(15.19)	0.553	-0.069	0.038
9	0.740	(5.73)	0.593	-0.112	0.066
Value	0.818	(10.73)	0.699	-0.036	0.025
Value-Growth	0.099	(0.72)	0.319	0.138	-0.041

Table 7: Fama-MacBeth regressions of value-weighted returns on durations and cash-flow risk between 1963Q3 and 2010Q2. 20 book-to-market equity portfolios are used. The left hand side variable is the quarterly real returns multiplied by 4. $\bar{g}_{i,t-1}$ is the average annual real dividend growth rate of the rebalanced portfolio i . Dur^{RB} and Dur^{KF} are the regression-based (regression 2) and Kalman-filter based durations (see procedures described in Tables 4 and 5). γ_i^8 and γ_i^{12} are cash-flow risk, measured from the regression $\log(1 + g_{i,t}) = \gamma_i^K \left(\frac{1}{K} \sum_{k=1}^K \log(1 + g_{c,t-k}) \right) + \epsilon_{i,t}$, for $K = 8, 12$, using all information between 1963 Q3 and 2010 Q2. Here $g_{i,t}$ is the quarterly real dividend growth rate, and $g_{c,t-k}$ is the quarterly real consumption growth rate.

	Duration	γ_i^8	γ_i^{12}	# Portfolios	Avg. R^2
<hr/>					
<i>Duration = $\bar{g}_{i,t-1}$</i>					
1	0.42 (2.01)			20	13.50%
2		0.003 (2.06)		20	8.83%
3			0.0011 (1.09)	20	6.14%
4	0.36 (1.88)	0.0017 (1.44)		20	19.10%
5	0.43 (2.08)		0.0007 (0.78)	20	19.18%
<hr/>					
<i>Duration = Dur^{RB}</i>					
6	0.0014 (2.01)			20	9.66%
7	0.0011 (1.82)	0.0024 (1.84)		20	16.50%
8	0.0013 (1.99)		0.0005 (0.55)	20	14.81%
<hr/>					
<i>Duration = Dur^{KF}</i>					
9	0.0019 (2.13)			20	8.69%
10	0.0017 (2.05)	0.0027 (1.96)		20	16.74%
11	0.0018 (2.12)		0.0009 (0.88)	20	14.39%

Table 8: Fama-MacBeth regressions of equal-weighted returns on durations and dividend betas between 1963 Q3 and 2010 Q2. 20 book-to-market equity portfolios are used. The left hand side variable is the quarterly real returns multiplied by 4. $\bar{g}_{i,t-1}$ is the average annual real dividend growth rate of the rebalanced portfolio i . Dur^{RB} and Dur^{KF} are the regression-based (regression 2) and Kalman-filter based durations (see procedure described in Tables 4 and 5). γ_i^8 and γ_i^{12} are cash-flow risk, measured from the regression $\log(1 + g_{i,t}) = \gamma_i^K \left(\frac{1}{K} \sum_{k=1}^K \log(1 + g_{c,t-k}) \right) + \epsilon_{i,t}$, for $K = 8, 12$, using all information between 1963Q3 and 2010Q2. Here $g_{i,t}$ is the quarterly real dividend growth rate, and $g_{c,t-k}$ is the quarterly real consumption growth rate.

	Duration	γ_i^8	γ_i^{12}	# Portfolios	Avg. R^2
<hr/> <i>Duration = $\bar{g}_{i,t-1}$</i> <hr/>					
1	0.75 (4.82)			20	26.05%
2		0.0114 (4.89)		20	18.77%
3			0.0079 (5.17)	20	11.11%
4	0.68 (4.83)	0.0031 (2.44)		20	30.78%
5	0.72 (4.60)		0.0026 (2.30)	20	31.64%
<hr/> <i>Duration = Dur^{RB}</i> <hr/>					
6	0.0008 (3.85)			20	15.47%
7	0.0005 (3.09)	0.0096 (4.92)		20	28.73%
8	0.0009 (4.19)		0.0097 (5.31)	20	29.63%
<hr/> <i>Duration = Dur^{KF}</i> <hr/>					
9	0.0040 (5.08)			20	19.80%
10	0.0028 (4.87)	0.0065 (4.10)		20	26.71%
11	0.0035 (4.61)		0.0035 (3.20)	20	25.32%

Table 9: Fama-MacBeth regressions of standard deviation of returns on duration measures between 1964 and 2010. The left hand side variable is the annualized standard deviation of monthly returns. $\bar{g}_{i,t-1}$ is the average annual real dividend growth rate of the rebalanced portfolio i . Dur^{RB} and Dur^{KF} are the regression-based (regression 2) and Kalman-filter based durations from Tables 4 and 5. $\sigma(\Delta d)$ is the standard deviation of the previous five years' quarterly dividend growth rates. $\sigma(\mu)$ is the standard deviation of the discount rates from the Binsbergen-Koijen system (Table 5). σ_{disc} is the return standard deviation caused by changes in discount rates. 20 value-weighted book-to-market equity portfolios are used. Newey-West t -statistics with automatically selected lags are provided.

	Duration	$\sigma(\Delta d)$	$\sigma(\mu)$	σ_{disc}	Obs.	Avg. R^2
<hr/> <i>Duration = $\bar{g}_{i,t-1}$</i> <hr/>						
1	0.2800 (3.08)				20	15.16%
2		0.0626 (2.18)			20	8.67%
3	0.2308 (2.63)	0.0371 (1.68)			20	21.58%
<hr/> <i>Duration = Dur^{RB}</i> <hr/>						
4	0.0007 (2.47)				20	7.40%
5	0.0005 (2.14)	0.0640 (2.34)			20	15.13%
<hr/> <i>Duration = Dur^{KF}</i> <hr/>						
6	0.0008 (2.24)				20	6.11%
7	0.0006 (1.90)	0.0661 (2.34)			20	14.33%
8	0.0008 (2.62)	0.0588 (2.18)	0.3711 (4.78)		20	21.04%
9	0.0009 (2.59)	0.0429 (1.76)	0.5155 (5.50)	0.0710 (2.56)	20	21.91%